PROJECT MANUAL

IHS WHITERIVER HOSPITAL

Prepared for: INDIAN HEALTH SERVICE

100% CONSTRUCTION DOCUMENTS
Project No: 14904.000
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VOLUME 4

Prepared by:

SMITHGROUP

PHOENIX, ARIZONA

IHS REVIEW AND APPROVAL

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DOCUMENT 000107 - SEALS PAGE

Include on this Seals Page Document the seals of the design professionals of record required by statute to affix their seal to the documents. Where required, include a description of the Specification Sections prepared under the direction of each design professions *EDIT FOR YOUR PROJECT-USE DIVISION AND/OR SECTION NUMBERS*. If such listing is required, you may alternatively use the MasterSpec seals page instead of this SmithGroup seals page.

Architect SmithGroup, Inc. Phoenix, AZ Matthew Hess, AIA, NCARB Responsible for Divisions 01-49 Sections except where indicated as prepared by other design professionals of record. 	Structural Engineer PK Associates and Pimara Paul Koehler Scottsdale, Arizona Christa Chau, PE, SE Responsible for: Division 03, Sections 030000 and 032000; Division 04, Section 042000; Division 05, Sections 051200 and 053100; and Division 31, Section 316329
Civil Engineer Dibble & Associates Consulting Engineers, Inc. Phoenix, Arizona Christina Shannon Mauck, PE Responsible for: Division 01, Section 015713, Division 02, Section 024100, Division 09, Section 099713, Division 31, Sections 312213, 312300, 312316.16, 312323.13, 312333, 312500, Division 32, Sections 321123, 321216, 321313, 321315, Division 33, Sections 331000, 331623, 333000, 333213, 333723, 334213 	Fire Protection Engineer SmithGroup, Inc. Phoenix, AZ Andrew Ochsankehl, PE Responsible for: Division 13, Section 131200*; Division 21, Sections 211300, 213000, 210533; Division 27, Section 273226; Division 28, Section 283111 *Fire Protection Related Requirements Only

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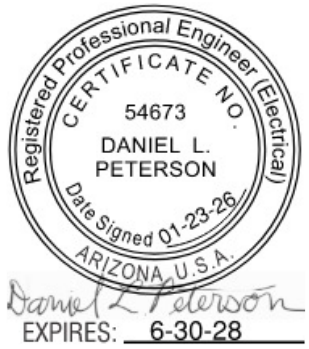
Responsible for: Division 26, except for those Sections labeled with “WWTP”



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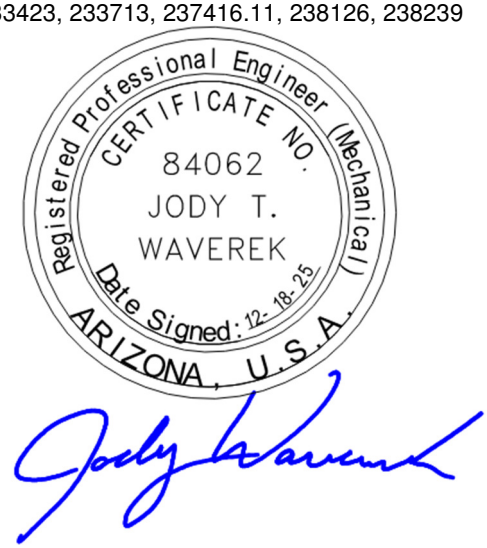
Plumbing Engineer Morrison-Maierle Phoenix, Arizona Jody Waverek, PE Responsible for plumbing specifications for the WWTPs: Division 22: 220517, 220518, 220519, 220523.12, 220523.14, 220529, 220548, 220553, 220719, 221116, 221119, 221123, 221123.13, 221316, 221429, 223300, 224213.13, 224213.16, 224216.13, 224216.16, 224223, 224500 	Mechanical Engineer Morrison-Maierle Phoenix, Arizona Jody Waverek, PE Responsible for mechanical specifications for the WWTPs: Division 23: 230513, 230529, 230548, 230553, 230593, 230713, 230716, 230900, 233113, 233300, 233423, 233713, 237416.11, 238126, 238239 

Environmental Engineer Morrison-Maierle Phoenix, Arizona Ulrike Lashley, PE Responsible for the following specifications for the WWTPs: Division 09: 099600; Division 10: 101400.01, 104352; Division 40: 400205, 400510, 400510.03, 400510.04, 400510.09, 400510.12, 400510.13, 400510.30, 400553, 400555, 400557, 406110, 406115, 406116, 406120, 406120.01, 406120.02, 406120.03, 406120.04, 406121, 406124, 406127, 406128, 406140, 406160, 406171, 406176, 406177, 406180, 406181, 406182, 406191; Division 41: 413313.17; Division 43: 431030, 431111, 432256, 432321, 432331, 432331.01, 432358, 433230, 433269, 434010; Division 46: 460754, 460754.01, 460754.02, 460754.03, 460754.04, 460754.05, 460754.06, 460754.07, 460754.08, 460754.09, 460754.10, 461155, 461155.01, 461155.02, 461155.03, 461155.04, 462113, 462113.01, 462113.02, 462113.03, 465035, 465035.01, 465035.02, 465131, 465131.01, 465131.02 	Hazardous Building Materials Mabbett & Associates, Inc. Stoneham, Massachusetts Michael Delaney, Asbestos Designer Responsible for: 028200, 028313

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PART 1 - GENERAL

1.1 SUMMARY

A. Design Intent:
   1. The Contract Documents indicate and specify the electrical design intent. The Contract Drawings are schematic and diagrammatic and are not intended to indicate construction details and routing unless specifically indicated. The specifications establish minimum performance, product and installation requirements.
   2. In addition to the specified and indicated performance and quality requirements, furnish products and perform installation work consistent with the design intent, industry standards and as necessary to the provision of complete operating electrical systems.
   3. Install electrical work in accordance with the National Electrical Code and all applicable local codes in a neat and workmanlike manner.
   4. This Section specifies basic electrical requirements applicable to all Divisions unless explicitly excepted.
   5. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
   6. Contractor shall thoroughly review entire set of Contract Documents, including all discipline drawings and specifications prior to bidding and include all required electrical work in bid, even if not explicitly shown on electrical Drawings and Specifications.
   7. The project is pursuing LEED certification. Contractor shall provide requirements in compliance with LEED standards as identified in the Contract Documents.

1.2 REFERENCES

A. Codes and Standards indicated in General Sheets.

B. American National Standards Institute (ANSI) C2 - National Electrical Safety Code.

C. National Electrical Contractors Association (NECA).
   1. 1 - Standard for Good Workmanship in Electrical Construction.
   2. 500 - Recommended Practice for Installing Indoor Commercial Lighting Systems.

D. National Fire Protection Association (NFPA).
   1. 70 - National Electrical Code (NEC).
   2. 70E - Standard for Electrical Safety in the Workplace.
   3. 72 - National Fire Alarm and Signaling Code.
   4. 99 - Healthcare Facilities Code
   5. 101 - Life Safety Code.
   6. 111 - Standard for Stored Electrical Energy Emergency and Standby Power Systems.

E. Leadership in Energy and Environmental Design (LEED).
   1. Interior Design and Construction (ID+C) v4 - Commercial Interiors.

1.3 Submittals

A. General
1. Submit Shop Drawings, Product Data, Samples and other specified submittals on a "system" basis. Retain, and assemble drawings and data from manufacturer or component manufacturers such that each submittal is for a complete system.
2. Refer to Section 013300, "Shop Drawings, Product Data and Samples", for basic definitions and requirements for submittals.
3. Refer to Section 013330 for submittal compliance form.

B. Contract Closeout Submittals
1. Refer to Division 01, "Record Documents", for basic definitions and requirements for record documents.

1.4 Quality Assurance

A. Owner Construction Design Standards
1. Provide an electrical installation in accordance with the Owner's construction design standards and specifications, unless specific written waivers are provided by the Owner.

B. Regulatory Requirements
1. Comply with the applicable requirements of ANSI C2 and the latest NFPA 70.
2. Comply with applicable requirements of city, county, and state laws, ordinances and regulations including modifications and supplements to ANSI C2 and NFPA 70.
3. Comply with the applicable requirements of U.S.Department of Labor, Occupational Safety and Health Administration Standards (OSHA).
4. All materials shall conform with the standards of the Underwriter¢¢s Laboratories in every case where such standards have been established for the particular type of material or assembly .
5. All material and equipment shall be UL listed and bear the UL label where such listing and labeling exists.
6. In the case where two or more Codes conflict or contradict each other, comply with the more stringent Code or standard.

C. Contractor Qualifications and Character of Work
1. Contractor personnel must be knowledgeable in local, state and national codes and regulations. Contractor shall have been in the business of installing electrical systems for a minimum of ten (10) years.
2. Contractor must possess and maintain current liability insurance certificates.
3. Contractor shall obtain and pay for all permits and inspections required by laws, local ordinances, rules, and regulations having jurisdiction for the work. Permits shall be readily available and posted in a prominent place at building site and protected from weather and physical damage.
4. The installation shall be executed in a workmanlike manner and shall present a neat physical appearance when completed.

1.5 PROJECT/SITE CONDITIONS

A. Environmental Requirements
1. Provide products suitable for operation under the following environmental conditions:

a. Temperature: -18 to 38 degrees C (0 to 100 degrees F).
b. Humidity: 0 to 95 relative percent, non-condensing.
c. Altitude: 2010 meters (6600 feet) above sea level.
d. Outdoor: Products that are UL listed for wet locations.

1.6 WARRANTIES

A. Refer to the Conditions of the Contract for provisions concerning Contract general warranty, Statements of Compliance, correction of Work period, and form of Special Warranty.

B. All electrical systems, equipment and installations shall be provided with a one-year minimum Warranty starting from the date of substantial completion.

C. During the warranty period, and for non-conformities the contractor shall take all necessary and appropriate action; free of charge, to correct any non-conformity with the warranties contained in the manufacturer agreement. During the warranty period, contractor shall provide to Owner, free of costs and charges, all support necessary to ensure that the installation meets the requirements specified in the Contract Documents and performance guarantees provided by the contractors. During the warranty period, contractors shall furnish, or cause to be furnished, all maintenance, service, parts and replacements necessary to maintain the installation in good working condition, at no cost to Owner.

1.7 CONDUCTOR SIZING

A. Feeder and Branch Circuit Sizing
1. Provide feeder and branch circuits per the circuit sizing schedules indicated on Drawings. Where schedules are not indicated, provide conductors which are sized as required per the NEC for the indicated overcurrent protective device rating. Circuit sizing and installation shall consider the field routing and anticipated voltage drop. Upsize wire, as necessary, to compensate for voltage drop and/or other forms of derating required in accordance with the NEC.
2. Derate conductor ampacities per the NEC for field conditions including but not limited to conduits exposed to sunlight, elevated ambient temperature, and/or more than 3 current carrying conductors in a raceway.

1.8 SYSTEMS INTEGRATION

A. Coordinate with equipment suppliers and ensure integration of systems comprised of disparate equipment which work together to form a complete system.

B. Provide all miscellaneous components, wiring, hardware, etc. required for complete and operational equipment and systems whether or not these items are explicitly shown in the Contract Documents.

C. Provide systems which maintain the UL rating of the individual pieces of equipment.

D. Submit system integration wiring diagrams, control diagrams and sequence of operation, as needed.

1.9 COORDINATION

A. Contractor shall participate in the project scheduling, coordination meetings and coordination drawing/modeling activities as specified in Division 01.

B. All potential coordination issues shall be brought to the attention of the Construction Manager immediately before proceeding with the installation.

C. Contractor shall be responsible for all cross connecting and coordination with vendors and other trade contractors to provide complete operational systems.

D. For purpose of clarify and legibility, drawings are diagrammatic. Locate equipment as close as practical to the locations shown on the drawings. Should field conditions prevent the installation of equipment or materials as indicated on the drawings, make deviations only with the prior approval of the Owner's representative.

E. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping at required slope.
   4. To allow connecting raceways, cables, wireways, cable trays, and busways to be clear of obstructions and of the working and access space of other equipment.

F. Coordinate work with other trades to ensure completion is consistent with the project schedule. Ensure the NEC-required working space and dedicated electrical space about electrical equipment is provided. Foreign systems shall not be located within these dedicated zones. Any work that encroaches on the working space or dedicated electrical space shall be relocated at the Contractor's expense.

G. Equipment and device mounting heights and alignment shall adhere to architectural drawings, rules and requirements. Devices of all trades within the same general area shall be coordinated prior to construction. Care shall be taken to align devices horizontally and vertically. Devices that are not aligned properly shall be relocated at the Contractor's expense.

H. Coordinate exact conduit routing in the field with other trades and with building elements such as structural steel members. Conduit and raceways are not explicitly shown. Conduit routing where shown on drawings shall be considered approximate. Contractor shall be responsible for final routing in the field and shall be responsible for complete coordination with all other trades.

I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

J. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8.

K. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

PART 2 - PRODUCTS

2.1 Manufacturers

A. General

1. Furnish products by one of the equipment manufacturers listed under the heading "Manufacturers" within the applicable sections. When given, furnish the specified product model or brand for the selected manufacturer.
2. Provide products, for which quantities of two or more are to be furnished, from the same manufacturer and of the same product or model series.
3. Furnish product components designed to be used together and which are physically and electrically compatible.

B. Comparable Products
1. Comparable products may be proposed when the "or as approved" clause is specified under the heading "Manufacturers". Submit such products substitutions for approval per Division 01, "Product Requirements.• •

C. Product Substitutions
1. Product substitutions may be requested under the conditions specified in Division 01 'Substitution Procedures'.• • Submit product substitutions for consideration per Division 01, "Substitution Procedures".

2.2 Products

A. Product Listing and Labeling
1. Provide listed and labeled product for which listings and labels exist by Underwriters Laboratories Inc. (UL), Factory Mutual (FM), or similar independent testing organizations recognized by the authorities having jurisdiction. For products for which there are no such listings and labels, provide listed and labeled components of those products, for which component listing and labels exist.

B. PCB Content Prohibited
1. Provide products which do not contain any amounts of polychlorinated biphenyl (PCB) compounds.

C. Lead Limits
1. Electrical wire and cable to have lead content less than 300 parts per million.

D. Asbestos Content Prohibited
1. Provide products which do not contain any amounts of asbestos.

E. Access Doors
1. Provide access doors necessary to access devices, whether for control or maintenance, governed by these Basic Electrical Materials and Methods. Comply with access door requirements specified in Division 08. Access doors are not explicitly shown on the Drawings.
2. Access doors shall be coordinated with other trades and final locations shall be approved by Architect. Access doors not approved by Architect shall be removed or relocated at the Contractors expense.
3. Access doors installed in fire rated floors, walls or ceilings shall be sufficiently rated to maintain the rating of the surface where installed.

2.3 Source Quality Control

A. Factory Tests
1. Permit Architect and Owner to observe factory tests. Provide minimum five working 14 days notice of factory tests.
2. Schedule no more than one equipment or system factory test per week.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHASING

A. The project will utilize phased construction. Contractor shall account for any and all costs associated with a phased construction schedule in bid.

3.2 SHUTDOWNS

A. Interruption of Existing Service: Do not interrupt electric, communications or fire alarm 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 Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of service.
   2. Indicate method of providing temporary service.
   3. Do not proceed with interruption of service without Architect's, Construction Manager's and Owner’s written permission.
   4. Comply with NFPA 70E.

B. Coordinate all service interruptions with other disciplines and Owner's representative. Shutdowns shall be performed during off hours, which may include weekends or holidays. This premium time cost shall be included in the Contractor's base bid.

C. Maintain Owner communications and network services operations during construction. Coordinate all service interruptions with other disciplines and Owner's representative.

D. Maintain Owner fire alarm systems and services operations during construction. Coordinate all service interruptions with other disciplines and Owner's representative.

3.3 DEMOLITION

A. Protect adjacent building services and materials indicated to remain. Install and maintain barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition is complete.

B. “Carefully remove, clean and restore and reinstall items that are relocated during construction to a "like new" condition.

C. Building elements such as walls, partitions, floors and ceilings affected by electrical construction such as conduit penetrations shall be repaired, patched, painted and otherwise restored to a "like new" condition.

D. Lamp and Ballast Recycling.
   1. Recycle lamps, ballasts and drivers containing hazardous materials such as mercury during construction. These shall include tubular fluorescent, compact fluorescent, HID, LED, induction and cold cathode lamps. These lamp types, ballasts and drivers associated with these lamps shall not be disposed of as solid municipal waste.

E. Equipment Protection and Cleanup.
   1. Protect equipment and materials during shipment, storage and construction against damage, dust and contamination. Items that become damaged, dirty or contaminated during construction shall be restored to a "like new" condition or replaced at the Contractor's expense.

2. Remove and legally dispose of demolished items, rubbish, debris and construction waste from the construction site daily, and at the completion of the work. The contractor shall maintain a "clean" work site. Failure to do so may result in the cleanup being performed by others and all costs thereof being deducted from the Contractor's final payment.

3.4 TEMPORARY SERVICE

A. The facility will remain operational during construction. Provide equipment, hardware, wiring, etc. to maintain systems scheduled to remain operational during construction. Coordinate detailed work phasing plans with the Construction Manager, Architect and Owner prior to commencing work.

B. Provide, maintain and remove all temporary lighting, power and communications required to complete the project.
   1. Coordinate temporary service installation with the local utility companies and building landlord prior to construction.

C. In addition to NEC ground fault protection requirements, provide ground fault protection on temporary feeders 200 amps and greater.

D. Temporary feeders shall be limited to the following types:
   1. Conductors installed in raceways.
   2. Type MC cable.
   3. Multi-conductor cable with an overall protective outer jacket (where inaccessible to the public and not subject to physical damage or abuse).
   4. NEC recognized hard usage cord (where inaccessible to the public and not subject to physical damage or abuse).
   5. Label temporary feeders every 25 feet maximum

3.5 INSTALLATION

A. General
   1. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless otherwise indicated.
   2. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
   3. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
   4. Right of Way: Give to piping systems installed at a required slope.

B. Wiring Installation
   1. Install wiring for control systems, power feeder and branch circuits, lighting branch circuits, communication and auxiliary systems, such as fire alarm and security, in separate raceways unless otherwise indicated.
   2. Install power system wiring for "Life Safety," "Legally Required Standby," and "Optional Standby," systems in separate raceways.

3. Install wiring and devices and make connections for Owner furnished equipment and furnished under other sections of the specifications such as, but not limited to, automatic doors, projection screens, pneumatic tube stations, casework, medical headwalls, radiation oncology equipment, diagnostic imaging equipment and laboratory equipment. Refer to the specific sections for electrical requirements. Coordinate installation with the equipment supplier and the approved shop drawings.
4. Prior to rough-in of electrical and telecommunications devices, verify locations with the owner's final furniture plans and the system supplier's approved installation drawings. Adjust locations of devices to coordinate with furniture and equipment layouts.

C. Device Location
1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, occupancy sensors, fire alarm devices and access control devices, within a 10-foot radius of indicated location without additional cost.
2. Refer to architectural plans for device location, mounting and alignment rules and requirements. Coordinate all device and lighting fixture placement with other trades prior to rough-in.
3. Devices in proximity to each other shall be horizontally and vertically aligned. Devices which are not aligned properly shall be relocated as required to meet alignment requirements at no cost to Owner.
4. Coordinate device placement and installation with other trades and Architect/Engine#er prior to construction and rough-in.

D. NECA Compliance
1. Install products in accordance with applicable NECA Standards, unless otherwise specified or indicated.

E. Wet, Damp, or Dry Location Work
1. Provide products as appropriate for wet, damp, or dry locations as defined by NFPA 70.

F. Manufacturer Installation Instructions
1. Install equipment in accordance with the manufacturer's installation instructions and recommendations.

G. Fire and Smoke Barrier Penetrations
1. Install firestopping to raceways, boxes and electrical equipment installed in or penetrating fire-rated floor and wall assemblies and smoke barrier assemblies, in a manner which maintains the fire resistance rating or barrier intent.

H. Field Painting
1. Refer to Division 09 for prime and finish field painting requirements.
2. Field paint electrical equipment, products, materials, components and systems where indicated.
3. In a manner approved by the manufacturer and satisfactory to the Owner, touch-up or refinish factory-applied paints or finishes which are chipped, defaced, scratched, or in any other way disturbed due to handling, installation, or general construction work.

I. Exposed Construction

1. Take care in areas where the installation is exposed and visible to the public. Install electrical systems and equipment in an organized fashion and field painted. Mounting surfaces shall be repaired, patched, and painted to provide a "like new" appearance.
2. Coordinate systems (e.g. conduit, cable tray, wiring, duct work, piping, hanger, supports, etc.) prior to installation.

J. Personnel Protection from Suspended Work
1. Where suspended equipment, piping or ductwork or any of their supporting or reinforcing members extend 2.1 meters (7 feet) or less above the floor or any other walking surface, cover all edges, projecting surfaces and sharp corners with pre-fabricated soft rubber pads, elastomeric insulation, caps or equivalent to prevent injury to personnel.

K. Elevator Installation
1. Provide electrical service, wiring, disconnects and an installation that complies with NEC Article 620, ANSI-A17.1, Division 14 . Provide all required electrical work for elevators, even if it is not shown on the electrical drawings, at no additional cost to the owner.

L. Medical Equipment Installation
1. Provide electrical services, circuit breakers, conduit, wire raceways, outlets receptacles, accessories, and other required material for the complete installation of medical equipment such as surgical booms, surgical lights, radiographic systems, documentation stations, and other medical equipment. The equipment manufacturer's design and installation drawings have been included with the contract documents as reference. Coordinate the electrical requirements with the manufacturer's approved installation drawings and provide the necessary materials for a complete installation.

M. Feeder and Branch Circuit Sizing
1. Provide feeder and branch circuit sizing per schedules indicated on drawings.

3.6 ACCEPTANCE TESTING

A. General.
1. Provide necessary test equipment and be responsible for setting-up test equipment, wire checks of factory wiring and any other preliminary work in preparation for the electrical acceptance tests.
2. Perform tests which do not exceed the manufacturer's recommended limit for the equipment being tested.
3. Where required for the validity of tests or safety of equipment and personnel, isolate equipment to be tested from the system.
4. Include the ambient temperature and relative humidity existing at the time when performing insulation resistance, dielectric absorption or high potential tests.
5. Coordinate testing and inspections with commissioning agent.

B. Visual Inspections.
1. Prior to any testing, perform visual inspections to verify the following:
   a. The equipment is completely and properly installed.
   b. The equipment is free from damage and defects.
   c. Shipping blocks and restraints have been removed.`
   d. Electrical terminations are properly tightened.

e. The equipment is properly aligned.
f. The equipment is properly lubricated.
g. The ventilation louvers are open and unobstructed.
h. The equipment is ready to be tested.

C. Manual Operation.
1. Prior to any testing, operate mechanical devices to verify that they function properly and freely.

D. Insulation Resistance Test.
1. Perform test with a voltage source capable of providing a constant direct voltage for the time intervals as specified below.
a. 150 volts and under - 500 volts.
b. 151-600 volts - 1000 volts.
c. Hold 1000-volt and 500-volt insulation resistance tests for a minimum of one minute or until the reading reaches a constant value for 15 seconds unless specified otherwise.
d. Apply tests from phase to ground with the other phases grounded. Test each phase in a similar manner.
e. Check phase matching and phase identification immediately prior to energizing equipment.

E. Fire Alarm System Test.
1. Fire alarm and smoke detector systems shall be tested by operating each pull station and activating all system sensors to verify proper operation.
2. Voice communications systems shall be tested to verify correct operation of all voice inputs and all speakers.

F. Ethernet Systems.
1. A complete test shall be performed per ANSI-TIA-568-C.2 on each cable, end to end. A full test report shall be submitted for each cable in electronic format. Test equipment shall be UL certified for Category 3/5E/6/6A testing, fully compliance with ANSI-TIA-568-C.2 Accuracy Level II, utilizing the most recent version of software for the test equipment. Submit proposed test method and equipment for approval prior to testing.
2. Refer to Division 27 specifications for additional testing requirements.

3.7 Field Quality Control

A. Field Tests
1. Permit Architect and Owner to observe field tests. Provide minimum five working days notice of field test.
2. Schedule tests in coordination with other Contract work. Schedule no more than one equipment or system field test per day.

B. Inspect installed sleeves and firestopping for damage or faulty work. Replace defective installations.

C. Replace any equipment, system or materials found to be defective or found to be of lesser quality than that specified or shown on the Drawings.

3.8 CLEANING

A. Clean electrical equipment and systems to remove dirt, paint or other foreign materials and restore to match original condition and finish upon completion of construction.

3.9 TRAINING

A. General
   1. Provide training for Owner's personnel in the operation and maintenance of equipment as specified in the applicable Section for the particular equipment and system.
   2. Develop training schedule which is acceptable to the Owner. Submit schedule for approval.
   3. Provide instruction books, manuals, and other classroom material required as part of the training sessions.
   4. Provide instructors who are certified by the equipment and system manufacturers.
   5. Provide training for a minimum of three of the Owner's personnel, or as specified in the applicable Section.
   6. Conduct training at Project Site after the equipment/system has been installed.
   7. Conduct classes at the manufacturer's training center, using equipment similar to equipment proposed and at the Project site after initial training at manufacturer's training center and after the equipment has been installed.

B. Operations and Maintenance Training
   1. Train personnel in all aspects of normal operation of the equipment, including starting, adjustments while running, and shutdown.
      a. Train personnel to recognize incipient problems, including inefficient or dangerous modes of operation, and provide instruction in corrective actions to be taken.
   2. Train personnel to perform all recommended maintenance on the equipment.

END OF SECTION

SECTION 260400 - COMMON WORK RESULTS FOR ELECTRICAL - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Design Intent:
1. The Contract Documents indicate and specify the electrical design intent. The Contract Drawings are schematic and diagrammatic and are not intended to indicate construction details and routing unless specifically indicated. The specifications establish minimum performance, product and installation requirements.
2. In addition to the specified and indicated performance and quality requirements, furnish products and perform installation work consistent with the design intent, industry standards and as necessary to the provision of complete operating electrical systems.
3. Install electrical work in accordance with the National Electrical Code and all applicable local codes in a neat and workmanlike manner.
4. This Section specifies basic electrical requirements applicable to all Divisions unless explicitly excepted.
5. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
6. Contractor shall thoroughly review entire set of Contract Documents, including all discipline drawings and specifications prior to bidding and include all required electrical work in bid, even if not explicitly shown on electrical Drawings and Specifications.
7. The project is pursuing LEED certification. Contractor shall provide requirements in compliance with LEED standards as identified in the Contract Documents.

1.2 REFERENCES

A. Codes and Standards indicated in General Sheets.

B. American National Standards Institute (ANSI) C2 - National Electrical Safety Code.

C. National Electrical Contractors Association (NECA).
1. 1 - Standard for Good Workmanship in Electrical Construction.
2. 500 - Recommended Practice for Installing Indoor Commercial Lighting Systems.

D. National Fire Protection Association (NFPA).
1. 70 - National Electrical Code (NEC).
2. 70E - Standard for Electrical Safety in the Workplace.
3. 72 - National Fire Alarm and Signaling Code.
4. 99 - Healthcare Facilities Code
5. 101 - Life Safety Code.
6. 111 - Standard for Stored Electrical Energy Emergency and Standby Power Systems.

E. Leadership in Energy and Environmental Design (LEED).
1. Interior Design and Construction (ID+C) v4 - Commercial Interiors.

1.3 Submittals

A. General
1. Submit Shop Drawings, Product Data, Samples and other specified submittals on a "system" basis. Retain, and assemble drawings and data from manufacturer or component manufacturers such that each submittal is for a complete system.
2. Refer to Section 013300, SUBMITTAL PROCEDURES, for basic definitions and requirements for submittals.

B. Contract Closeout Submittals
1. Refer to Division 01, "Record Documents", for basic definitions and requirements for record documents.

1.4 Quality Assurance

A. Owner Construction Design Standards
1. Provide an electrical installation in accordance with the Owner's construction design standards and specifications, unless specific written waivers are provided by the Owner.

B. Regulatory Requirements
1. Comply with the applicable requirements of ANSI C2 and the latest NFPA 70.
2. Comply with applicable requirements of city, county, and state laws, ordinances and regulations including modifications and supplements to ANSI C2 and NFPA 70.
3. Comply with the applicable requirements of U.S.Department of Labor, Occupational Safety and Health Administration Standards (OSHA).
4. All materials shall conform with the standards of the Underwriter¢¢s Laboratories in every case where such standards have been established for the particular type of material or assembly .
5. All material and equipment shall be UL listed and bear the UL label where such listing and labeling exists.
6. In the case where two or more Codes conflict or contradict each other, comply with the more stringent Code or standard.

C. Contractor Qualifications and Character of Work
1. Contractor personnel must be knowledgeable in local, state and national codes and regulations. Contractor shall have been in the business of installing electrical systems for a minimum of ten (10) years.
2. Contractor must possess and maintain current liability insurance certificates.
3. Contractor shall obtain and pay for all permits and inspections required by laws, local ordinances, rules, and regulations having jurisdiction for the work. Permits shall be readily available and posted in a prominent place at building site and protected from weather and physical damage.
4. The installation shall be executed in a workmanlike manner and shall present a neat physical appearance when completed.

1.5 PROJECT/SITE CONDITIONS

A. Environmental Requirements
1. Provide products suitable for operation under the following environmental conditions:
   a. Temperature: -18 to 38 degrees C (0 to 100 degrees F).
   b. Humidity: 0 to 95 relative percent, non-condensing.
   c. Altitude: 2010 meters (6600 feet) above sea level.

d. Outdoor: Products that are UL listed for wet locations.

1.6 WARRANTIES

A. Refer to the Conditions of the Contract for provisions concerning Contract general warranty, Statements of Compliance, correction of Work period, and form of Special Warranty.

B. All electrical systems, equipment and installations shall be provided with a one-year minimum Warranty starting from the date of substantial completion.

C. During the warranty period, and for non-conformities the contractor shall take all necessary and appropriate action; free of charge, to correct any non-conformity with the warranties contained in the manufacturer agreement. During the warranty period, contractor shall provide to Owner, free of costs and charges, all support necessary to ensure that the installation meets the requirements specified in the Contract Documents and performance guarantees provided by the contractors. During the warranty period, contractors shall furnish, or cause to be furnished, all maintenance, service, parts and replacements necessary to maintain the installation in good working condition, at no cost to Owner.

1.7 CONDUCTOR SIZING

A. Feeder and Branch Circuit Sizing
1. Provide feeder and branch circuits per the circuit sizing schedules indicated on Drawings. Where schedules are not indicated, provide conductors which are sized as required per the NEC for the indicated overcurrent protective device rating. Circuit sizing and installation shall consider the field routing and anticipated voltage drop. Upsize wire, as necessary, to compensate for voltage drop and/or other forms of derating required in accordance with the NEC.
2. Derate conductor ampacities per the NEC for field conditions including but not limited to conduits exposed to sunlight, elevated ambient temperature, and/or more than 3 current carrying conductors in a raceway.

1.8 SYSTEMS INTEGRATION

A. Coordinate with equipment suppliers and ensure integration of systems comprised of disparate equipment which work together to form a complete system.

B. Provide all miscellaneous components, wiring, hardware, etc. required for complete and operational equipment and systems whether or not these items are explicitly shown in the Contract Documents.

C. Provide systems which maintain the UL rating of the individual pieces of equipment.

D. Submit system integration wiring diagrams, control diagrams and sequence of operation, as needed.

1.9 COORDINATION

A. Contractor shall participate in the project scheduling, coordination meetings and coordination drawing/modeling activities as specified in Division 01.

B. All potential coordination issues shall be brought to the attention of the Construction Manager immediately before proceeding with the installation.

C. Contractor shall be responsible for all cross connecting and coordination with vendors and other trade contractors to provide complete operational systems.

D. For purpose of clarify and legibility, drawings are diagrammatic. Locate equipment as close as practical to the locations shown on the drawings. Should field conditions prevent the installation of equipment or materials as indicated on the drawings, make deviations only with the prior approval of the Owner's representative.

E. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping at required slope.
   4. To allow connecting raceways, cables, wireways, cable trays, and busways to be clear of obstructions and of the working and access space of other equipment.

F. Coordinate work with other trades to ensure completion is consistent with the project schedule. Ensure the NEC-required working space and dedicated electrical space about electrical equipment is provided. Foreign systems shall not be located within these dedicated zones. Any work that encroaches on the working space or dedicated electrical space shall be relocated at the Contractor's expense.

G. Equipment and device mounting heights and alignment shall adhere to architectural drawings, rules and requirements. Devices of all trades within the same general area shall be coordinated prior to construction. Care shall be taken to align devices horizontally and vertically. Devices that are not aligned properly shall be relocated at the Contractor's expense.

H. Coordinate exact conduit routing in the field with other trades and with building elements such as structural steel members. Conduit and raceways are not explicitly shown. Conduit routing where shown on drawings shall be considered approximate. Contractor shall be responsible for final routing in the field and shall be responsible for complete coordination with all other trades.

I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

J. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8.

K. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

PART 2 - PRODUCTS

2.1 Manufacturers

A. General
   1. Furnish products by one of the equipment manufacturers listed under the heading "Manufacturers" within the applicable sections. When given, furnish the specified product model or brand for the selected manufacturer.
   2. Provide products, for which quantities of two or more are to be furnished, from the same manufacturer and of the same product or model series.
   3. Furnish product components designed to be used together and which are physically and electrically compatible.

B. Comparable Products
1. Comparable products may be proposed when the "or as approved" clause is specified under the heading "Manufacturers". Submit such products substitutions for approval per Division 01, "Product Requirements.

C. Product Substitutions
1. Product substitutions may be requested under the conditions specified in Section 012500, SUBSTITUTION PROCEDURES. Submit product substitutions for consideration per Section 012500, SUBSTITUTION PROCEDURES.

2.2 Products

A. Product Listing and Labeling
1. Provide listed and labeled product for which listings and labels exist by Underwriters Laboratories Inc. (UL), Factory Mutual (FM), or similar independent testing organizations recognized by the authorities having jurisdiction. For products for which there are no such listings and labels, provide listed and labeled components of those products, for which component listing and labels exist.

B. PCB Content Prohibited
1. Provide products which do not contain any amounts of polychlorinated biphenyl (PCB) compounds.

C. Lead Limits
1. Electrical wire and cable to have lead content less than 300 parts per million.

D. Asbestos Content Prohibited
1. Provide products which do not contain any amounts of asbestos.

E. Access Doors
1. Provide access doors necessary to access devices, whether for control or maintenance, governed by these Basic Electrical Materials and Methods. Comply with access door requirements specified in Division 08. Access doors are not explicitly shown on the Drawings.
2. Access doors shall be coordinated with other trades and final locations shall be approved by Architect. Access doors not approved by Architect shall be removed or relocated at the Contractors expense.
3. Access doors installed in fire rated floors, walls or ceilings shall be sufficiently rated to maintain the rating of the surface where installed.

2.3 Source Quality Control

A. Factory Tests
1. Permit Architect and Owner to observe factory tests. Provide minimum five working 14 days notice of factory tests.
2. Schedule no more than one equipment or system factory test per week.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHASING

A. The project will utilize phased construction. Contractor shall account for any and all costs associated with a phased construction schedule in bid.

3.2 SHUTDOWNS

A. Interruption of Existing Service: Do not interrupt electric, communications or fire alarm 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 Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of service.
   2. Indicate method of providing temporary service.
   3. Do not proceed with interruption of service without Architect's, Construction Manager's and Owner’s written permission.
   4. Comply with NFPA 70E.

B. Coordinate all service interruptions with other disciplines and Owner's representative. Shutdowns shall be performed during off hours, which may include weekends or holidays. This premium time cost shall be included in the Contractor's base bid.

C. Maintain Owner communications and network services operations during construction. Coordinate all service interruptions with other disciplines and Owner's representative.

D. Maintain Owner fire alarm systems and services operations during construction. Coordinate all service interruptions with other disciplines and Owner's representative.

3.3 DEMOLITION

A. Protect adjacent building services and materials indicated to remain. Install and maintain barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition is complete.

B. “Carefully remove, clean and restore and reinstall items that are relocated during construction to a "like new" condition.

C. Building elements such as walls, partitions, floors and ceilings affected by electrical construction such as conduit penetrations shall be repaired, patched, painted and otherwise restored to a "like new" condition.

D. Lamp and Ballast Recycling.
   1. Recycle lamps, ballasts and drivers containing hazardous materials such as mercury during construction. These shall include tubular fluorescent, compact fluorescent, HID, LED, induction and cold cathode lamps. These lamp types, ballasts and drivers associated with these lamps shall not be disposed of as solid municipal waste.

E. Equipment Protection and Cleanup.
   1. Protect equipment and materials during shipment, storage and construction against damage, dust and contamination. Items that become damaged, dirty or contaminated during construction shall be restored to a "like new" condition or replaced at the Contractor's expense.
   2. Remove and legally dispose of demolished items, rubbish, debris and construction waste from the construction site daily, and at the completion of the work. The contractor shall maintain a "clean" work site. Failure to do so may result in the cleanup being performed by others and all costs thereof being deducted from the Contractor’s final payment.

3.4 TEMPORARY SERVICE

A. The facility will remain operational during construction. Provide equipment, hardware, wiring, etc. to maintain systems scheduled to remain operational during construction. Coordinate detailed work phasing plans with the Construction Manager, Architect and Owner prior to commencing work.

B. Provide, maintain and remove all temporary lighting, power and communications required to complete the project.
   1. Coordinate temporary service installation with the local utility companies and building landlord prior to construction.

C. In addition to NEC ground fault protection requirements, provide ground fault protection on temporary feeders 200 amps and greater.

D. Temporary feeders shall be limited to the following types:
   1. Conductors installed in raceways.
   2. Type MC cable.
   3. Multi-conductor cable with an overall protective outer jacket (where inaccessible to the public and not subject to physical damage or abuse).
   4. NEC recognized hard usage cord (where inaccessible to the public and not subject to physical damage or abuse).
   5. Label temporary feeders every 25 feet maximum

3.5 INSTALLATION

A. General
   1. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless otherwise indicated.
   2. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
   3. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
   4. Right of Way: Give to piping systems installed at a required slope.

B. Wiring Installation
   1. Install wiring for control systems, power feeder and branch circuits, lighting branch circuits, communication and auxiliary systems, such as fire alarm and security, in separate raceways unless otherwise indicated.
   2. Install power system wiring for “Life Safety,” “Legally Required Standby,” and “Optional Standby,” systems in separate raceways.
   3. Install wiring and devices and make connections for Owner furnished equipment and furnished under other sections of the specifications such as, but not limited to, automatic doors, projection screens, pneumatic tube stations, casework, medical headwalls, radiation oncology equipment, diagnostic imaging equipment and laboratory equipment. Refer to the specific sections for electrical requirements. Coordinate installation with the equipment supplier and the approved shop drawings.

4. Prior to rough-in of electrical and telecommunications devices, verify locations with the owner's final furniture plans and the system supplier's approved installation drawings. Adjust locations of devices to coordinate with furniture and equipment layouts.

C. Device Location
1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, occupancy sensors, fire alarm devices and access control devices, within a 10-foot radius of indicated location without additional cost.
2. Refer to architectural plans for device location, mounting and alignment rules and requirements. Coordinate all device and lighting fixture placement with other trades prior to rough-in.
3. Devices in proximity to each other shall be horizontally and vertically aligned. Devices which are not aligned properly shall be relocated as required to meet alignment requirements at no cost to Owner.
4. Coordinate device placement and installation with other trades and Architect/Engine#er prior to construction and rough-in.

D. NECA Compliance
1. Install products in accordance with applicable NECA Standards, unless otherwise specified or indicated.

E. Wet, Damp, or Dry Location Work
1. Provide products as appropriate for wet, damp, or dry locations as defined by NFPA 70.

F. Manufacturer Installation Instructions
1. Install equipment in accordance with the manufacturer's installation instructions and recommendations.

G. Fire and Smoke Barrier Penetrations
1. Install firestopping to raceways, boxes and electrical equipment installed in or penetrating fire-rated floor and wall assemblies and smoke barrier assemblies, in a manner which maintains the fire resistance rating or barrier intent.

H. Field Painting
1. Refer to Division 09 for prime and finish field painting requirements.
2. Field paint electrical equipment, products, materials, components and systems where indicated.
3. In a manner approved by the manufacturer and satisfactory to the Owner, touch-up or refinish factory-applied paints or finishes which are chipped, defaced, scratched, or in any other way disturbed due to handling, installation, or general construction work.

I. Exposed Construction
1. Take care in areas where the installation is exposed and visible to the public. Install electrical systems and equipment in an organized fashion and field painted. Mounting surfaces shall be repaired, patched, and painted to provide a "like new" appearance.
2. Coordinate systems (e.g. conduit, cable tray, wiring, duct work, piping, hanger, supports, etc.) prior to installation.

J. Personnel Protection from Suspended Work
1. Where suspended equipment, piping or ductwork or any of their supporting or reinforcing members extend 2.1 meters (7 feet) or less above the floor or any other walking surface, cover all edges, projecting surfaces and sharp corners with pre-fabricated soft rubber pads, elastomeric insulation, caps or equivalent to prevent injury to personnel.

K. Elevator Installation
1. Provide electrical service, wiring, disconnects and an installation that complies with NEC Article 620, ANSI-A17.1, Division 14 . Provide all required electrical work for elevators, even if it is not shown on the electrical drawings, at no additional cost to the owner.

L. Medical Equipment Installation
1. Provide electrical services, circuit breakers, conduit, wire raceways, outlets receptacles, accessories, and other required material for the complete installation of medical equipment such as surgical booms, surgical lights, radiographic systems, documentation stations, and other medical equipment. The equipment manufacturer's design and installation drawings have been included with the contract documents as reference. Coordinate the electrical requirements with the manufacturer's approved installation drawings and provide the necessary materials for a complete installation.

M. Feeder and Branch Circuit Sizing
1. Provide feeder and branch circuit sizing per schedules indicated on drawings.

3.6 ACCEPTANCE TESTING

A. General.
1. Provide necessary test equipment and be responsible for setting-up test equipment, wire checks of factory wiring and any other preliminary work in preparation for the electrical acceptance tests.
2. Perform tests which do not exceed the manufacturer's recommended limit for the equipment being tested.
3. Where required for the validity of tests or safety of equipment and personnel, isolate equipment to be tested from the system.
4. Include the ambient temperature and relative humidity existing at the time when performing insulation resistance, dielectric absorption or high potential tests.
5. Coordinate testing and inspections with commissioning agent.

B. Visual Inspections.
1. Prior to any testing, perform visual inspections to verify the following:
   a. The equipment is completely and properly installed.
   b. The equipment is free from damage and defects.
   c. Shipping blocks and restraints have been removed.`
   d. Electrical terminations are properly tightened.
   e. The equipment is properly aligned.
   f. The equipment is properly lubricated.
   g. The ventilation louvers are open and unobstructed.
   h. The equipment is ready to be tested.

C. Manual Operation.
1. Prior to any testing, operate mechanical devices to verify that they function properly and freely.

D. Insulation Resistance Test.
1. Perform test with a voltage source capable of providing a constant direct voltage for the time intervals as specified below.
a. 150 volts and under - 500 volts.
b. 151-600 volts - 1000 volts.
c. Hold 1000-volt and 500-volt insulation resistance tests for a minimum of one minute or until the reading reaches a constant value for 15 seconds unless specified otherwise.
d. Apply tests from phase to ground with the other phases grounded. Test each phase in a similar manner.
e. Check phase matching and phase identification immediately prior to energizing equipment.

E. Fire Alarm System Test.
1. Fire alarm and smoke detector systems shall be tested by operating each pull station and activating all system sensors to verify proper operation.
2. Voice communications systems shall be tested to verify correct operation of all voice inputs and all speakers.

F. Ethernet Systems.
1. A complete test shall be performed per ANSI-TIA-568-C.2 on each cable, end to end. A full test report shall be submitted for each cable in electronic format. Test equipment shall be UL certified for Category 3/5E/6/6A testing, fully compliance with ANSI-TIA-568-C.2 Accuracy Level II, utilizing the most recent version of software for the test equipment. Submit proposed test method and equipment for approval prior to testing.
2. Refer to Division 27 specifications for additional testing requirements.

3.7 Field Quality Control

A. Field Tests
1. Permit Architect and Owner to observe field tests. Provide minimum five working days notice of field test.
2. Schedule tests in coordination with other Contract work. Schedule no more than one equipment or system field test per day.

B. Inspect installed sleeves and firestopping for damage or faulty work. Replace defective installations.

C. Replace any equipment, system or materials found to be defective or found to be of lesser quality than that specified or shown on the Drawings.

3.8 CLEANING

A. Clean electrical equipment and systems to remove dirt, paint or other foreign materials and restore to match original condition and finish upon completion of construction.

3.9 TRAINING

A. General
1. Provide training for Owner's personnel in the operation and maintenance of equipment as specified in the applicable Section for the particular equipment and system.
2. Develop training schedule which is acceptable to the Owner. Submit schedule for approval.

3. Provide instruction books, manuals, and other classroom material required as part of the training sessions.
4. Provide instructors who are certified by the equipment and system manufacturers.
5. Provide training for a minimum of three of the Owner's personnel, or as specified in the applicable Section.
6. Conduct training at Project Site after the equipment/system has been installed.
7. Conduct classes at the manufacturer's training center, using equipment similar to equipment proposed and at the Project site after initial training at manufacturer's training center and after the equipment has been installed.

B. Operations and Maintenance Training
   1. Train personnel in all aspects of normal operation of the equipment, including starting, adjustments while running, and shutdown.
      a. Train personnel to recognize incipient problems, including inefficient or dangerous modes of operation, and provide instruction in corrective actions to be taken.
   2. Train personnel to perform all recommended maintenance on the equipment.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
1. Product Data: For solvents and adhesives, indicating VOC content.
2. Lead content verification less than 300 parts per million.
3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

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, provide products by one of the following:
1. Cerro Wire LLC.
2. Encore Wire Corporation.
3. Okonite Company (The).
4. Southwire Company.

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 and ASTM B 496 for stranded conductors.
1. Lead content shall be less than 300 parts per million.

D. Conductor Insulation:
1. Refer to Part 3 for conductor insulation application. Comply with UL Standard appropriate for cable insulation.

2.2 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cerro Wire LLC.
2. Encore Wire Corporation.
3. General Cable Technologies Corporation.
4. Okonite Company (The).
5. Southwire Company.

C. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.
1. Lead content shall be less than 300 parts per million.

D. Conductor Insulation:
1. Refer to Part 3 for conductor insulation application. Comply with UL Standard appropriate for cable insulation.

2.3 HEALTH CARE FACILITIES CABLE, TYPE HCF

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 provide products from one of the following:
   1. AFC Cable Systems Inc.
   2. Alpha Wire Company.
   3. Encore Wire Corporation.
   4. General Cable Technologies Corporation.
   5. Okonite Company.
   6. Southwire Company.

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.

D. Circuits:
   1. Single circuit or multicircuit (3-circuit, maximum) with color-coded conductors.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
   1. Lead content shall be less than 300 parts per million.

F. Ground Conductor: Insulated, green colored.

G. Bond Wire: Aluminum, bare.

H. Conductor Insulation:
   1. Type THHN/THWN-2: Comply with UL 83.
   2. Type XHHW-2: Comply with UL 44.

I. Armor: Steel, interlocked, green colored.

2.4 PHOTOVOLTAIC CABLE, TYPE PV

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Encore Wire Corporation.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
   1. Lead content shall be less than 300 parts per million.

D. Conductor Insulation: Comply with UL 44 and UL 4703.

2.5 MINERAL-INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. nVent Pyrotenax.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. UL 2196 for fire resistance.

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper.
   1. Lead content shall be less than 300 parts per million.

E. Insulation: Compressed magnesium oxide, minimum 55 mils for 600 volt power and control cables; minimum 23 mils for 300 volt twisted pair cables.

F. Sheath: Copper, continuous and seamless, liquid- and gas-tight.

2.6 TRAY CABLE, TYPE TC FOR VFD OUTPUT CIRCUITS

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Encore Wire Corporation.
   2. General Cable Technologies Corporation.
   3. Okonite Company (The).
   4. Southwire Company.

C. Standards:
   1. RoHS compliant.
   2. Comply with UL 1277.
   3. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
   1. Lead content shall be less than 300 parts per million.

E. Ground Conductor: Three stranded bare copper ground wires.

F. Conductor Insulation: Type XHHW-2 or RHW-2. Comply with UL 44.

G. Shield: Copper tape shield with a minimum of 50% overlap.

2.7 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs 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.
   1. Lead content shall be less than 300 parts per million.

B. Manufacturers: Subject to compliance with requirements, provide products 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. ILSCO.
   6. O-Z/Gedney; a brand of Emerson Industrial Automation.
   7. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Bronze or matching conductor material.

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. Feeders: Copper for feeders smaller than 100 amps; except as noted in the Drawings feeders over 100 amps may be copper or aluminum . Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. VFC Input / Output Circuits Cable: Variable Frequency Drive Cable.

E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

F. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

G. Isolated Power System Secondary Conductor Type: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

B. Feeders: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: .

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
   1. Essential electrical system branch circuits: Type THHN-2/THWN-2, single conductors in raceway.
      a. Type HCF cable may be used for lighting fixture whips, maximum length of 6 feet, upon approval of the authority having jurisdiction.

2. Normal power branch circuits: Type HCF cable, in lengths not exceeding 10 feet. Type HCF cable shall not be installed for home runs. Type HCF cable shall only be installed for final connections to light fixtures and wiring devices.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2 or XHHW-2, single conductors in raceway .

F. Feeders and Branch Circuits Installed on Rooftops: Type XHHW-2, single conductors in raceway.

G. Isolated Power System Secondary Conductors: Type XHHW-2 with cross-linked polyethylene (XLP) insulation complying with NEMA WC-70, single conductors in raceway. The insulation shall have a minimum thickness of 1/32 inches and a dielectric constant no greater than 3.5.

H. Feeders and Branch Circuits, Exposed on Roofs: Type XHHW-2, single conductors in raceway.

I. Emergency Power System Branch Circuits: Type THHN-2/THWN-2, single conductors in raceway.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. VFD Input / Output Circuits: Type Variable Frequency Drive cable.

L. PV Circuits: Type PV for PV source circuits rated at 600 V.

M. MI cable shall be used as an option where feeder is required to be fire rated.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. 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.

C. 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.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Install cable per manufacturer's recommendations.

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 and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches slack line.

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 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."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. After installing conductors and cables and before electrical circuitry has been energized, test conductors feeding the following critical equipment and services for compliance with requirements:
      a. Automatic transfer switches.
      b. Distribution Switchboards
      c. Branch Circuit Panelboards
   3. 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. Continuity test on each conductor and cable.
      g. 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 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES - WWTP

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
1. Product Data: For solvents and adhesives, indicating VOC content.
2. Lead content verification less than 300 parts per million.
3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

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, provide products by one of the following:
1. Cerro Wire LLC.
2. Encore Wire Corporation.
3. Okonite Company (The).
4. Southwire Company.

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 and ASTM B 496 for stranded conductors.
1. Lead content shall be less than 300 parts per million.

D. Conductor Insulation:
1. Refer to Part 3 for conductor insulation application. Comply with UL Standard appropriate for cable insulation.

2.2 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cerro Wire LLC.
2. Encore Wire Corporation.
3. General Cable Technologies Corporation.
4. Okonite Company (The).
5. Southwire Company.

C. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.
1. Lead content shall be less than 300 parts per million.

D. Conductor Insulation:
1. Refer to Part 3 for conductor insulation application. Comply with UL Standard appropriate for cable insulation.

2.3 HEALTH CARE FACILITIES CABLE, TYPE HCF

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 provide products from one of the following:
1. AFC Cable Systems Inc.
2. Alpha Wire Company.
3. Encore Wire Corporation.
4. General Cable Technologies Corporation.
5. Okonite Company.
6. Southwire Company.

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.

D. Circuits:
1. Single circuit or multicircuit (3-circuit, maximum) with color-coded conductors.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
1. Lead content shall be less than 300 parts per million.

F. Ground Conductor: Insulated, green colored.

G. Bond Wire: Aluminum, bare.

H. Conductor Insulation:
1. Type THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

I. Armor: Steel, interlocked, green colored.

2.4 PHOTOVOLTAIC CABLE, TYPE PV

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Encore Wire Corporation.
2. General Cable; General Cable Corporation.
3. Southwire Company.

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
1. Lead content shall be less than 300 parts per million.

D. Conductor Insulation: Comply with UL 44 and UL 4703.

2.5 MINERAL-INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. nVent Pyrotenax.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. UL 2196 for fire resistance.

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper.
   1. Lead content shall be less than 300 parts per million.

E. Insulation: Compressed magnesium oxide, minimum 55 mils for 600 volt power and control cables; minimum 23 mils for 300 volt twisted pair cables.

F. Sheath: Copper, continuous and seamless, liquid- and gas-tight.

2.6 TRAY CABLE, TYPE TC FOR VFD OUTPUT CIRCUITS

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Encore Wire Corporation.
   2. General Cable Technologies Corporation.
   3. Okonite Company (The).
   4. Southwire Company.

C. Standards:
   1. RoHS compliant.
   2. Comply with UL 1277.
   3. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
   1. Lead content shall be less than 300 parts per million.

E. Ground Conductor: Three stranded bare copper ground wires.

F. Conductor Insulation: Type XHHW-2 or RHW-2. Comply with UL 44.

G. Shield: Copper tape shield with a minimum of 50% overlap.

2.7 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs 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.
   1. Lead content shall be less than 300 parts per million.

B. Manufacturers: Subject to compliance with requirements, provide products 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. ILSCO.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Bronze or matching conductor material.

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. Feeders: Copper for feeders smaller than 100 amps; except as noted in the Drawings feeders over 100 amps may be copper or aluminum . Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. VFC Input / Output Circuits Cable: Variable Frequency Drive Cable.

E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

F. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

G. Isolated Power System Secondary Conductor Type: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

B. Feeders: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: .

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
1. Essential electrical system branch circuits: Type THHN-2/THWN-2, single conductors in raceway.
   a. Type HCF cable may be used for lighting fixture whips, maximum length of 6 feet, upon approval of the authority having jurisdiction.
2. Normal power branch circuits: Type HCF cable, in lengths not exceeding 10 feet. Type HCF cable shall not be installed for home runs. Type HCF cable shall only be installed for final connections to light fixtures and wiring devices.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2 or XHHW-2, single conductors in raceway .

F. Feeders and Branch Circuits Installed on Rooftops: Type XHHW-2, single conductors in raceway.

G. Isolated Power System Secondary Conductors: Type XHHW-2 with cross-linked polyethylene (XLP) insulation complying with NEMA WC-70, single conductors in raceway. The insulation shall have a minimum thickness of 1/32 inches and a dielectric constant no greater than 3.5.

H. Feeders and Branch Circuits, Exposed on Roofs: Type XHHW-2, single conductors in raceway.

I. Emergency Power System Branch Circuits: Type THHN-2/THWN-2, single conductors in raceway.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. VFD Input / Output Circuits: Type Variable Frequency Drive cable.

L. PV Circuits: Type PV for PV source circuits rated at 600 V.

M. MI cable shall be used as an option where feeder is required to be fire rated.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS-WWTP prior to pulling conductors and cables.

C. 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.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529, HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS-WWTP.

G. Install cable per manufacturer's recommendations.

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 and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches slack line.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

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 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.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. After installing conductors and cables and before electrical circuitry has been energized, test conductors feeding the following critical equipment and services for compliance with requirements:
      a. Automatic transfer switches.
      b. Distribution Switchboards
      c. Branch Circuit Panelboards
   3. 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. Continuity test on each conductor and cable.
      g. 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 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low-voltage control cabling.
   2. Control-circuit conductors.
   3. Identification products.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

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.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
   1. Flame Travel Distance: 60 inches or less.
   2. Peak Optical Smoke Density: 0.5 or less.
   3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. Lead content shall be less than 300 parts per million.
   3. PVC insulation.
   4. Unshielded.
   5. PVC jacket.
   6. Flame Resistance: Comply with NFPA 262.

2.4 CONTROL-CIRCUIT CONDUCTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Encore Wire Corporation.
   2. General Cable Technologies Corporation.
   3. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2 Type XHHW-2, in raceway, complying with UL 44.

C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway Type XHHW-2, in raceway power-limited tray cable, in cable tray, complying with UL 44.

D. Lead content shall be less than 300 parts per million.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 incheshigh, and 2-1/2 inches deep.
   2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.

4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:
1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
10. Support: Do not allow cables to lay on removable ceiling tiles.
11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Installation of Control-Circuit Conductors:
1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits; No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

END OF SECTION

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Low-voltage control cabling.
2. Control-circuit conductors.
3. Identification products.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

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.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. Lead content shall be less than 300 parts per million.
   3. PVC insulation.
   4. Unshielded.
   5. PVC jacket.
   6. Flame Resistance: Comply with NFPA 262.

2.4 CONTROL-CIRCUIT CONDUCTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Encore Wire Corporation.
   2. General Cable Technologies Corporation.
   3. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2 Type XHHW-2, in raceway, complying with UL 44.

C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway Type XHHW-2, in raceway power-limited tray cable, in cable tray, complying with UL 44.

D. Lead content shall be less than 300 parts per million.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 incheshigh, and 2-1/2 inches deep.
   2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.
   4. Extend conduits 3 inches above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:
   1. Comply with TIA-568-C Series of standards.
   2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
   3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   4. Cables may not be spliced.
   5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
   9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
   10. Support: Do not allow cables to lay on removable ceiling tiles.
   11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Installation of Control-Circuit Conductors:
   1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
   3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits; No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413, PENETRATION FIRESTOPPING.

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

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

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
         1) Test wells.
         2) Ground rods.
         3) Ground rings.
         4) Grounding arrangements and connections for separately derived systems.
      b. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS.
         1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
         2) Include recommended testing intervals.

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, provide products by one of the following:
   1. Burndy; Part of Hubbell Electrical Systems.
   2. ERICO International Corporation.
   3. ILSCO.
   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 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. Bonding Conductor: No. 6 AWG, minimum, stranded conductor.
   4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, in cross section, with 9/32-inch holes spaced 1-1/8 inches apart, unless otherwise indicated or specified. 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 exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

E. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Water Pipe Clamps:
   1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.
      a. Material:Die-cast zinc alloy.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

J. Lead Content: Less than 300 parts per million.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 5/8 by 96 inches.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

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, No. 2/0 AWG minimum.
   1. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus:
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

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. Ground separately-derived ac power system neutrals, including distribution transformers, to the grounding electrode system as indicated on Drawings.

B. 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.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. 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.

C. 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.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

G. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
   2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
   3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
   1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
      a. Gates and Other Fence Openings: Ground fence on each side of opening.
         1) Bond metal gates to gate posts.
         2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 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 24 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.
   3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. 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.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, 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.

G. 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.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

L. 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.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. 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.
    b. Perform tests by fall-of-potential method according to IEEE 81.
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.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. 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 of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS -WWTP

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

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

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
         1) Test wells.
         2) Ground rods.
         3) Ground rings.
         4) Grounding arrangements and connections for separately derived systems.
      b. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS.
         1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
         2) Include recommended testing intervals.

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, provide products by one of the following:
   1. Burndy; Part of Hubbell Electrical Systems.
   2. ERICO International Corporation.
   3. ILSCO.
   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 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. Bonding Conductor: No. 6 AWG, minimum, stranded conductor.
   4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, in cross section, with 9/32-inch holes spaced 1-1/8 inches apart, unless otherwise indicated or specified. 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 exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

E. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Water Pipe Clamps:
   1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.
      a. Material:Die-cast zinc alloy.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

J. Lead Content: Less than 300 parts per million.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 5/8 by 96 inches.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

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, No. 2/0 AWG minimum.
   1. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus:
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

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. Ground separately-derived ac power system neutrals, including distribution transformers, to the grounding electrode system as indicated on Drawings.

B. 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.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. 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.

C. 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.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

G. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
   2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
   3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
   1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
      a. Gates and Other Fence Openings: Ground fence on each side of opening.
         1) Bond metal gates to gate posts.
         2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 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 24 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.
   3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. 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.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, 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.

G. 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.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

L. 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.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. 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.
    b. Perform tests by fall-of-potential method according to IEEE 81.
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.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. 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 of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

F. 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.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:
1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

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.
2. Include rated capacities and furnished specialties and accessories.

B. Delegated-Design Submittal: For hangers and supports for electrical systems.
1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
   2. Component Importance Factor: As shown in Structural drawings..
   3. Component Amplification Factor and Component Response Modification Factor: As shown in Structural drawings..

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 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, provide products by one of the following:
      a. B-line, an Eaton business.
      b. ERICO International Corporation.
      c. Thomas & Betts Corporation; A Member of the ABB Group.
      d. 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: Selected for applicable load criteria.
   5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface. Only permitted as required by non-ferrous equipment requirements, for example magnetic resonance imaging (MRI) suites etc.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper Industries, Inc..
      b. Haydon Corporation.
      c. MKT Metal Manufacturing.
      d. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Material: 6063-T5 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
5. Channel Width: Selected for applicable load criteria.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

F. 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, provide products by the following:
        1) Hilti, Inc..
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc..
        3) Simpson Strong-Tie Co., Inc..
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, provide products by one of 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 A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

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 or other 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 single-bolt conduit clamps.

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. To Existing Concrete: Expansion anchor fasteners.
   5. 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.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. 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 Division 03.

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 Division 09 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

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS - WWTP

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.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:
1. Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP for products and installation requirements necessary for compliance with seismic criteria.

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.
2. Include rated capacities and furnished specialties and accessories.

B. Delegated-Design Submittal: For hangers and supports for electrical systems.
1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000, QUALITY REQUIREMENTS, to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
   2. Component Importance Factor: As shown in Structural drawings..
   3. Component Amplification Factor and Component Response Modification Factor: As shown in Structural drawings..

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 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, provide products by one of the following:
      a. B-line, an Eaton business.
      b. ERICO International Corporation.
      c. Thomas & Betts Corporation; A Member of the ABB Group.
      d. 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: Selected for applicable load criteria.
   5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface. Only permitted as required by non-ferrous equipment requirements, for example magnetic resonance imaging (MRI) suites etc.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper Industries, Inc..
      b. Haydon Corporation.
      c. MKT Metal Manufacturing.
      d. Unistrut; Part of Atkore International.
   2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Channel Material: 6063-T5 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
5. Channel Width: Selected for applicable load criteria.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

F. 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, provide products by the following:
      1) Hilti, Inc..
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc..
      3) Simpson Strong-Tie Co., Inc..
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, provide products by one of 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 A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000, METAL FABRICATIONS - WWTP for steel shapes and plates.

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-WWTP.

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 or other 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 single-bolt conduit clamps.

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. To Existing Concrete: Expansion anchor fasteners.
   5. 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.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. 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 - WWTP 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 Division 03.

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 Division 09 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

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. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Sustainable Design Submittals:
1. Product Data: For solvents and adhesives, indicating VOC content.
2. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFC Cable Systems; a part of Atkore International.
b. Allied Tube & Conduit; a part of Atkore International.
c. O-Z/Gedney; a brand of Emerson Industrial Automation.
d. Republic Conduit.
e. Southwire Company.
f. Thomas & Betts Corporation; A Member of the ABB Group.
g. Western Tube and Conduit Corporation.
h. 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.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Manufacturers: As specified above.
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. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:
   a. Material: Steel.
   b. Type: Compression only. Setscrew not acceptable.
7. 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.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFC Cable Systems; a part of Atkore International.
   b. CANTEX INC.
   c. RACO; Hubbell.
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.
4. LFNC: Comply with UL 1660.
5. Rigid HDPE: Comply with UL 651A.
6. Continuous HDPE: Comply with UL 651A.
7. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:
1. Manufacturers: As specified above.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
   a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line, an Eaton business.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. MonoSystems, Inc.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 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: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems.
      b. Panduit Corp.
      c. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Crouse-Hinds, an Eaton business.
   2. FSR Inc.
   3. Hoffman; a brand of Pentair Equipment Protection.
   4. Hubbell Incorporated.
   5. RACO; Hubbell.
   6. Spring City Electrical Manufacturing Company.
   7. Thomas & Betts Corporation; A Member of the ABB Group.
   8. Wiremold / Legrand.

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, Type FD, with gasketed cover.

E. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. 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.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

K. Gangable boxes are allowed.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:
1. NEMA 250, Type 1 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.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armorcast Products Company.
      b. Oldcastle Precast, Inc.
      c. Quazite: Hubbell Power Systems, Inc.
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "ELECTRIC.".
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

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: GRC.
   3. Underground Conduit: RNC, Type EPC-40-PVCdirect buried or concrete encased as indicated.
   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 and Subject to Physical Damage: GRC. Raceway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: GRC.
   6. 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 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 nonferrous conduit or tubing for circuits operating above 60 Hz and as required by specific equipment spaces such as magnetic resonance imaging (MRI) suites as required by equipment provider. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Install surface raceways only where indicated on Drawings.

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. 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.

I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:
   1. All slab embedded conduits shalll be coordinated with Structural for final routing and cover requirements beyond what is listed here.

2. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
4. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
5. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

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.
1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

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 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 expansion fittings at all locations where conduits cross building or structure expansion joints.
   3. 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

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 center 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.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Refer to underground ducts and raceways section for additional requirements.
   2. 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 in Section 312000 "Earth Moving."
   3. 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.
   4. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Refer to underground ducts and raceways section for additional requirements.

B. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

C. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

D. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 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."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 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

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS - WWTP

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. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Sustainable Design Submittals:
1. Product Data: For solvents and adhesives, indicating VOC content.
2. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFC Cable Systems; a part of Atkore International.
b. Allied Tube & Conduit; a part of Atkore International.
c. O-Z/Gedney; a brand of Emerson Industrial Automation.
d. Republic Conduit.
e. Southwire Company.
f. Thomas & Betts Corporation; A Member of the ABB Group.
g. Western Tube and Conduit Corporation.
h. 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.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Manufacturers: As specified above.
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. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:
   a. Material: Steel.
   b. Type: Compression only. Setscrew not acceptable.
7. 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.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFC Cable Systems; a part of Atkore International.
   b. CANTEX INC.
   c. RACO; Hubbell.
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.
4. LFNC: Comply with UL 1660.
5. Rigid HDPE: Comply with UL 651A.
6. Continuous HDPE: Comply with UL 651A.
7. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:
   1. Manufacturers: As specified above.
   2. Fittings, General: Listed and labeled for type of conduit, location, and use.
   3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
      a. Fittings for LFNC: Comply with UL 514B.
   4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line, an Eaton business.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. MonoSystems, Inc.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 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: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems.
      b. Panduit Corp.
      c. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Crouse-Hinds, an Eaton business.
   2. FSR Inc.
   3. Hoffman; a brand of Pentair Equipment Protection.
   4. Hubbell Incorporated.
   5. RACO; Hubbell.
   6. Spring City Electrical Manufacturing Company.
   7. Thomas & Betts Corporation; A Member of the ABB Group.

8. Wiremold / Legrand.

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, Type FD, with gasketed cover.

E. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. 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.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

K. Gangable boxes are allowed.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:
1. NEMA 250, Type 1 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.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Oldcastle Precast, Inc.
   c. Quazite: Hubbell Power Systems, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

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: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVCdirect buried or concrete encased as indicated.
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 and Subject to Physical Damage: GRC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: GRC.

6. 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 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 nonferrous conduit or tubing for circuits operating above 60 Hz and as required by specific equipment spaces such as magnetic resonance imaging (MRI) suites as required by equipment provider. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with requirements in Section 260529, HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS-WWTP 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. 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.

I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:
   1. All slab embedded conduits shalll be coordinated with Structural for final routing and cover requirements beyond what is listed here.
   2. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
   3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   4. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
   5. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

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.
   1. Install surface raceway with a minimum 2-inch radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

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 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 expansion fittings at all locations where conduits cross building or structure expansion joints.
3. 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

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 center 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.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Refer to underground ducts and raceways section for additional requirements.
   2. 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 in Section 312000 "Earth Moving."
   3. 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.
   4. Underground Warning Tape: Comply with requirements in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Refer to underground ducts and raceways section for additional requirements.

B. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

C. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

D. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 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-WWTP.

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413, PENETRATION FIRESTOPPING.

3.7 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

260536 – CABLE TRAYS FOR ELECTRICAL SYSTEMS – WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Channel cable tray.
4. Fiberglass cable tray.
5. Fiberglass channel cable tray.
6. Cable tray accessories.
7. Warning signs.

B. Related Requirements:
1. Section 270536, CABLE TRAYS FOR COMMUNICATIONS SYSTEMS for cable trays and accessories serving communications systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.
1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For seismic restraints.
1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer who is licensed in the state where Project is located and who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, and coordinated with each other, using input from installers of the items involved:

B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Component Importance Factor: 1.5.
   3.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAY

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Description: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.

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. B-line, an Eaton business.
   2. Chalfant Manufacturing Company.
   3. Cope Cable Tray; A Part of Atkore International.
   4. MP Husky USA Cable Tray & Cable Bus.

C. Capacities and Characteristics:
   1. Width: 6 inches, 9 inches, 12 inches, 18 inches, 24 inches, 30 inches, or 36 inches unless otherwise indicated on Drawings.
   2. Minimum Usable Load Depth: 6 inches.
   3. Straight Section Lengths: 10 feet, 12 feet, or 20 feet, except where shorter lengths are required to facilitate tray assembly.
   4. Rung Spacing: 9 inches or 12 inches o.c.
   5. Radius-Fitting Rung Spacing: 12 inches at center of tray's width.
   6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
   7. No portion of the rungs shall protrude below the bottom plane of side rails.

8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
9. Fitting Minimum Radius: 24 inches.
10. Class Designation: Comply with NEMA VE 1, Class 10A.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
13. Covers: Ventilated-hat type made of same materials and with same finishes as cable tray.

D. Materials and Finishes:
1. Aluminum:
a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: Chromium-zinc-plated steel, ASTM F 1136.
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 CHANNEL CABLE TRAY

A. Description: Single, formed sheet with a solid or ventilated bearing surface, complying with NEMA VE 1 as indicated on the drawings.

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. Cooper Industries; Cooper B-Line; GS Metals Corp.

C. Capacities and Characteristics:
1. Width: 4 inches or 6 inches unless otherwise indicated on Drawings.
2. Minimum Usable Load Depth: 2 inches.
3. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
5. Fitting Minimum Radius: 12 inches.
6. Class Designation: Comply with NEMA VE 1, Class 8A.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
9. Covers: Solid type made of same materials and with same finishes as cable tray.

D. Materials and Finishes:
1. Aluminum:
a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: Chromium-zinc-plated steel, ASTM F 1136.
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Comply with Section 260553, Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable tray and support systems according to NEMA VE 2.

B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure and install seismic restraints.

F. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529, HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS-WWTP. Comply with seismic-restraint details according to Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.

G. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Do not install more than one cable tray splice between supports.

J. Make changes in direction and elevation using manufacturer's recommended fittings.

K. Make cable tray connections using manufacturer's recommended fittings.

L. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413, PENETRATION FIRESTOPPING.

M. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

N. Install cable trays with enough workspace to permit access for installing cables.

O. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.

P. Install permanent covers and cover clamps, if used, after installing cable.

Q. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

R. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

F. In existing construction, remove inactive or dead cables from cable trays.

3.3 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
   3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 260539 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Flush, flat-top underfloor raceways.
2. Supports, raceway fittings, and hardware.
3. Junction boxes.
4. Service fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For underfloor raceway components, fittings, and accessories.

B. Shop Drawings: For underfloor raceways.
1. Include floor plans, elevations, sections, and details.
2. Identify components and accessories, such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
3. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
4. Provide raceway fill charts for each duct size provided for each conductor size the duct is identified to accept.
5. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements, including slab reinforcement, floor finish work, permanent partitions, expansion joints, architectural module lines.
6. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
7. Indicate thickening of slabs where required for adequate encasement of raceway components.
8. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
9. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
10. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.
11. Identify those cells of cellular floor deck that are to be connected and fitted.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

B. Project record documents.

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. Jacks, Receptacles, and Fittings:
1. Comply with Section 262726 "Wiring Devices" for power outlets, faceplates, and connectors.
2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for twisted pair jacks, outlets, assemblies, and faceplates.
3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber jacks, outlets, assemblies, and faceplates.
4. Comply with Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial jacks, outlets, assemblies, and faceplates.

2.2 FLUSH, FLAT-TOP UNDERFLOOR RACEWAYS

A. Description: Single or multichannel underfloor raceways installed on floor slab with top of raceway flush with concrete topping added hereafter, and then covered with finish material.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or an approved equal:
1. Walker Systems, Inc.

D. Material: Steel.

E. Cross-Section Shape: Rectangular, single channel multichannel, separated by steel wall(s).

F. Listed and labeled for installation with top flush with concrete floor.

G. Service Raceways: Fitted with preset inserts.
1. Number of Longitudinal Channels per Multichannel Raceway: Two.
2. Number of Single-Channel Raceways per Run: One unless otherwise indicated.

2.3 SUPPORTS, RACEWAY FITTINGS, AND HARDWARE

A. Supports, fittings, and hardware shall be compatible with raceway and outlet system and shall be listed for use with raceway systems and components delivered.

B. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.

C. Raceway Fittings: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.

2.4 JUNCTION BOXES

A. Description: Raceway manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:
   1. Mounting brackets.
   2. Escutcheons and holders to accommodate surrounding floor covering.
   3. Means for leveling and height adjustment more than 3/8 inch before and after concrete is placed.
   4. Boxes shall withstand a minimum 300-lb concentrated load. Internal supports shall be provided as needed to meet this requirement.
   5. All boxes shall provide 2-inch- minimum bend radius for data and communication cables.
   6. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.
   7. Covers shall have appropriate depth recess to receive specific floor finish material.
   8. Partitions to separate wiring of different systems.

2.5 SERVICE FITTINGS/ACTIVATIONS

A. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.

B. Flush, System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.
   1. Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts. Include device plates for indicated systems and provisions for receptacles, jacks, and connectors. Include hinged flush covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies.

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to floor supports.

B. Maintain arrangement of conductor services throughout the raceway system.

C. Install a concrete mud slab for support of cellular metal, flush duct, or trench duct raceway. Construct mud slab with wire mesh in the top 1 inch of concrete.

D. Install a vapor barrier between the cellular metal raceway and a substrate in contact with earth.

E. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Fasten supports securely at ends and at intervals not to exceed 60 inches, to prevent movement during concrete pour.

F. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

G. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of the Work.

H. Install preset inserts per manufacturer's instructions.

I. Adjust supports to maintain a 1/8- to 3/8-inch finished concrete cover over preset inserts.

J. Remove burrs, sharp edges, dents, and mechanical defects.

K. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

L. Install expansion fittings with suitable bonding jumper where raceways cross building expansion joints.

M. Bond underfloor raceway components to create a continuous bonding path.

N. Seal raceways, cells, junction boxes, and inserts, as recommended in writing by underfloor raceway manufacturer, to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill.

O. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.
   1. Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
   2. Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications, and use another distinctive screw head to identify third system, such as special-purpose wiring.

P. Protect underfloor raceway system from damage. Do not use the installed duct system as working platforms or walkways. Do not allow equipment or heavy traffic over duct during construction period, without first installing ramps over the duct. Ramps shall be designed so that imposed loads are not transferred to the duct. Components of the system that are damaged during construction shall be replaced.

Q. Install concrete surrounding underfloor raceways according to Section 033000 "Cast-in-Place Concrete."

R. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation at locations indicated on plans.

S. Wiring shall comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and NFPA 70 requirements for wet locations.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform visual inspection of interior of each junction box and section of trench raceway to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
   2. Prior to and after concrete pour, perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.
      a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 ohms.
      b. Comply with NETA Acceptance Testing Specification about safety, suitability of test equipment, test instrument calibration, and test report and records.

B. Prepare test and inspection reports.

3.4 CLEANING

A. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

END OF SECTION

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.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Precast manholes.

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.
3. Include accessories for manholes, handholes, boxes, and other utility structures.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:
1. Precast or Factory-Fabricated Underground Utility Structures:
a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder or step details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
   a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
   b. Include duct entry provisions, including locations and duct sizes.
   c. Include cover design.
   d. Include grounding details.
   e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

A. Profile Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer.

1.5 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.6 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 and Owner no fewer than five days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's and Owner'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, provide products by one of the following:
   1. AFC Cable Systems; a part of Atkore International.
   2. Allied Tube & Conduit; a part of Atkore International.
   3. Calconduit.
   4. O-Z/Gedney; a brand of Emerson Industrial Automation.
   5. Republic Conduit.
   6. Southwire Company.

7. Thomas & Betts Corporation; A Member of the ABB Group.
8. Western Tube and Conduit Corporation.
9. 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-80-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, provide products by one of the following:
1. CANTEX INC.
2. Condux International, Inc.
3. ElecSys, Inc.
4. Electri-Flex Company.
5. National Pipe & Plastics.
6. Opti-Com Manufacturing Network, Inc (OMNI).
7. 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 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: Type EPEC-80 HDPE, complying with NEMA TC 7 and UL 651A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ARNCO Corp.
   b. National Pipe & Plastics.
   c. Premier Conduit.
2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
1. Manufacturers: Subject to compliance with requirements,provide products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. CANTEX INC.
   c. Carlon; a brand of Thomas & Betts Corporation.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.5 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Christy Concrete Products.
   2. Oldcastle Precast, Inc.
   3. Utility Concrete Products, LLC.
   4. Utility Vault Co.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   1. Cover Hinges: Concealed, with hold-open ratchet assembly.
   2. Cover Handle: Recessed.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering, "ELECTRIC."

G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   1. Extension shall provide increased depth of 12 inches.
   2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Center window location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

K. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct to be terminated.
   2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

L. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armorcast Products Company.
2. NewBasis.
3. Oldcastle Enclosure Solutions.
4. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC."

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Christy Concrete Products.
2. Oldcastle Precast, Inc.
3. Utility Concrete Products, LLC.
4. Utility Vault Co.

C. Comply with ASTM C 858.

D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Center window location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct to be terminated.
   2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

G. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

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 according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Where noted to provide GRC 90 degree bends, provide PVC coated and transition fittings as required to provide contiguous pathway.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC , concrete-encased unless otherwise indicated. Provide GRC 90 degree bends.

C. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC , direct-buried unless otherwise indicated. Provide GRC 90 degree bends.

D. Duct for Electrical Branch Circuits: Type EPC-80-PVC , direct-buried unless otherwise indicated.

E. Bored Underground Duct: Type EPEC-80-HDPE unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.

G. Stub-ups: Concrete-encased PVC-coated GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:
1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area .

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

A. 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. Provide GRC 90 degree fittings in PVC runs.
   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. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line 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 duct with calculated expansion of more than 3/4 inch.

I. 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."

J. 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.

K. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:
   1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
   2. Width: Excavate trench 12 inches wider than duct on each side.
   3. Width: Excavate trench 3 inches wider than duct on each side.
   4. 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.
   5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
   6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five 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.
   7. 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.
   8. 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.
   9. 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

10. 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.
11. 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.
12. 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.
13. 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.
14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place 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.

M. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts 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 five 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 ducts 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. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.

9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
    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 inchesfrom 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. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
    a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

O. 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.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891 unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:
   1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
   2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
   3. Install handholes with bottom below frost line, per structural drawings and geotechnical report below grade.
   4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
   5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, frost depth per structural drawings and geotechnical report, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 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.

B. Clean internal surfaces of manholes, including sump.
   1. Sweep floor, removing dirt and debris.
   2. Remove foreign material.

END OF SECTION

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS - WWTP

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.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Precast manholes.

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.
3. Include accessories for manholes, handholes, boxes, and other utility structures.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:
1. Precast or Factory-Fabricated Underground Utility Structures:
a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder or step details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
   a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
   b. Include duct entry provisions, including locations and duct sizes.
   c. Include cover design.
   d. Include grounding details.
   e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

A. Profile Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer.

1.5 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.6 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 and Owner no fewer than five days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's and Owner'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, provide products by one of the following:
   1. AFC Cable Systems; a part of Atkore International.
   2. Allied Tube & Conduit; a part of Atkore International.
   3. Calconduit.
   4. O-Z/Gedney; a brand of Emerson Industrial Automation.
   5. Republic Conduit.
   6. Southwire Company.

7. Thomas & Betts Corporation; A Member of the ABB Group.
8. Western Tube and Conduit Corporation.
9. 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-80-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, provide products by one of the following:
1. CANTEX INC.
2. Condux International, Inc.
3. ElecSys, Inc.
4. Electri-Flex Company.
5. National Pipe & Plastics.
6. Opti-Com Manufacturing Network, Inc (OMNI).
7. 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 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: Type EPEC-80 HDPE, complying with NEMA TC 7 and UL 651A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ARNCO Corp.
   b. National Pipe & Plastics.
   c. Premier Conduit.
2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
1. Manufacturers: Subject to compliance with requirements,provide products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. CANTEX INC.
   c. Carlon; a brand of Thomas & Betts Corporation.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

2.5 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Christy Concrete Products.
   2. Oldcastle Precast, Inc.
   3. Utility Concrete Products, LLC.
   4. Utility Vault Co.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   1. Cover Hinges: Concealed, with hold-open ratchet assembly.
   2. Cover Handle: Recessed.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering, "ELECTRIC."

G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   1. Extension shall provide increased depth of 12 inches.
   2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Center window location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

K. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct to be terminated.
   2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

L. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armorcast Products Company.
2. NewBasis.
3. Oldcastle Enclosure Solutions.
4. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC."

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Christy Concrete Products.
2. Oldcastle Precast, Inc.
3. Utility Concrete Products, LLC.
4. Utility Vault Co.

C. Comply with ASTM C 858.

D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Center window location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct to be terminated.
   2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

G. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

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 according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Where noted to provide GRC 90 degree bends, provide PVC coated and transition fittings as required to provide contiguous pathway.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC , concrete-encased unless otherwise indicated. Provide GRC 90 degree bends.

C. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC , direct-buried unless otherwise indicated. Provide GRC 90 degree bends.

D. Duct for Electrical Branch Circuits: Type EPC-80-PVC , direct-buried unless otherwise indicated.

E. Bored Underground Duct: Type EPEC-80-HDPE unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.

G. Stub-ups: Concrete-encased PVC-coated GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:
1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000, EARTH MOVING, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area .

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200, TURF AND GRASSES and Section 329300, PLANTS.

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300, EXECUTION.

3.5 DUCT AND DUCT-BANK INSTALLATION

A. 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. Provide GRC 90 degree fittings in PVC runs.
   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. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line 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 duct with calculated expansion of more than 3/4 inch.

I. 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-WWTP.

J. 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.

K. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. 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.
5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five 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.
7. 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.
8. 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.
9. 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

10. 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.
11. 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.
12. 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.
13. 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.
14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000, CAST-IN-PLACE CONCRETE-WWTP. 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.

M. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000, EARTH MOVING for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts 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 five 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 ducts 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. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.

9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
    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 inchesfrom 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. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
    a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

O. 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.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891 unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:
   1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
   2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
   3. Install handholes with bottom below frost line, per structural drawings and geotechnical report below grade.
   4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
   5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, frost depth per structural drawings and geotechnical report, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi, 28-day strength, complying with Section 033000, CAST-IN-PLACE CONCRETE-WWTP, with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

3.9 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.

B. Clean internal surfaces of manholes, including sump.
   1. Sweep floor, removing dirt and debris.
   2. Remove foreign material.

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.

B. Related Requirements:
1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

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. 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, provide products by one of the following:
a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Pipeline Seal and Insulator, Inc.

d. Proco Products, Inc.

2. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
   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.

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 or unless seismic criteria require different clearance.
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.

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

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING - WWTP

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.

B. Related Requirements:
1. Section 078413, PENETRATION FIRESTOPPING for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

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. 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, provide products by one of the following:
a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Pipeline Seal and Insulator, Inc.

d. Proco Products, Inc.

2. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
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.

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 or unless seismic criteria require different clearance.
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.

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

SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Restraint channel bracings.
   2. Restraint cables.
   3. Seismic-restraint accessories.
   4. Mechanical anchor bolts.
   5. Adhesive anchor bolts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.
   1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   3. Seismic-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
      c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.3 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from agency acceptable to the authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: As defined in the Strucutral Drawings.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: As defined in the Structural Drawings.
   a. Component Importance Factor: As defined in the Structural Drawings.
   b. Component Response Modification Factor: As defined in the Structural Drawings.
   c. Component Amplification Factor: As defined in the Structural Drawings.
3. Design Spectral Response Acceleration at Short Periods As defined in the Structural Drawings.
4. Design Spectral Response Acceleration at 1.0-Second Period: As defined in the Structural Drawings.

2.2 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Atkore International.

C. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

C. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

C. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install cables so they do not bend across edges of adjacent equipment or building structure.

C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

E. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION

SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Restraint channel bracings.
2. Restraint cables.
3. Seismic-restraint accessories.
4. Mechanical anchor bolts.
5. Adhesive anchor bolts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.
1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. Seismic-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.3 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from agency acceptable to the authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: As defined in the Strucutral Drawings.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: As defined in the Structural Drawings.
   a. Component Importance Factor: As defined in the Structural Drawings.
   b. Component Response Modification Factor: As defined in the Structural Drawings.
   c. Component Amplification Factor: As defined in the Structural Drawings.
3. Design Spectral Response Acceleration at Short Periods As defined in the Structural Drawings.
4. Design Spectral Response Acceleration at 1.0-Second Period: As defined in the Structural Drawings.

2.2 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Atkore International.

C. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

C. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

C. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install cables so they do not bend across edges of adjacent equipment or building structure.

C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

E. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. 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 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:
      a. 208/120-V or 120/240-V Circuits: White.
      b. 480/277-V Circuits: Grey.

5. Color for Equipment Grounds: Green.

C. Warning Label Colors:
1. Identify system voltage with black letters on an orange background.

D. 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."

E. Equipment Identification Labels:
1. Black letters on a white field.

2.3 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. emedco.
5. Hellermann Tyton
6. Ideal Industries, Inc.
7. LEM Products Inc.
8. Marking Services, Inc.
9. Panduit Corp.
10. Seton Identification Products.

2.4 LABELS

A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

B. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
a. 1-1/2 by 6 inches for raceway and conductors
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.5 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.

2.6 TAPES AND STENCILS

A. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

B. Underground-Line Warning Tape:

1. Tape:
   a. Shall be detectable as specified below.
   b. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   c. Printing on tape shall be permanent and shall not be damaged by burial operations.
   d. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
   a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
   b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .
   c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .
3. Detectable Warning Tape:
   a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Width: 3 inches.
   c. Overall Thickness: 5 mils.
   d. Foil Core Thickness: 0.35 mil.
   e. Weight: 28 lb/1000 sq. ft..
   f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

2.7 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory permanent designations; punched for use with self-locking cable tie fastener.

2.8 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
   a. For signs up to 20 sq. in., minimum 1/16 inch thick.
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face or as otherwise specified.
      .
   d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

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.

B. Rolled or otherwise loose label edges will not be approved.

3.2 INSTALLATION

A. General Requirements
   1. 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.

2. Install identifying devices before installing acoustical ceilings and similar concealment.
3. Verify identity of each item before installing identification products.
4. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
5. Apply identification devices to surfaces that require finish after completing finish work.
6. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
7. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
8. Hand-written labels are not acceptable.

B. 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.

C. 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.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

E. 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, load shedding, etc.** Signs shall be engraved phenolic.

F. 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 with a printed label. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

H. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

I. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

J. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

K. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

L. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

M. Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose or plenum-rated cable ties.

N. Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

O. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs or Metal-backed, butyrate warning signs.
   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
      a. Power-transfer switches.
      b. Controls with external control power connections.

H. Arc Flash Warning Labeling: Self-adhesive labels.

I. Operating Instruction Signs: Baked-enamel warning signs, Metal-backed, butyrate warning signs or Laminated acrylic or melamine plastic signs.

J. Emergency Operating Instruction Signs: Baked-enamel warning signs, Metal-backed, butyrate warning signs,Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer,load shedding,etc.

K. Equipment Identification Labels:
   1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
   2. Outdoor Equipment: Laminated acrylic or melamine sign.
   3. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchgear.
      e. Switchboards.
      f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      g. Emergency system boxes and enclosures.
      h. Enclosed switches.
      i. Enclosed circuit breakers.
      j. Enclosed controllers.
      k. Variable-speed controllers.
      l. Push-button stations.
      m. Power-transfer equipment.
      n. Contactors.
      o. Remote-controlled switches, dimmer modules, and control devices.
      p. Battery-inverter units.
      q. Battery racks.
      r. Power-generating units.
      s. Monitoring and control equipment.
      t. UPS equipment.
   4. Include the following information on equipment labels:
      a. Equipment Identification per the Drawings
      b. Source of power: (e.g., "Fed From PP-1A")
      c. What is fed (e.g., "Feeds EF-3")

END OF SECTION

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP

PART 1 - GENERAL

1.1 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. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. 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 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:
      a. 208/120-V or 120/240-V Circuits: White.
      b. 480/277-V Circuits: Grey.

5. Color for Equipment Grounds: Green.

C. Warning Label Colors:
1. Identify system voltage with black letters on an orange background.

D. 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."

E. Equipment Identification Labels:
1. Black letters on a white field.

2.3 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. emedco.
5. Hellermann Tyton
6. Ideal Industries, Inc.
7. LEM Products Inc.
8. Marking Services, Inc.
9. Panduit Corp.
10. Seton Identification Products.

2.4 LABELS

A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

B. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
a. 1-1/2 by 6 inches for raceway and conductors
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.5 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.

2.6 TAPES AND STENCILS

A. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

B. Underground-Line Warning Tape:

1. Tape:
   a. Shall be detectable as specified below.
   b. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   c. Printing on tape shall be permanent and shall not be damaged by burial operations.
   d. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
   a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
   b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .
   c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .
3. Detectable Warning Tape:
   a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Width: 3 inches.
   c. Overall Thickness: 5 mils.
   d. Foil Core Thickness: 0.35 mil.
   e. Weight: 28 lb/1000 sq. ft..
   f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

2.7 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory permanent designations; punched for use with self-locking cable tie fastener.

2.8 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
   a. For signs up to 20 sq. in., minimum 1/16 inch thick.
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face or as otherwise specified.
      .
   d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

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.

B. Rolled or otherwise loose label edges will not be approved.

3.2 INSTALLATION

A. General Requirements
   1. 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.

2. Install identifying devices before installing acoustical ceilings and similar concealment.
3. Verify identity of each item before installing identification products.
4. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
5. Apply identification devices to surfaces that require finish after completing finish work.
6. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
7. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
8. Hand-written labels are not acceptable.

B. 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.

C. 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.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

E. 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, load shedding, etc.** Signs shall be engraved phenolic.

F. 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 with a printed label. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

H. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

I. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

J. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

K. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

L. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

M. Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose or plenum-rated cable ties.

N. Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

O. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs or Metal-backed, butyrate warning signs.
   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
      a. Power-transfer switches.
      b. Controls with external control power connections.

H. Arc Flash Warning Labeling: Self-adhesive labels.

I. Operating Instruction Signs: Baked-enamel warning signs, Metal-backed, butyrate warning signs or Laminated acrylic or melamine plastic signs.

J. Emergency Operating Instruction Signs: Baked-enamel warning signs, Metal-backed, butyrate warning signs, Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer, load shedding,etc.

K. Equipment Identification Labels:
   1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
   2. Outdoor Equipment: Laminated acrylic or melamine sign.
   3. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchgear.
      e. Switchboards.
      f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      g. Emergency system boxes and enclosures.
      h. Enclosed switches.
      i. Enclosed circuit breakers.
      j. Enclosed controllers.
      k. Variable-speed controllers.
      l. Push-button stations.
      m. Power-transfer equipment.
      n. Contactors.
      o. Remote-controlled switches, dimmer modules, and control devices.
      p. Battery-inverter units.
      q. Battery racks.
      r. Power-generating units.
      s. Monitoring and control equipment.
      t. UPS equipment.
   4. Include the following information on equipment labels:
      a. Equipment Identification per the Drawings
      b. Source of power: (e.g., "Fed From PP-1A")
      c. What is fed (e.g., "Feeds EF-3")

END OF SECTION

SECTION 260573.13 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

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.

1.2 ACTION SUBMITTALS

A. Other Action Submittals: Submit the following prior to approval of system protective devices submittals. Submittals shall be in digital form including PDF.
   1. Short-circuit study input data including protective relay settings, including completed computer program input data sheets.

1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
   1. Operation Technology, Inc (ETAP).
   2. SKM Systems Analysis, Inc.
   3. Bentley Systems (EasyPower).

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary highlighting deficiencies, code violations, and recommended optimizations.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size, material, insulation, and lengths.
   3. Conduit size, material.
   4. Transformer kilovolt ampere (kVA) and voltage ratings.
   5. Motor and generator designations and kVA ratings.
   6. Switchgear, switchboard, motor-control center, and panelboard designations matched to the Drawings.

D. Separate one-line diagram, showing the following:

1. Calculated short-circuit momentary and interrupting duties for a three-phase bolted fault at system each node including all distribution equipment as well as transformer primary and secondaries.
2. Transformer kilovolt ampere (kVA) and voltage ratings.
3. Motor and generator designations and kVA ratings.
4. Switchgear, switchboard, motor-control center, and panelboard designations matched to the Drawings.

E. Comments and recommendations for system improvements, where needed.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short-circuit ratings.
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 the standards to 1/2-cycle symmetrical fault current.

G. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

H. Short-Circuit Study Output:
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) Based on calculated symmetrical value multiplied by 2.7.
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.

2.3 PROTECTIVE RELAY DATABASE FILES

A. Create relay database files formatted as required by manufacturer.
   1. Files shall include settings recommended by this study.
   2. Files shall include I/O needed for system operation per schematics and wiring diagrams.
   3. This requirement includes all logic required in the relay for functional performance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.
   1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Engineer.
   2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support the short-circuit study:
   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. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
   8. Motor horsepower and NEMA MG 1 code letter designation.
   9. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

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 the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal system low-voltage load buses where fault current is 10 kA or less.

F. 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.

G. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   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. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
   1. Electric utility's supply termination point.
   2. Incoming switchgear.
   3. Low-voltage switchgear.
   4. Motor-control centers.
   5. Control panels.
   6. Automatic transfer switches.
   7. Branch circuit panelboards.
   8. Disconnect switches.

I. Upload relay settings to protective relays in field and provide test reports to indicate functionality.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

B. Upload relay settings to SEL relays in field and provide test reports to indicate functionality.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION 260573.13

SECTION 260573.13 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY - WWTP

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.

1.2 ACTION SUBMITTALS

A. Other Action Submittals: Submit the following prior to approval of system protective devices submittals. Submittals shall be in digital form including PDF.
   1. Short-circuit study input data, including completed computer program input data sheets.

1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
   1. Operation Technology, Inc (ETAP).
   2. SKM Systems Analysis, Inc.
   3. Bentley Systems (EasyPower).

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary highlighting deficiencies, code violations, and recommended optimizations.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size, material, insulation, and lengths.
   3. Conduit size, material.
   4. Transformer kilovolt ampere (kVA) and voltage ratings.
   5. Motor and generator designations and kVA ratings.
   6. Switchgear, switchboard, motor-control center, and panelboard designations matched to the Drawings.

D. Separate one-line diagram, showing the following:

1. Calculated short-circuit momentary and interrupting duties for a three-phase bolted fault at system each node including all distribution equipment as well as transformer primary and secondaries.
2. Transformer kilovolt ampere (kVA) and voltage ratings.
3. Motor and generator designations and kVA ratings.
4. Switchgear, switchboard, motor-control center, and panelboard designations matched to the Drawings.

E. Comments and recommendations for system improvements, where needed.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short-circuit ratings.
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 the standards to 1/2-cycle symmetrical fault current.

G. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

H. Short-Circuit Study Output:
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) Based on calculated symmetrical value multiplied by 2.7.
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 EXAMINATION

A. Obtain all data necessary for the conduct of the study.
   1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Engineer.
   2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support the short-circuit study:
   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. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
   8. Motor horsepower and NEMA MG 1 code letter designation.
   9. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

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 the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal system low-voltage load buses where fault current is 10 kA or less.

F. 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.

G. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   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. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
   1. Electric utility's supply termination point.
   2. Incoming switchgear.
   3. Low-voltage switchgear.
   4. Motor-control centers.
   5. Control panels.
   6. Automatic transfer switches.
   7. Branch circuit panelboards.
   8. Disconnect switches.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

END OF SECTION

SECTION 260573.16 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Executive summary highlighting deficiencies, code violations, and recommended optimizations.

C. Other Action Submittals: Submit the following prior to approval of system protective devices submittals. Submittals shall be in digital form including PDF.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
      a. Submit study report for action prior to receiving final approval of the distribution equipment submittals, including but not limited to panelboards, transformers, switchboards, switchgear, substations, transfer switches, generators, motor controllers, and disconnect switches.. If formal completion of studies will cause delay in equipment manufacturing, provide preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices 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. The following parts from the Protective Device Coordination Study Report:
         1) One-line diagram.
         2) Protective device coordination study.
         3) Time-current coordination curves.
      b. Power system data.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. Operation Technology, Inc (ETAP).
2. SKM Systems Analysis, Inc.
3. Bentley Systems (EasyPower).

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 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.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
2. Cable size 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.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Overcurrent Protective Device Short-Circuit Study."

F. 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, ground).
        2) Adjustable time-current characteristic.
        3) Adjustable instantaneous pickup.
        4) Recommendations on improved trip systems, if applicable.
    c. Fuses: Show current rating, voltage, and class.

G. 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. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
      c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
      d. Transformer full-load current, magnetizing inrush current.
      e. Ground-fault protective devices.
      f. 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.
   6. Comments and recommendations for system improvements.

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. 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 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Comply with NEC requirements.

D. The study shall be based on the device characteristics supplied by device manufacturer.

E. The extent of the electrical power system to be studied is indicated on Drawings.

F. Protective relay logic and settings shall be by the manufacturer and study engineer. Coordinate with Section 262313 "Paralleling Low-Voltage Switchgear" and Section 262300 "Low-Voltage Switchgear".

G. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal system low-voltage load buses where fault current is 10 kA or less.

H. 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.

I. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   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.

J. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
   1. Electric utility's supply termination point.
   2. Switchgear.
   3. Low-voltage switchgear.
   4. Motor-control centers.
   5. Standby generators and automatic transfer switches.
   6. Branch circuit panelboards.

K. 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.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study.
   1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
   2. Use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide.
   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 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.
9. Maximum demands from service meters.
10. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
11. Motor horsepower and NEMA MG 1 code letter designation.
12. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
13. Data sheets to supplement electrical distribution system 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. Ratings, types, and settings of utility company's overcurrent protective devices.
    c. Special overcurrent protective device settings or types stipulated by utility company.
    d. Time-current-characteristic curves of devices indicated to be coordinated.
    e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    g. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

3.4 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
   1. Incorporate relay logic per the sequence of operations described in Section 262313 "Paralleling Low-Voltage Switchgear" and Section 262300 "Low-Voltage Switchgear".

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 Level III certification or NICET Electrical Power Testing Level III certification.
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

END OF SECTION

SECTION 260573.16 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY - WWTP

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.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Executive summary highlighting deficiencies, code violations, and recommended optimizations.

C. Other Action Submittals: Submit the following prior to approval of system protective devices submittals. Submittals shall be in digital form including PDF.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
      a. Submit study report for action prior to receiving final approval of the distribution equipment submittals, including but not limited to panelboards, transformers, switchboards, switchgear, substations, transfer switches, generators, motor controllers, and disconnect switches.. If formal completion of studies will cause delay in equipment manufacturing, provide preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices 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. The following parts from the Protective Device Coordination Study Report:
         1) One-line diagram.
         2) Protective device coordination study.
         3) Time-current coordination curves.
      b. Power system data.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
   1. Operation Technology, Inc (ETAP).
   2. SKM Systems Analysis, Inc.
   3. Bentley Systems (EasyPower).

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 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.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size 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.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY-WWTP.

F. 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, ground).
         2) Adjustable time-current characteristic.
         3) Adjustable instantaneous pickup.
         4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

G. 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. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   d. Transformer full-load current, magnetizing inrush current.
   e. Ground-fault protective devices.
   f. 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.
6. Comments and recommendations for system improvements.

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. 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 PROTECTIVE DEVICE COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Comply with NEC requirements.

D. The study shall be based on the device characteristics supplied by device manufacturer.

E. The extent of the electrical power system to be studied is indicated on Drawings.

F. Protective relay logic and settings shall be by the manufacturer and study engineer. Coordinate with Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR and Section 262300, LOW-VOLTAGE SWITCHGEAR.

G. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal system low-voltage load buses where fault current is 10 kA or less.

H. 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.

I. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   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.

J. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
   1. Electric utility's supply termination point.
   2. Switchgear.
   3. Low-voltage switchgear.
   4. Motor-control centers.
   5. Standby generators and automatic transfer switches.
   6. Branch circuit panelboards.

K. 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.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study.
   1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
   2. Use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide.
   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 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.
9. Maximum demands from service meters.
10. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
11. Motor horsepower and NEMA MG 1 code letter designation.
12. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
13. Data sheets to supplement electrical distribution system 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. Ratings, types, and settings of utility company's overcurrent protective devices.
    c. Special overcurrent protective device settings or types stipulated by utility company.
    d. Time-current-characteristic curves of devices indicated to be coordinated.
    e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    g. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

3.4 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
   1. Incorporate relay logic per the sequence of operations described in Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR and Section 262300, LOW-VOLTAGE SWITCHGEAR.

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 Level III certification or NICET Electrical Power Testing Level III certification.
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

END OF SECTION

SECTION 260573.19 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Executive summary highlighting deficiencies, code violations, and recommendedorecommendedo optimizations.

C. Study Submittals: Submit the following submittals prior to the approval of system protective devices submittals. Submittals shall be in digital form including PDF.
   1. Arc-flash study input data, including completed computer program input data sheets.
   2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
      a. Submit study report for action prior to receiving final approval of the distribution equipment submittals, including but not limited to panelboards, transformers, switchboards, switchgear, substations, transfer switches, generators, motor controllers, and disconnect switches.. If formal completion of studies will cause delay in equipment manufacturing, provide preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
   2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

PART 2 - PRODUCTS

2.1 SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide software by one of the following:
   1. Operation Technology, Inc (ETAP).
   2. SKM Systems Analysis, Inc.
   3. Bentley Systems (EasyPower).

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size 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.

D. Seperate One-line diagram showing equipment names with arc-flash incident energy value reported at each node as described herein.

E. Study Input Data: As described in "Power System Data" Article.

F. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

G. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

H. Arc-Flash Study Output:
   1. 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.

I. 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. Hazard risk category.
   8. Recommendations for arc-flash energy reduction.

J. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

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.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:
   1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Overcurrent Protective Device Short-Circuit Study."
   2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573.16 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.
   1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
   2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

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 shall be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond three to five cycles.

G. Arc-flash computation shall include 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 the conduct of the arc-flash hazard analysis.
   1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.

2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Electrical Survey Data: Gather and tabulate the following input data to support study.
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 at the service.
3. Power sources and ties.
4. 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.
5. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
6. Motor horsepower and NEMA MG 1 code letter designation.
7. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION

SECTION 260573.19 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Executive summary highlighting deficiencies, code violations, and recommendedorecommendedo optimizations.

C. Study Submittals: Submit the following submittals prior to the approval of system protective devices submittals. Submittals shall be in digital form including PDF.
   1. Arc-flash study input data, including completed computer program input data sheets.
   2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
      a. Submit study report for action prior to receiving final approval of the distribution equipment submittals, including but not limited to panelboards, transformers, switchboards, switchgear, substations, transfer switches, generators, motor controllers, and disconnect switches.. If formal completion of studies will cause delay in equipment manufacturing, provide preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
   2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

PART 2 - PRODUCTS

2.1 SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide software by one of the following:
   1. Operation Technology, Inc (ETAP).
   2. SKM Systems Analysis, Inc.
   3. Bentley Systems (EasyPower).

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size 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.

D. Seperate One-line diagram showing equipment names with arc-flash incident energy value reported at each node as described herein.

E. Study Input Data: As described in "Power System Data" Article.

F. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY-WWTP.

G. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY-WWTP.

H. Arc-Flash Study Output:
   1. 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.

I. 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. Hazard risk category.
   8. Recommendations for arc-flash energy reduction.

J. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

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.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:
   1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY-WWTP.
   2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY-WWTP.

C. Calculate maximum and minimum contributions of fault-current size.
   1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
   2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

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 shall be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond three to five cycles.

G. Arc-flash computation shall include 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 the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

B. Electrical Survey Data: Gather and tabulate the following input data to support study.
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 at the service.
3. Power sources and ties.
4. 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.
5. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
6. Motor horsepower and NEMA MG 1 code letter designation.
7. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION

SECTION 260800 – ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the contractor is partially responsible to execute, is defined in SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) hired by IHS will manage the commissioning process.

B. Related Sections:
   1. The requirements of this Section apply to all Sections of Division 26
   2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
   3. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

1.2 DEFINITIONS

A. Refer to SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS, for definitions.

1.3 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 26 is part of the construction process. Documentation and testing of these systems, as well as training of O&M personnel in accordance with the requirements of Division 01 and 26 Sections, is required in cooperation with the IHS and CxA.

B. The ELECTRICAL Systems Commissioning will include the systems listed in SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

1.4 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The CxA will provide a list of Submittals earmarked for CxA review. This list will be reviewed and approved by IHS prior to sharing with the contractor. Refer to SECTION 01 33 00 – SUBMITTAL PROCEDURES for further details.

B. The commissioning process requires Cx Submittal review simultaneous to A/E Submittal review. Specific submittal requirements related to the Commissioning Process are specified in SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 START-UP AND CONSTRUCTION INSPECTIONS

A. General. Commissioning of the Building Electrical Systems will require inspection of individual elements of the Electrical System construction throughout the construction period. The Contractor shall coordinate with the CxA in accordance with SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS and the Commissioning Plan to schedule inspections as required to support the commissioning process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. General. Pre-functional Checklists are developed and completed for all major equipment and systems being commissioned. The checklist captures equipment nameplate and characteristics data, confirming the as-built status of the equipment or system. These checklists also ensure that the systems are complete and operational, so that the functional performance testing can be scheduled. The checklists are drafted by the CxA and completed (filled out) by the installing Contractor.

B. Review. Upon notification of checklist completion, the CxA and IHS will review the Pre-Functional Checklists for accuracy. If the CxA or IHS determine that the information provided on a checklist is not accurate, the marked-up checklist will be returned to the Contractor for correction and resubmission. An item be added to the Commissioning Issue Log (CIL) to track the deficiency.

If the CxA or IHS determine that a significant number of completed checklists for similar equipment are not accurate, all the checklists for the equipment type will be returned to the Contractor for correction and resubmission.

Refer to SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

3.3 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. 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 sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, no flow, equipment failure, etc. shall also be tested.

B. Development of Test Procedures. Before test procedures are written, the CxA 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 CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA shall review contracted or factory testing which the CxA is not responsible to oversee and shall determine what further testing may be required to comply with the Contract Documents. Redundancy of testing shall be minimized.

C. 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 the control system's trend log capabilities or by stand-alone data loggers. The CxA will determine which method is most appropriate.
2. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures,

etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

3. Sampling. Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy will be developed by the CxA and approved by the Owner's Representative. For details on Sampling, refer to the Commissioning Plan. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units are tested at the Contractor's expense.

D. Coordination and Scheduling. The Contractor shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the Owner's Representative. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractor shall execute the tests.

E. Problem Solving. The CxA will recommend solutions to problems found; however, the burden of responsibility to solve, correct, and retest problems lie with the Contractor and their subcontractors.

3.4 O&M PERSONNEL TRAINING REQUIREMENTS

A. Training Plans: Contractor shall develop an instructional program that includes individual training modules for each system, subsystem, and equipment as specified in SECTION 01 79 00 – DEMONSTRATION AND TRAINING.

B. The minimum training requirements for Electrical Systems are specified in technical sections.

C. The CxA shall review and provide comment on the training plans developed by the contractor for alignment with the requirements of the OPR and BOD.

-- END OF SECTION --

SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes equipment and systems used to monitor and control electrical consumption:
   1. Multifunction meters.
   2. Power meters.
   3. Electrical power monitoring system software.
   4. Electrical power monitoring and control software.
   5. Network configuration software.
   6. Monitoring and control of power distribution equipment.
   7. System operator interfaces.
   8. Desktop workstations.
   9. Raceways and boxes.
   10. Wires and cables.
   11. Identification.

B. Related Requirements:
   1. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.
   2. Section 262313 "Paralleling Low-voltage Switchgear" for interfacing communication, monitoring, control, and metering requirements.

1.2 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. LAN: Local area network.

H. L-G: Line to ground.

I. L-L: Line to line.

J. L-N: Line to neutral.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

L. Modbus TCP/IP: An open protocol for exchange of process data.

M. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

N. N-G: Neutral to ground.

O. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

P. 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.

Q. TCP/IP: Transport control protocol/Internet.

R. UPS: Uninterruptible power supply; used both in singular and plural context.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:
   1. Product Data: Indicating that computers used by the system are certified by ENERGY STAR.

C. Shop Drawings: For power monitoring and control equipment.
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.
      a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:
         1) Location of the meters and gateways, and routing of the connecting wiring.
         2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
   3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
   4. Network naming and numbering scheme.
   5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
   6. Specifications for workstations.
   7. UPS sizing calculations for workstation.
   8. Surge Suppressors: Data for each device used and where applied.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:
   1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
      a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
      b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
      c. As-built versions of submittal Product Data.
      d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
      e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
      f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
      g. Engineering, installation, and maintenance manuals that explain how to do the following:
         1) Design and install new points, panels, and other hardware.
         2) Perform preventive maintenance and calibration.
         3) Debug hardware problems.
         4) Repair or replace hardware.
      h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
      i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
      j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
      k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
      l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
      m. Protective relay database files.
      n. Owner training materials.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Provide separately for each PC.
5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on compact disk or portable storage device with a USB interface of the hard-copy submittal.
6. Program Software Backup: On compact disk or portable storage device with a USB interface, complete with data files.
7. Device address list.
8. 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. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
   2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:
   1. Electrical meters that monitor, control, and connect to the data transmission network.
   2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
   3. Include PC-based workstation and displays as described in Section "262313 "Paralleling Low-voltage Switchgear" with web access, with its operating system and application software, connected to data transmission network.

B. The facility electrical power monitoring and control (SCADA) shall be fully integrated to, or included with the multiple-generator and PV paralleling microgrid monitoring and control system. See Section 262313 "Paralleling Low-voltage Switchgear" for additional power monitoring and control requirements.

C. The electrical power monitoring and control system shall be Internet based.
   1. System software shall be based on server thin-client architecture, designed around open standards of internet technology.
   2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
   3. Internet access shall be password protected.

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.

E. UL Compliance: Listed and labeled as complying with UL 61010-1.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
   1. Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

C. Interface with BAS for HVAC: Provide factory-installed hardware and software to enable the BAS for HVAC to monitor, display, and record data for use in processing reports.
   1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
   2. ASHRAE 135 (BACnet/IP) communication interface with the BAS system for HVAC shall enable the BAS for HVAC operator to remotely monitor meter information from a BAS for HVAC workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS for HVAC.

D. Backup Power Source:
   1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company.
   3. Schneider Electric USA, Inc.
   4. Schneider Electric.

B. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.
   1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
   2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of minus 4 deg to 158 deg F dry bulb and 5 to 95 percent relative humidity, noncondensing.
   2. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

E. Accuracy:
   1. Comply with ANSI C12.20, Class 0.5.
   2. Neutral Current Measurement: Not more than 0.65 percent.
   3. Power Factor: 1.0 percent.
   4. Frequency: 0.1 percent.
   5. THD: 1.0 percent.
   6. Waveform Sampling: 64 per cycle.

F. Data Link:
   1. RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port.

G. Meter Physical Characteristics:
   1. Display: Backlit LCD with antiglare and scratch-resistant lens.
   2. Display of Metered Values:
      a. One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:
         1) All meters.
         2) Measurements.
         3) THD.
         4) Energy.
         5) Demand.
         6) Minimum and maximum values.
         7) Power demand.

H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.

I. Meters:
   1. Instantaneous, rms:
      a. Current: Each phase, neutral and three-phase average.
      b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
      c. Active Power (kW): Each phase and three-phase total.
      d. Reactive Power (kVAR): Each phase and three-phase total.
      e. Apparent Power (kVA): Each phase and three-phase total.
      f. Power Factor: Each phase and three-phase total.
   2. Energy:
      a. Active Energy (kWh): Three-phase total.
   3. Demand, Derived from Instantaneous rms Meters:
      a. Current: Present and maximum.
      b. Active: Present and maximum.
      c. Reactive: Present and maximum.
      d. Apparent: Present and maximum.
   4. Power Quality Measurements:
      a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

J. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
   1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
      a. User-defined pulse output, associated with kWh.
      b. User-defined pulse output, associated with kVARh.

K. Capacities and Characteristics:
   1. Power Supply: 120-V ac, 60 Hz.
   2. Circuit Connections:
      a. Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
      b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
      c. Frequency: 45 to 65 Hz.
      d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Schneider Electric USA, Inc.
4. Siemens Industry Inc.;Low and Medium Voltage.

B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.
1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor installation in non-air-conditioned nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of minus 13 to 158 deg F Insert temperature range dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

E. Accuracy:
1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

F. Data Link:
1. RS-485 Modbus RTU protocol, 4-wire connection.
a. Provide for firmware and software updates through the communications port.

G. Meter Physical Characteristics:
1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:
a. All meters, including those listed under the following:
1) Measurements.
2) THD.
3) Energy.
4) Demand.
5) Minimum and maximum values.
6) Power demand.

H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.

I. Meters:
   1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.
      a. Voltage: L-L each phase, L-N each phase, and three-phase average.
      b. Current: Each phase, three-phase average, and neutral.
      c. Unbalanced current, L-L V ac and L-N V ac.
      d. Active Power (+/- kW): Each phase and three-phase total.
      e. Reactive Power (+/- kVAR): Each phase and three-phase total.
      f. Apparent Power (+/- kVA): Each phase and three-phase total.
      g. Displacement Power Factor: Each phase and three-phase total.
      h. Distortion Power Factor: Each phase and three-phase total.
      i. Frequency.
   2. THD from measurements simultaneously from the same cycle, through 15th harmonic.
      a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
      b. Current THD: Each phase and three-phase average.
      c. Total demand distortion.
   3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.
      a. Active kWh.
      b. Reactive kVARh.
      c. Apparent kVAh.
   4. Demand: Present, last, predicted, peak.
      a. Three-phase average current.
      b. Three-phase total active power (kW).
      c. Reactive power (kVAR).
      d. Apparent power (kVA).
   5. Minimum and Maximum Values:
      a. L-L and L-N voltages.
      b. Current in each phase.
      c. Power factor.
      d. Active power total.
      e. Reactive power total.
      f. Apparent power total.
      g. THD L-L and L-N voltages.
      h. THD current in each phase.
      i. Frequency.

J. Power Demand, User Selectable:
   1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
   2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
      a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.

b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:
   a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
   b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
   c. Provide for synchronizing the demand with the internal of this instrument.

K. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
1. Minimum and maximum of real-time rms measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

L. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:
1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

M. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:
1. Normal contact closure where the contacts change state for as long as the signal exists.
2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

N. Meter Face:
1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

O. Capacities and Characteristics:
1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:

a. Voltage: Measurements autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.

B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

C. Minimum Requirements:
1. Real-time multitasking and multiuser 64-bit operating system that allows execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

2.6 NETWORKED PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save parameters and features available at each of the connected meters.

B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be web enabled.

C. System Software Minimum Requirements:
1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

D. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity.
6. Security Access:
   a. Operator access to electrical monitoring and control system shall be under password control.
   b. An alphanumeric password shall be user assignable to each operator.
   c. Software shall have at least five access levels.
      1) View - View information. No change privileges allowed.
      2) User - Same as View, but is able to initiate control functions.
      3) Controller - Same as User, but is able to initiate communications.
      4) Operator - Same as Controller, but is able to modify configurations.
      5) Supervisor - Same as Operator, but is able to administer security privileges.
   d. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
   e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

E. Graphic Interface Software:
1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such shall be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.7 PROTECTIVE RELAY DATABASE FILES

A. Create relay and RTAC database files formatted as required by SEL manufacturer.
1. Files shall include settings recommended by Section 260573.13 "Power Systems Study".
2. Files shall include I/O needed for system operation per schematics and wiring diagrams.
3. This requirement includes all logic required in the relay for functional performance and sequences of operation.

2.8 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:
1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.

4. Query and download logs of interval data generated by the software and calculated by the meters.
5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.
    a. Support on-line changes while the data storage/retrieval application is running.
    b. Suffer no interruption to its operation while changes are being made.
    c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:
    a. Locations and identification of all monitored and controlled electrical equipment.
3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation with device identification.
4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, gateways and other network devices.

2.9 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:
1. Add and remove devices in the power monitoring and control network.
2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:
    a. Communication request/response and error rates, and timeouts.
    b. Log acquisition services.

B. Database Maintenance Features:
1. Backup, archive, and trim data, event, and waveform logs.
    a. Record start and end date for operation.
    b. Allow copying data to another database.

c. Be capable of selecting any or all of the logs specified for the meters that are Work of this Section.
   1) Data logs.
   2) Event logs.
   3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.
   1. Features:
      a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
      b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
      c. Distribution of reports via email.
   2. Report on power and demand profiles.
   3. Power quality report with CBEMA evaluation.
   4. EN 50160 compliance report.
   5. 100-ms PQ report.
   6. Energy over Period Report:
      a. User-defined rollup interval by day, week, month, or year.
      b. Compare daily energy to the following:
         1) Previous day.
         2) Same day, previous week.
         3) Same day, previous month.
         4) User-defined specific day.
      c. Compare weekly energy to the following:
         1) Previous week.
         2) Same week from previous month.
         3) Same week from previous year.
         4) User-defined specific week.
      d. Compare monthly energy to the following:
         1) Previous month.
         2) Same month from previous year.
         3) User-defined specific month.
      e. Compare annual energy to the following:
         1) Previous year.
         2) User-defined specific year.
   7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
   8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
   9. Trend Report:
      a. Show values for multiple measurements and measurements from multiple devices in any of the following graphical formats:
         1) Line chart.
         2) Pie graph.
         3) Bar chart.
         4) Column chart.
         5) Smooth line chart.

6) Stacked column chart.
7) Stacked bar chart.

10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:
    a. Device name.
    b. Device type.
    c. Device address.
    d. Connection status.
    e. Device protocol.
    f. Device description.
12. Each default report shall include the following:
    a. Summary aggregation of data from the selected devices.
    b. Individual device information.
    c. Raw data.
13. The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:
    a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
    b. Off-peak and on-peak times.

2.10 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:
1. A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.
3. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:
1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:
    a. User configurable, with secure password-protected login process.

b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.
d. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across all styles of power equipment.

E. Distribution Equipment Monitoring:
1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:
a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
b. Load current summary page to display circuit name, and phase a, b, and c rms current values.
c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.11 SYSTEM OPERATOR INTERFACES

A. Operator means of system access shall be through the following:
1. Touchscreen displays on switchgear and displays as described in Seciton 262313 "Paralleling Low-voltage Switchgear".
2. Desktop workstation with hardwired connection through LAN port.
3. Portable terminal with hardwired connection through LAN port at each meter.
4. Remote connection using outside of system PC, tablet, or phone using an internet portal.

2.12 DESKTOP WORKSTATIONS

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

1. Dell Inc.; Precision T-series.
2. HP; HP Z Workstation.
3. Lenovo; ThinkStation P Series.

B. Performance Requirements:
1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running Microsoft Windows.
3. ENERGY STAR compliant.

C. Personal Computer:
1. Minimum Processor Speed: Core i7.
2. RAM:
   a. Capacity: 64.
   b. Speed and Type: 1333 MHz.
3. Primary Hard Drive:
   a. Media: Solid state .
   b. Number of Hard Drives: Two.
4. Second Hard Drive:
   a. Media: Solid state .
5. Optical Drive:
   a. Reading Formats: Data, audio, recordable, and rewritable.
6. Optical Read and Write Drive:
   a. Include with at least 2 MB of data buffer.
   b. Average access time of 150 ms or less.
   c. MTBF of at least 100,000 power-on hours.
7. Expansion Slots: Minimum of 4, 64 bit.
8. Video Card:
   a. Capable of supporting four monitors.
   b. Resolution: 1920 by 1200 pixels minimum for each monitor.
   c. RAM: 16 GB.
9. Sound Card:
   a. At least 128 voice wavetable synthesis.
   b. Capable of delivering three-dimensional sound effects.
   c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
10. Network Interface Card: Include card with connection, as applicable.
    a. 10-100-1000 base TX Ethernet with RJ45 connector port.
    b. 100 base FX Ethernet with SC or ST port.
11. Wireless Ethernet, 802.11 a/b/g/n.
12. Optical Modem: Full duplex link for connection to optical fiber cable provided.
13. I/O Ports:
    a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    b. One serial port.
    c. One parallel port.
    d. Two PS/2 ports.
    e. One RJ-45.
    f. One stereo line-in and line-out on back panel.
    g. One microphone and headphone connector on front panel.

h. One IEEE 1394 on front and back panel with PCI-e card.
i. One ESATA port on back panel.

14. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

D. Keyboard:
1. 101-key enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to 72 inches in front of workstation.

E. Pointing Device:
1. Either a two- or three-button mouse.
2. Wireless operation within up to 72 inches in front of workstation.

F. Flat Panel Display Monitor:
1. Number of Displays: Two.
a. Display Support: Individual tilt adjustable base.
2. Color display with large viewable area.
3. Aspect Ratio: 16 to 9.
4. Resolution: 1920 by 1080 pixels at 60 Hz with pixel size of 0.277 mm or smaller.
5. ENERGY STAR compliant.
6. Antiglare display.

G. Speakers:
1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

H. I/O Cabling: Include applicable cabling to connect I/O devices.

I. Software:
1. Factory-installed operating system.

2.13 RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.14 WIRES AND CABLES

A. Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

2.15 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB France.
   2. Eaton.
   3. Schneider Electric USA, Inc.
   4. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 2.
   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 5A and 250-Vac, one normally open and one normally closed, for remote monitoring of protection status. 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.

C. 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 metal-oxide varistors in a given mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277V 208Y/120V, three-phase, four-wire circuits shall not exceed the following:
   1. L-N: 1200V for 480Y/277V, 700V for 208Y/120V.
   2. L-G: 1200V for 480Y/277V, 700V for 208Y/120V.
   3. N-G: 1200V for 480Y/277V, 700V for 208Y/120V.
   4. L-L: 2000V for 480Y/277V, 1200V for 208Y/120V.

F. Protection modes and UL 1449 SPD for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
   1. L-N: 700V.
   2. L-G: 700V.
   3. N-G: 700V.
   4. L-L: 1200V.

G. SCCR: Equal or exceed 200 kA.

H. Indoor Enclosures: NEMA 250, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Wiring and Cabling Installation:
1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.

E. Raceways Installation:
1. Comply with Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

F. Identification Installation:
1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, RS-485 cable, low-voltage control cable, and RS-232 cable.
3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

3.3 PROTECTIVE RELAY DATABASE FILES & INTEGRATION

A. Upload settings and programming in field and provide test reports to indicate functionality.

B. Upload relay settings to protective relays in field and provide test reports to indicate functionality.

C. Fully integrate relay devices with Generator Control System.

3.4 WORKSTATION INSTALLATION

A. Desktop Workstations Installation:
1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
3. Install software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

B. Graphics Application:
1. Use system schematics indicated 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. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.5 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.6 GROUNDING

A. For data communication wiring, comply with NECA/BICSI 568.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
   5. Optical-Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:
1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

6. Power Monitoring and Control System Tests.
a. Test 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.
b. Test Digital Signals:
1) Check digital signals using a jumper wire.
2) Check digital signals using an ohmmeter to test for contact making or breaking.
c. I/O Control Loop Tests:
1) Test every I/O point 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) Operate each analog point at the following:
a) Upper quarter of range.
b) Lower quarter of range.
c) At midpoint of range.
7) Exercise each binary point.
8) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.
9) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

B. Wiring and cabling will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when the power monitoring and control system is ready for final review. Written request shall state the following:
   1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
   2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
   3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
   4. The system is complete and ready for final review.

B. Review by Architect and Construction Manager will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review shall include a demonstration to parties participating in final review.

3.9 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.

B. Extent of Training:
   1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
   2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.

3. Minimum Training Requirements:
   a. Provide no fewer than two days of training total.
   b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
   c. Total days of training shall be broken into not more than four separate training classes.
   d. Each training class shall be no fewer than two consecutive day(s).

C. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

D. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have no fewer than five years of providing instructional training on no fewer than five past projects with similar electrical monitoring and control system scope and complexity.

E. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

F. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

3.12 At Completion of Training:

A. Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

B. Demonstration shall include, but not be limited to, the following:

1. Accuracy and calibration of 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.
2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.
7. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:
    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
12. For Each Workstation:
    a. I/O point lists agree with naming conventions.
    b. Graphics are complete.
    c. UPS unit, if applicable, operates.

END OF SECTION

SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes equipment and systems used to monitor and control electrical consumption:
   1. Multifunction meters.
   2. Power meters.
   3. Electrical power monitoring system software.
   4. Electrical power monitoring and control software.
   5. Network configuration software.
   6. Monitoring and control of power distribution equipment.
   7. System operator interfaces.
   8. Desktop workstations.
   9. Raceways and boxes.
   10. Wires and cables.
   11. Identification.

B. Related Requirements:
   1. Section 262713, ELECTRICITY METERING - WWTP for equipment to meter electricity consumption and demand for tenant submetering.
   2. Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR for interfacing communication, monitoring, control, and metering requirements.

1.2 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. LAN: Local area network.

H. L-G: Line to ground.

I. L-L: Line to line.

J. L-N: Line to neutral.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

L. Modbus TCP/IP: An open protocol for exchange of process data.

M. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

N. N-G: Neutral to ground.

O. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

P. 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.

Q. TCP/IP: Transport control protocol/Internet.

R. UPS: Uninterruptible power supply; used both in singular and plural context.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:
   1. Product Data: Indicating that computers used by the system are certified by ENERGY STAR.

C. Shop Drawings: For power monitoring and control equipment.
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.
      a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:
         1) Location of the meters and gateways, and routing of the connecting wiring.
         2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
   3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
   4. Network naming and numbering scheme.
   5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
   6. Specifications for workstations.
   7. UPS sizing calculations for workstation.
   8. Surge Suppressors: Data for each device used and where applied.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:
   1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
      a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
      b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
      c. As-built versions of submittal Product Data.
      d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
      e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
      f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
      g. Engineering, installation, and maintenance manuals that explain how to do the following:
         1) Design and install new points, panels, and other hardware.
         2) Perform preventive maintenance and calibration.
         3) Debug hardware problems.
         4) Repair or replace hardware.
      h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
      i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
      j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
      k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
      l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
      m. Owner training materials.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.

2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Provide separately for each PC.
5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on compact disk or portable storage device with a USB interface of the hard-copy submittal.
6. Program Software Backup: On compact disk or portable storage device with a USB interface, complete with data files.
7. Device address list.
8. 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. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
   2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:
   1. Electrical meters that monitor, control, and connect to the data transmission network.
   2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
   3. Include PC-based workstation and displays as described in Section "262313 "Paralleling Low-voltage Switchgear" with web access, with its operating system and application software, connected to data transmission network.

B. Obtain the facility electrical power monitoring and control (SCADA) from the multiple-generator and PV paralleling microgrid monitoring and control system, and paralleling low-voltage switchgear, and engine generator manufacturer.

C. The electrical power monitoring and control system shall be Internet based.
   1. System software shall be based on server thin-client architecture, designed around open standards of internet technology.
   2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
   3. Internet access shall be password protected.

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.

E. UL Compliance: Listed and labeled as complying with UL 61010-1.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
   1. Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

C. Interface with BAS System for HVAC: Provide factory-installed hardware and software to enable the BAS system for HVAC to monitor, display, and record data for use in processing reports.
   1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
   2. ASHRAE 135 (BACnet) communication interface with the BAS system for HVAC shall enable the BAS system for HVAC operator to remotely monitor meter information from a BAS system for HVAC workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS system for HVAC.

D. Backup Power Source:
   1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company.

3. Schneider Electric USA, Inc.
4. Schneider Electric.

B. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.
   1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
   2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of minus 4 deg to 158 deg F dry bulb and 5 to 95 percent relative humidity, noncondensing.
   2. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

E. Accuracy:
   1. Comply with ANSI C12.20, Class 0.5.
   2. Neutral Current Measurement: Not more than 0.65 percent.
   3. Power Factor: 1.0 percent.
   4. Frequency: 0.1 percent.
   5. THD: 1.0 percent.
   6. Waveform Sampling: 64 per cycle.

F. Data Link:
   1. RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port.

G. Meter Physical Characteristics:
   1. Display: Backlit LCD with antiglare and scratch-resistant lens.
   2. Display of Metered Values:
      a. One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:
         1) All meters.
         2) Measurements.
         3) THD.
         4) Energy.
         5) Demand.
         6) Minimum and maximum values.
         7) Power demand.

H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 Insert number samples per cycle, simultaneously on all voltage and current channels of the meter.

I. Meters:
   1. Instantaneous, rms:
      a. Current: Each phase, neutral and three-phase average.

b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
c. Active Power (kW): Each phase and three-phase total.
d. Reactive Power (kVAR): Each phase and three-phase total.
e. Apparent Power (kVA): Each phase and three-phase total.
f. Power Factor: Each phase and three-phase total.

2. Energy:
   a. Active Energy (kWh): Three-phase total.
3. Demand, Derived from Instantaneous rms Meters:
   a. Current: Present and maximum.
   b. Active: Present and maximum.
   c. Reactive: Present and maximum.
   d. Apparent: Present and maximum.
4. Power Quality Measurements:
   a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

J. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
   a. User-defined pulse output, associated with kWh.
   b. User-defined pulse output, associated with kVARh.

K. Capacities and Characteristics:
1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:
   a. Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
   b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
   c. Frequency: 45 to 65 Hz.
   d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. General Electric Company.
3. Schneider Electric USA, Inc.
4. Siemens Industry Inc.; Low and Medium Voltage.

B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor installation in non-air-conditioned nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of minus 13 to 158 deg F Insert temperature range dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

E. Accuracy:
1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

F. Data Link:
1. RS-485 Modbus RTU protocol, 4-wire connection.
a. Provide for firmware and software updates through the communications port.

G. Meter Physical Characteristics:
1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:
a. All meters, including those listed under the following:
1) Measurements.
2) THD.
3) Energy.
4) Demand.
5) Minimum and maximum values.
6) Power demand.

H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle Insert number, simultaneously on all voltage and current channels of the meter.

I. Meters:
1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.

a. Voltage: L-L each phase, L-N each phase, and three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Unbalanced current, L-L V ac and L-N V ac.
d. Active Power (+/- kW): Each phase and three-phase total.
e. Reactive Power (+/- kVAR): Each phase and three-phase total.
f. Apparent Power (+/- kVA): Each phase and three-phase total.
g. Displacement Power Factor: Each phase and three-phase total.
h. Distortion Power Factor: Each phase and three-phase total.
i. Frequency.

2. THD from measurements simultaneously from the same cycle, through 15th harmonic.
   a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
   b. Current THD: Each phase and three-phase average.
   c. Total demand distortion.
3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.
   a. Active kWh.
   b. Reactive kVARh.
   c. Apparent kVAh.
4. Demand: Present, last, predicted, peak.
   a. Three-phase average current.
   b. Three-phase total active power (kW).
   c. Reactive power (kVAR).
   d. Apparent power (kVA).
5. Minimum and Maximum Values:
   a. L-L and L-N voltages.
   b. Current in each phase.
   c. Power factor.
   d. Active power total.
   e. Reactive power total.
   f. Apparent power total.
   g. THD L-L and L-N voltages.
   h. THD current in each phase.
   i. Frequency.

J. Power Demand, User Selectable:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
   a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
   b. Fixed block that calculates demand at end of the interval.
   c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
3. Demand Calculation Initiated by a Synchronization Signal:

a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
c. Provide for synchronizing the demand with the internal of this instrument.

K. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
1. Minimum and maximum of real-time rms measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

L. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 Insert number metered items. Each alarm shall be user configured, by using the following options:
1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

M. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:
1. Normal contact closure where the contacts change state for as long as the signal exists.
2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

N. Meter Face:
1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

O. Capacities and Characteristics:
1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:
a. Voltage: Measurements autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.

b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.

B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

C. Minimum Requirements:
1. Real-time multitasking and multiuser 64-bit operating system that allows execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

2.6 NETWORKED PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save parameters and features available at each of the connected meters.

B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be web enabled.

C. System Software Minimum Requirements:
1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

D. Operator Interface Software:
1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.

3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity.
6. Security Access:
   a. Operator access to electrical monitoring and control system shall be under password control.
   b. An alphanumeric password shall be user assignable to each operator.
   c. Software shall have at least five access levels.
      1) View - View information. No change privileges allowed.
      2) User - Same as View, but is able to initiate control functions.
      3) Controller - Same as User, but is able to initiate communications.
      4) Operator - Same as Controller, but is able to modify configurations.
      5) Supervisor - Same as Operator, but is able to administer security privileges.
   d. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
   e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

E. Graphic Interface Software:
1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such shall be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.7 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:
1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.
4. Query and download logs of interval data generated by the software and calculated by the meters.
5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.
   a. Support on-line changes while the data storage/retrieval application is running.
   b. Suffer no interruption to its operation while changes are being made.

c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:
a. Locations and identification of all monitored and controlled electrical equipment.
3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation with device identification.
4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, gateways and other network devices.

2.8 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:
1. Add and remove devices in the power monitoring and control network.
2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:
a. Communication request/response and error rates, and timeouts.
b. Log acquisition services.

B. Database Maintenance Features:
1. Backup, archive, and trim data, event, and waveform logs.
a. Record start and end date for operation.
b. Allow copying data to another database.
c. Be capable of selecting any or all of the logs specified for the meters that are Work of this Section.
1) Data logs.
2) Event logs.
3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.
1. Features:
a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
c. Distribution of reports via email.

2. Report on power and demand profiles.
3. Power quality report with CBEMA evaluation.
4. EN 50160 compliance report.
5. 100-ms PQ report.
6. Energy over Period Report:
    a. User-defined rollup interval by day, week, month, or year.
    b. Compare daily energy to the following:
        1) Previous day.
        2) Same day, previous week.
        3) Same day, previous month.
        4) User-defined specific day.
    c. Compare weekly energy to the following:
        1) Previous week.
        2) Same week from previous month.
        3) Same week from previous year.
        4) User-defined specific week.
    d. Compare monthly energy to the following:
        1) Previous month.
        2) Same month from previous year.
        3) User-defined specific month.
    e. Compare annual energy to the following:
        1) Previous year.
        2) User-defined specific year.
7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. Trend Report:
    a. Show values for multiple measurements and measurements from multiple devices in any of the following graphical formats:
        1) Line chart.
        2) Pie graph.
        3) Bar chart.
        4) Column chart.
        5) Smooth line chart.
        6) Stacked column chart.
        7) Stacked bar chart.
10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:
    a. Device name.
    b. Device type.
    c. Device address.
    d. Connection status.
    e. Device protocol.
    f. Device description.
12. Each default report shall include the following:
    a. Summary aggregation of data from the selected devices.
    b. Individual device information.

c. Raw data.

13. The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:
    a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
    b. Off-peak and on-peak times.

2.9 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:
1. A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.
3. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:
1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:
    a. User configurable, with secure password-protected login process.
    b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
    c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.
    d. Allow firmware upgrades through the communications port.
4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across all styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:
   a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
   b. Load current summary page to display circuit name, and phase a, b, and c rms current values.
   c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
   d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
   e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
   f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
   g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.10 SYSTEM OPERATOR INTERFACES

A. Operator means of system access shall be through the following:
   1. Touchscreen displays on switchgear and displays as described in Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR.
   2. Desktop workstation with hardwired connection through LAN port.
   3. Portable terminal with hardwired connection through LAN port at each meter.
   4. Remote connection using outside of system PC, tablet, or phone using an internet portal.

2.11 RACEWAYS AND BOXES

A. Comply with requirements in Section 260533, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS - WWTP for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

B. Comply with requirements in Section 270528, PATHWAYS FOR COMMUNICATIONS SYSTEMS for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.12 WIRES AND CABLES

A. Electrical Power Wiring: Comply with requirements in Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES - WWTP.
   1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring: Comply with requirements in Section 260523, CONTROL-VOLTAGE ELECTRICAL POWER CABLES - WWTP.

2.13 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB France.
   2. Eaton.
   3. Schneider Electric USA, Inc.
   4. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 2.
   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 5A and 250-Vac, one normally open and one normally closed, for remote monitoring of protection status. 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.

C. 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 metal-oxide varistors in a given mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277V 208Y/120V, three-phase, four-wire circuits shall not exceed the following:
   1. L-N: 1200V for 480Y/277V, 700V for 208Y/120V.
   2. L-G: 1200V for 480Y/277V, 700V for 208Y/120V.
   3. N-G: 1200V for 480Y/277V, 700V for 208Y/120V.
   4. L-L: 2000V for 480Y/277V, 1200V for 208Y/120V.

F. Protection modes and UL 1449 SPD for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
   1. L-N: 700V.
   2. L-G: 700V.
   3. N-G: 700V.
   4. L-L: 1200V.

G. SCCR: Equal or exceed 200 kA.

H. Indoor Enclosures: NEMA 250, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Wiring and Cabling Installation:
1. Comply with Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES - WWTP for electrical power wiring.
2. Comply with Section 260523, CONTROL-VOLTAGE ELECTRICAL POWER CABLES - WWTP for control wiring.

E. Raceways Installation:
1. Comply with Section 260533, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS - WWTP for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
2. Comply with Section 270528, PATHWAYS FOR COMMUNICATIONS SYSTEMS for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

F. Identification Installation:
1. Comply with Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES - WWTP for electrical power wiring.
2. Comply with Section 271513, COMMUNICATIONS COPPER HORIZONTAL CABLING for identification products and cable management system requirements for twisted pair cable, RS-485 cable, low-voltage control cable, and RS-232 cable.
3. Comply with Section 271523, COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING for identification products and cable management system requirements for optical-fiber cable.

3.3 WORKSTATION INSTALLATION

A. Desktop Workstations Installation:
1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
3. Install software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

B. Graphics Application:
1. Use system schematics indicated 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. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.

7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

A. For data communication wiring, comply with NECA/BICSI 568.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS - WWTP.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
   5. Optical-Fiber Cable Tests:
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Link End-to-End Attenuation Tests:
         1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.

c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

6. Power Monitoring and Control System Tests.
   a. Test 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.
   b. Test Digital Signals:
      1) Check digital signals using a jumper wire.
      2) Check digital signals using an ohmmeter to test for contact making or breaking.
   c. I/O Control Loop Tests:
      1) Test every I/O point 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) Operate each analog point at the following:
         a) Upper quarter of range.
         b) Lower quarter of range.
         c) At midpoint of range.
      7) Exercise each binary point.
      8) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.
      9) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

B. Wiring and cabling will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when the power monitoring and control system is ready for final review. Written request shall state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by Architect and Construction Manager will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review shall include a demonstration to parties participating in final review.

3.8 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.

B. Extent of Training:
1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:
   a. Provide no fewer than two days of training total.
   b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.

c. Total days of training shall be broken into not more than four separate training classes.
d. Each training class shall be no fewer than two consecutive day(s).

C. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

D. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have no fewer than five years of providing instructional training on no fewer than five past projects with similar electrical monitoring and control system scope and complexity.

E. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

F. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

3.11 At Completion of Training:

A. Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

B. Demonstration shall include, but not be limited to, the following:
1. Accuracy and calibration of 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.

2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.
7. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:
    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
12. For Each Workstation:
    a. I/O point lists agree with naming conventions.
    b. Graphics are complete.
    c. UPS unit, if applicable, operates.

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 ACTION SUBMITALLS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show installation details for the following:
      a. Occupancy sensors.
      b. Vacancy sensors.
   2. Interconnection diagrams showing field-installed wiring, all devices and equipment shown on reflected ceiling plans, drawn to scale.
   3. Include diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. As-built drawings for the lighting control system.

C. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of lighting control software.
      b. Faulty operation of lighting control devices.
   2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products compatible with system specified in Section 260943 "Network Lighting Controls".

2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Description: System operates indoor lighting.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   1. Lighting control set point is based on the following two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2.5 EMERGENCY LIGHTING CONTROL RELAY

A. Description: Emergency lighting control relay which bypasses all local dimming/switching controls upon loss of normal power.
   1. Voltage: 120V or 277V as required to match circuit voltage.
   2. Dimming: Capable of acception 0-10V dimming signal and passing through the signal during normal operation. Relay shall bring the connected light fixtures to full brightness upon loss of normal power.
   3. Current rating: 16A, minimum.
   4. Compatible Load Types: LED.
   5. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.
   6. Test Switch: Visible momentary contact switch.
   7. UL 924 Listed.

2.6 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bodine.
   2. Hubbell.
   3. ETC.

B. Description: Emergency lighting transfer device which automatically transfers to an emergency power source upon loss of power and overrides all local dimming/switching controls.
   1. Voltage: 120V or 277V.
   2. Current Rating: 16A, minimum.
   3. Compatible Load Types: Incandescent, halogen, magnetic ballasts, electronic ballasts, LED drivers.
   4. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.

5. Test Switch: Visible momentary contact switch.
6. UL 1008 Listed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in other sections.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES - WWTP

PART 1 - GENERAL

1.1 ACTION SUBMITALLS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show installation details for the following:
      a. Occupancy sensors.
      b. Vacancy sensors.
   2. Interconnection diagrams showing field-installed wiring, all devices and equipment shown on reflected ceiling plans, drawn to scale.
   3. Include diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of lighting control software.
      b. Faulty operation of lighting control devices.
   2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products compatible with system specified in Section 260943, NETWORK LIGHTING CONTROLS.

2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Description: System operates indoor lighting.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   1. Lighting control set point is based on the following two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2.5 EMERGENCY LIGHTING CONTROL RELAY

A. Description: Emergency lighting control relay which bypasses all local dimming/switching controls upon loss of normal power.
   1. Voltage: 120V or 277V as required to match circuit voltage.
   2. Dimming: Capable of acception 0-10V dimming signal and passing through the signal during normal operation. Relay shall bring the connected light fixtures to full brightness upon loss of normal power.
   3. Current rating: 16A, minimum.
   4. Compatible Load Types: LED.
   5. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.
   6. Test Switch: Visible momentary contact switch.
   7. UL 924 Listed.

2.6 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bodine.
   2. Hubbell.
   3. ETC.

B. Description: Emergency lighting transfer device which automatically transfers to an emergency power source upon loss of power and overrides all local dimming/switching controls.
   1. Voltage: 120V or 277V.
   2. Current Rating: 16A, minimum.
   3. Compatible Load Types: Incandescent, halogen, magnetic ballasts, electronic ballasts, LED drivers.
   4. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.

5. Test Switch: Visible momentary contact switch.
6. UL 1008 Listed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES-WWTP. Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.
1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in other sections.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manually operated lighting controls with and control module.

B. Section includes manually operated, PC-based, digital lighting controls with external signal source and control module.

C. Related Requirements:
1. Section 260923 "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and multipole contactors.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

C. PC: Personal computer; sometimes plural as "PCs."

D. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

E. UTP: Unshielded twisted pair.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
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. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

B. As-built drawings for the lighting control system.

C. Software and Firmware Operational Documentation:
   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.

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. Electrically Held Relays: Equal to 10 percent of amount installed for each size indicated, but no fewer than 3 relays per panel installed.
   2. Electrically Operated, Molded-Case Circuit Breakers: Equal to 10 percent of amount installed for each size indicated, but no fewer than 3 circuit breakers per panel installed.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a 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 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.

E. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate lighting control components specified in this Section with components specified in Section 262416 "Panelboards."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   1. Failures include, but are not limited to, the following:

a. Failure of software input/output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.

2. Warranty Period: Two years from date of Substantial Completion.
3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Acuity Brands Lighting, Inc.; Lithonia Lighting brand.
2. Intelligent Lighting Controls.
3. Lutron Electronics Co., Inc.

2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switch operation sends a signal to network-system control module that processes the signal according to its programming and routes an open or close command to one or more in the power-supply circuits to groups of lighting fixtures or other loads.

C. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network-system control module that processes the signal according to its programming and routes an open or close command to one or more in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

D. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
   1. Hardwired Points:
      a. Monitoring: On-off status, .
      b. Control: On-off operation, .
   2. Communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.3 CONTROL MODULE

A. Control Module Description: Programmable, PC-based unit with 17-inch color video monitor and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.
   1. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
   2. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
   3. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
   4. Astronomic Control: Automatic adjustment of dawn and dusk switching.
   5. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
      a. Software shall interpret status signals, provide for their display, and initiate failure signals.
   6. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over . System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.
   7. Telephone Override Capability: Override programmed lighting shutdown commands by telephoning computer and entering a voice-menu-guided, override touch-tone code specific to zone being controlled.
   8. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
   9. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.
   10. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
   11. Programmed time signals shall change preset scenes and dimmer settings.

12. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.
13. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.
14. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.
15. Flicker Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
16. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
17. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

2.4 MANUAL ANALOG SWITCHES AND PLATES

A. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 262726 "Wiring Devices."

B. Wall-Box Dimmers: Comply with Section 262726 "Wiring Devices."

C. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.

B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
   1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Section 262726 "Wiring Devices."
   2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable and with Section 271500 "Communications Horizontal Cabling."

D. RS-485 Cables:
   1. Plenum-Rated Cable: NFPA 70, Type CMP.
      a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
      b. Fluorinated ethylene propylene insulation.
      c. Unshielded.
      d. Fluorinated ethylene propylene jacket.
      e. Flame Resistance: NFPA 262, Flame Test.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Minimum conduit size shall be 1/2 inch.
   1. For power wiring comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

3.2 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

END OF SECTION

SECTION 260943.23 - RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lighting control panels using mechanically held relays for switching.

B. Section Includes: Networked lighting control panels using control-voltage relays for switching and that are interoperable with HVAC DDC system.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital control.

C. IP: Internet protocol.

D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings: For each relay panel and related equipment.
1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.
6. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
7. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
8. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

1.4 INFORMATIONAL SUBMITTALS

A. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

B. As-built drawings for the lighting control system.

C. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.

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. Lighting Control Relays: Equal to 10 percent of amount installed, but no fewer than 15.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation according to NECA 407.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of standalone multipreset modular dimming controls that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Damage from transient voltage surges.
2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.

B. Interface with HVAC DDC System: Hardware and software shall interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."
   1. Hardwired Points:
      a. Monitoring: On-off status.
      b. Control: On-off operation.
   2. Communication Interface: Comply with ASHRAE 135. The communication interface shall enable the HVAC DDC system operator to remotely control and monitor lighting from a HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the HVAC DDC system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

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.

E. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

F. Comply with UL 916.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Lighting control panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Component Importance Factor: As defined in structural drawings. .
   3. Component Amplification Factor and Component Response Modification Factor: As defined in structural drawings.

2.3 LIGHTING CONTROL RELAY PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Intermatic, Inc.
   2. Leviton Manufacturing Co., Inc.
   3. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.

C. Lighting Control Panel:
   1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
   2. A vertical barrier separating branch circuits from control wiring.

D. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
   1. Timing Unit:

a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
c. Four independent schedules, each having 24 time periods.
d. Schedule periods settable to the minute.
e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
f. 10 special date periods.

2. Sequencing Control with Override:
a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
d. Override control "blink warning" shall warn occupants approximately five minutes before actuating the off sequence.

3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.

E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire, 24-V ac.

F. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac.

G. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.

H. Operator Interface:
1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
2. Log and display relay on-time.
3. Connect relays to one or more time and sequencing schemes.

2.4 NETWORKED LIGHTING CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Intermatic, Inc.
2. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels shall be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.

C. Main Control Unit: Installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.
   1. Ethernet Communications: Comply with protocol. The main control unit shall provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.
   2. Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.
   3. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.
      a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
      b. Panel summary showing the master and slave panels connected to the controller.
      c. Controller diagnostic information.
      d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens shall also allow direct breaker control and zone overrides.
   4. Timing Unit:
      a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
      b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
      c. Four independent schedules, each having 24 time periods.
      d. Schedule periods settable to the minute.
      e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
      f. 16 special date periods.
   5. Time Synchronization: The timing unit shall be updated not less than every hour(s) with the network time server.
   6. Sequencing Control with Override:
      a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
      b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
      c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
      d. Override control "blinking warning" shall warn occupants approximately five minutes before actuating the off sequence.
      e. Activity log, storing previous relay operation, including the time and cause of the change of status.
      f. Download firmware to the latest version offered by manufacturer.

D. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.

1. Electronic control for operating and monitoring individual relays, and display relay on-time.
2. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
3. Integral keypad and digital-display front panel for local setup, including the following:
   a. Blink notice, time adjustable from software.
   b. Ability to log and display relay on-time.
   c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire, 24-V ac digital control network.

F. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac digital control network.

G. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.

H. Operator Interface: At the main control unit, provide interface for a tethered connection of a portable PC running MS Windows Insert digital device and operating system for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device shall remain the property of Owner.

I. Software:
1. Menu-driven data entry.
2. Online and offline programming and editing.
3. Provide for entry of the room or space designation for the load side of each relay.
4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
5. Size the software appropriate to the system.

2.5 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.
1. Match color and style specified in Section 262726 "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED SIGNAL SOURCES

A. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

B. Indoor Occupancy Sensors and Extreme-Temperature Occupancy Sensors: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Twisted-Pair Data Cable: Category 5e. Comply with requirements for twisted pair cabling in Section 260523 "Control-Voltage Electrical Power Cables."

D. Twisted-Pair Data Cable: Category 5e. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental airspaces, including plenum ceilings.
   2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANEL INSTALLATION

A. Comply with NECA 1.

B. Install panels and accessories according to NECA 407.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panel cabinet plumb and rigid without distortion of box.

F. Install filler plates in unused spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections. Testing shall be coordinated with Owner for 3rd party observation.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

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. 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.
   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 panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:
1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Lighting control panel will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 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.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the 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 the control unit and operator interface.

END OF SECTION

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 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. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Certification: Indicate that equipment meets Project seismic requirements.

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. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. 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.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. Siemens Power Transmission & Distribution, Inc.
4. Square D; by Schneider Electric.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. 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.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.

2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

D. Coils: Continuous windings without splices except for taps.
1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

E. Taps for Transformers 3 kVA and Smaller: None.

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 two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 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 115 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

M. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

2.5 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:
   a. High-voltage to ground.
   b. Low-voltage to ground.
   c. High-voltage to low-voltage.
9. Temperature tests.

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.
   2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports as described below. Locate transformers away from corners and not parallel to adjacent wall surface.

1. Non-slab on grade installations: Floor or stack mounted transformers as shown on Drawings shall be provided with vibration isolation at each mounting point, minimum (4) per transformer. Isolator shall be Eaton B-Line; Part CNNK-9, with bolt isolation washer by Mason Industries; Part HG; equivalent parts may be considered. Bolt washer shall be sized per mounting hardware diameter and installed per manufacturers specifications.
2. Non-slab on grade installations:

C. Construct concrete bases according to Division 03 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.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. 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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
1. Visual and Mechanical Inspection.
    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, and grounding.
    c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    d. Verify the unit is clean.
    e. Perform specific inspections and mechanical tests recommended by manufacturer.
    f. Verify that as-left tap connections are as specified.

g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:
   a. Measure resistance at each winding, tap, and bolted connection.
   b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
   c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
   d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
      e. Perform specific inspections and mechanical tests recommended by manufacturer.
      f. Verify that as-left tap connections are as specified.
      g. Verify the presence of surge arresters and that their ratings are as specified.
   2. Electrical Tests:
      a. Measure resistance at each winding, tap, and bolted connection.
      b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
      c. Perform power-factor or dissipation-factor tests on all windings.
      d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
      e. Perform an excitation-current test on each phase.
      f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
      g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. 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 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 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. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Certification: Indicate that equipment meets Project seismic requirements.

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. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. 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.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. Siemens Power Transmission & Distribution, Inc.
4. Square D; by Schneider Electric.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. 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.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.

C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.

2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

D. Coils: Continuous windings without splices except for taps.
1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

E. Taps for Transformers 3 kVA and Smaller: None.

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 two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 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 115 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

M. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

2.5 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
   1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
   2. Ratio tests at rated voltage connections and at all tap connections.
   3. Phase relation and polarity tests at rated voltage connections.
   4. No load losses, and excitation current and rated voltage at rated voltage connections.
   5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
   6. Applied and induced tensile tests.
   7. Regulation and efficiency at rated load and voltage.
   8. Insulation-Resistance Tests:
      a. High-voltage to ground.
      b. Low-voltage to ground.
      c. High-voltage to low-voltage.
   9. Temperature tests.

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-WWTP 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.
   2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports as described below. Locate transformers away from corners and not parallel to adjacent wall surface.

1. Non-slab on grade installations: Floor or stack mounted transformers as shown on Drawings shall be provided with vibration isolation at each mounting point, minimum (4) per transformer. Isolator shall be Eaton B-Line; Part CNNK-9, with bolt isolation washer by Mason Industries; Part HG; equivalent parts may be considered. Bolt washer shall be sized per mounting hardware diameter and installed per manufacturers specifications.
2. Non-slab on grade installations:

C. Construct concrete bases according to Division 03 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-WWTP.
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.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

B. Connect wiring according to Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES-WWTP.

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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
1. Visual and Mechanical Inspection.
    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, and grounding.
    c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    d. Verify the unit is clean.
    e. Perform specific inspections and mechanical tests recommended by manufacturer.
    f. Verify that as-left tap connections are as specified.

g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:
   a. Measure resistance at each winding, tap, and bolted connection.
   b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
   c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
   d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
      e. Perform specific inspections and mechanical tests recommended by manufacturer.
      f. Verify that as-left tap connections are as specified.
      g. Verify the presence of surge arresters and that their ratings are as specified.
   2. Electrical Tests:
      a. Measure resistance at each winding, tap, and bolted connection.
      b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
      c. Perform power-factor or dissipation-factor tests on all windings.
      d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
      e. Perform an excitation-current test on each phase.
      f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
      g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. 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 262300 - LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:
1. Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19 "Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
3. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

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 switchgear.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For low-voltage switchgear.
1. System Power One-Line Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
a. Frame size of each circuit breaker.
b. Trip rating for each circuit breaker.
c. Conduit and wire size for each feeder.
2. Include plans, elevations, sections, shipping splits, and mounting details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
6. Indicate short-time and short-circuit current rating of switchgear assembly.
7. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include mimic-bus diagram.

C. Delegated-Design Submittal: For low-voltage switchgear.
   1. For the differential ground-fault protection scheme. Include wiring diagram of the differential system along with test procedure recommended by UL 1558, using high-current injection equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around the low-voltage switchgear where pipe and ducts are prohibited.

B. Qualification Data: For testing.

C. Seismic Qualification Data: Certificates, for switchgear, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Test Reports: Submit evidence that switchgear is compatible with connected monitoring and control devices and systems specified in Section 260913 "Electrical Power Monitoring and Control."
   1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
   2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

E. Protective Relay Database Files
   1. Create relay database files formatted as required by protective relay manufacturer.
      a. Files shall include settings recommended by Section 260573 Power System Studies.
      b. Files shall include I/O need for system operation per schematics and wiring diagrams.
      c. This requirement includes all logic required in the relay for functional performance.

F. Source quality-control reports.

G. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For equipment 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. Time-current curves (on full-size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

b. Lists of spare parts and replacement components recommended for storage at Project site.
c. Detailed instructions covering operation under both normal and abnormal conditions.
d. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.

B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

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. Fuses: One for every three of each type and rating, but no fewer than three of each for the following:
a. Potential transformers.
b. Control power circuits.
2. Drawout Circuit Breakers: One of each type and rating used for circuit breaker in the switchgear.

B. System Power Riser Diagram: For each switchgear, post on the wall at each location, using non-fugitive ink on high-quality paper.

1.6 QUALITY ASSURANCE

A. Testing Qualifications: Accredited by NETA.
1. Testing Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Indoor Switchgear Storage: Store in a dry, clean location, placed on a level surface to prevent strain and possible distortion. During the construction period, provide protection against dust, dirt, falling objects, dripping water, water, excessive moisture, and other possible causes of damage to the equipment. Any temporary covering shall not restrict ventilation and may not be removed until the equipment is ready for installation. Take special precaution to keep the equipment sufficiently warm with adequate ventilation to prevent condensation during the storage period. Install temporary heating if necessary.

B. When provisions for temporary power connection are provided as part of the switchgear assembly, provisions shall be included to prevent energization of primary buses or connections by means of backfeed through fuses or control power transformers connected to the primary buses or connections.

C. If outdoor switchgear cannot be installed and energized, temporary power shall be provided for the operation of the space heaters provided so as to prevent condensation of moisture within the housing.

D. Ventilation openings shall be left open to permit proper air circulation.

1.8 FIELD CONDITIONS

A. Ambient Environment Ratings:
   1. Ambient Temperature Rating: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Humidity Rating: Less than 95 percent (noncondensing).
   3. Altitude Rating: Not exceeding 6600 feet.
   4. The effect of solar radiation is insignificant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Inc.
   2. Eaton.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

2.2 SYSTEM DESCRIPTION

A. Description: Metal-enclosed, low-voltage switchgear with drawout power circuit breakers, with accessories and metering components.
   1. 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. Comply with IEEE C37.20.1.
   3. Listed and labeled as complying with UL 1558.
   4. Listed and labeled for use as service entrance equipment.

B. Service Entrance Switchgear (SES) "main" and "PV" circuit breakears shall be controlled by remote multiple-generator and PV paralleling microgrid monitoring and control system.
   1. See section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. See section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

C. Switchgear circuit breakers trip units report metering and monitoring data to multiple-generator and PV paralleling microgrid monitoring and control system.
   1. See section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. See section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

D. Service Entrance Switchgear (SES) "main" circuit breaker protective relays shall be equipped to control main circuit breakers and tie-into remote multiple-generator and PV paralleling microgrid monitoring and control system to satisfy utility requirements

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchgear shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the assembly will remain in place without separation of any parts when subjected to the seismic forces specified and the assembly will be fully operational after the seismic event."
   2. Component Importance Factor: As shown in Structural drawings.
   3. Component Amplification Factor and Component Response Modification Factor: As shown in Structural drawings.

B. Capacities and Characteristics: As shown on Drawings
   1. Short-Time and Short-Circuit Current: Match rating of integrated short-circuit current rating.

2.4 SWITCHGEAR STRUCTURE

A. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker. Extend section barriers between main and tie circuit breakers to the rear of the section.

B. Allow the following circuit-breaker functions to be performed when the compartment door is closed:
   1. Operate manual charging system.
   2. Open and close the circuit breaker.
   3. Examine and adjust the trip unit.
   4. Read the breaker nameplate.

C. Install instrument compartments when additional space is required for metering and instrumentation. Allow for routing of instrumentation, control and communications wires, and cables.

D. Switchgear Bus:
   1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
   2. Main Phase Bus: Uniform capacity the entire length of assembly.
   3. Neutral Bus: 100 percent of phase-bus ampacity unless otherwise indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
   4. Ground Bus: Uniform capacity the entire length of assembly, with pressure connector terminations for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
   5. Vertical Section Bus Size: Fully rated to the system continuous current, equal to the horizontal bus.
   6. Bus Material and Connections:
      a. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
      b. Use copper for connecting circuit-breaker line to copper bus.
      c. Contact Surfaces of Buses: Silver plated.
      d. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with compression connectors for outgoing circuit conductors.

7. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
8. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
    a. Sprayed Insulation Thickness: 3 mils, minimum.
    b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

E. Circuit-Breaker Compartment:
1. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:
    a. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
    b. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
    c. Circuit-Breaker Positioning: Permit the racking of an open circuit breaker to or from connected, test, and disconnected positions only when the compartment door is closed unless live parts are covered by a full dead-front shield. Permit manual withdrawal of an open circuit breaker to a position for removal from the structure. When compartment door is open, status for connection devices for different positions includes the following:
        1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
        2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
    d. Primary Disconnect: Mount on the stationary part of the compartment. Disconnect shall consist of a set of contacts extending to the rear through an insulating support barrier, and of corresponding moving finger contacts on the power circuit-breaker studs, which engage in only the connected position. Assembly shall provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs shall connect to bus extensions that terminate in solderless terminals in the rear cable compartment.
    e. Secondary Disconnect: Floating terminals mounted on the stationary part of the compartment that engage mating contacts at the front of breaker.
    f. Provide a verification of positive ground contact between the circuit breaker and its compartment when the accessory cover is removed while the circuit breaker is in connected, test, disconnected, and withdrawn positions.
    g. Place 2400-A frame and larger circuit breakers at the bottom of switchgear.

F. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
1. Utility metering compartment that complies with utility-company requirements.
2. Service Entrance Switchgear (SES) "main" circuit breaker protective relaying compartment.
3. Bus transition sections.
4. Incoming-line pull sections.
5. Hinged front panels for access to metering, accessory, and blank compartments.

G. Pull Boxes: Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and with ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
   1. Set pull box back from front to clear circuit-breaker lifting mechanism.
   2. Pull-Box Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
   3. Cable Supports: Arranged to ease cabling and adequate to support cables, including those for future installation.

2.5 ADDITIONAL REQUIREMENTS FOR INDOOR SWITCHGEAR

A. Enclosure Rating: Indoor.

B. Enclosure Material: Steel.

C. Enclosure Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Enclosure Rear Panels: Removable and hinged, to allow access to rear interior of switchgear.

2.6 CIRCUIT BREAKERS

A. Drawout type, unfused, power operated, with electromechanical or electronic trip devices. Comply with IEEE C37.13, IEEE C37.13a, and UL 1066.

B. Ratings: For continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear. Comply with IEEE C37.16.
   1. Circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 A, whether or not equipped with instantaneous trip protection.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   1. Normal Closing Speed: Independent of both control and operator.
   2. Slow Closing Speed: Optional with operator for inspection and adjustment.
   3. Stored-Energy Mechanism: Electrically charged, and the operator's choice of manual charging.
      a. Operating Handle: One for each circuit breaker capable of manual operation.
      b. Electric Close Button: One for each electrically operated circuit breaker.
   4. Provide an interlock to discharge the stored energy mechanism before the circuit breaker can be withdrawn from its compartment.
   5. Operation counter.

D. Operator Display: Located on the face of the circuit breaker.
   1. Electrical operation buttons to open and close the circuit breaker. Provide a clear lockable cover over the buttons.
   2. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. An energized or hot condition shall be indicated by a red light. The de-energized, open, and safe condition shall be indicated by a green light.

3. Indicator to show the position of the circuit-breaker contacts, status of the closing springs, and circuit-breaker position in its compartment.
4. Provide a "charged-not OK to close" indicator when closing springs are charged but circuit breaker is not ready to close.
5. Remote Computer Display: One or more computer displays, each with a dedicated CPU, to display data that are generated for transmission via the Ethernet connection. Display the following functions:
   a. Circuit-breaker status and circuit-breaker controls status.
   b. Onboard meters.
   c. User settings for overcurrent protection and undervoltage protection.
   d. See section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   e. See section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

E. Overcurrent Protective Tripping: Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:
1. Programmable functions independent of each other in both action and adjustment.
   a. Long-time setting.
   b. Long-time-delay with selectable I2T or I4T curve shaping.
   c. Short-time setting.
   d. Short-time-delay with flat or selectable I2T curve shaping.
   e. Instantaneous trip.
2. Field-adjustable, time-current characteristics.
3. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
4. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
5. Pickup Points:
   a. Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-T operation.
   b. Five minimum, for instantaneous-trip functions.

F. Ground-Fault Protection:
1. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.
2. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
3. Test Form: Provide each ground-fault relay with information sheets describing system-testing instructions, and with a test form; comply with UL 1558.

G. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

H. Shunt-Trip Devices.

I. Metering:
1. Accuracy: 0.5 percent of reading, complying with ANSI C12.20.
2. Values shall be rms average over a period of one second.

a. Current: Each phase, neutral and three-phase average.
b. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
c. Active Power (kW): Each phase and three-phase total.
d. Reactive Power (kVAr): Each phase and three-phase total.
e. Apparent Power (kVA): Each phase and three-phase total.
f. Power Factor: Each phase and three-phase total.
g. Active Energy (kWh): Three-phase total.

J. Auxiliary Contacts:
1. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
2. Spare auxiliary switches, at least two, unless otherwise indicated. Each switch shall consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.
3. Service Entrance Switchgear (SES) "main" and "PV" circuit breakers shall be equipped for remote control by the multiple-generator and PV paralleling microgrid monitoring and control system.
a. Closed
b. Open
c. Tripped
d. Cradle Position (connected/disconnected/test)
e. Remote Close (signal & return)
f. Remote Trip (signal & return)
g. Ground Fault Alarm
h. Normal After Trip (NAT)

K. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

L. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

M. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

N. Key Interlocks: Arranged to prevent opening or closing of interlocked circuit breakers, except in a specified sequence. Include mountings and hardware for future installation of key interlocks.

2.7 ARC-FLASH LIMITING FEEDER CIRCUIT BREAKERS

A. Feeder circuit breakers shall be without current-limiting fuses, listed as complying with UL 1066.

B. Short-circuit withstand current rating shall be 200 kA.

C. Equip the arc-flash limiting feeder circuit breakers with Arc-Flash Maintenance Setting switch for use as a temporary arc-flash incident energy-reduction device during maintenance activities on that feeder.

1. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
2. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
3. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
4. Provide dry relay contacts on each switch for annunciation of the switch position.

2.8 PROTECTIVE RELAYS

A. Provide a protective relay for Service Entrance Switchgear (SES) "main" circuit breaker as indicated on Drawings and with recommended settings and programming by the power systems study. Protective relays shall meet the minimum requirements for the circuit breaker application (main, feeder, busbar, capacitor, transformer, generator, etc.) with the protection types (ANSI/IEEE C37.2 device numbers) and protection levels (basic, standard, advanced) specified or shown.

B. Manufacturers: Subject to compliance with requirements, provide Multifunctional, solid-state microprocessor-based relay systems, complying with IEEE C37.90 products by Schweitzer Engineering Laboratories (SEL) Co.

C. (SEL) Relay Packages as indicated on Drawings and required by Utility.

D. Visual Display:
1. 5-inch, 800 x 480 color touchscreen display.
2. 4 customizable pushbutton and labels.
3. Each pushbutton shall be equipped with two programmable LED's.

E. Relay Mounting: Each relay shall be equipped at the service entrance integral to the service entrance switchgear assembly to satisfy the utility backfeed restriction requirements.

F. Equip each relay system with a communication module to transfer data between relay and multiple-generator and PV paralleling microgrid monitoring and control system:
1. Relay's metered and target data, such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.
2. Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is configured in remote open-close mode.
3. The relay shall be equipped for the functions indicated in the drawings and all metering and monitoring. Minimum capabilities for each relay:
   a. Ethernet: Dual 10/100-Base-T1.
   b. Ethernet/IP Protocol.
   c. Two EIA-232
   d. Slot C with three additional digital inputs.
   e. Slot C with four additional digital outputs.
   f. Slot C with one additional analog output (4-20mA).

G. Instrument Transformers: Comply with IEEE C57.13.
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

2.9 SURGE SUPPRESSION

A. Surge Suppression: Factory installed as an integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:
1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5-A 250-V ac, one NO and one NC, for remote monitoring of protection status. 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.
5. Surge counter.

2.10 CONTROL POWER SUPPLY, 120-V AC

A. Control Power Transformer: Supply 120-V control circuits through dry-type control power transformers, include secondary disconnect devices.
1. Place transformers larger than 3 kVA in separate compartments at the bottom of the vertical section, including the related primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker and PV circuit breaker.
   a. Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
   b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
3. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

2.11 CONTROL POWER SUPPLY, 24-V DC

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity shall be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.

B. Battery: Premium VRLA batteries, with battery disconnect and overcurrent protective device.

C. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. Rate battery rack, cell supports, and anchorage for seismic requirements.

D. Accessories:
1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.
   1. DC ammeter.
   2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
   3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.
   4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell, and equalizing charge at 2.33 V per cell.
   5. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation shall be automatic until manually reset.
   6. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. Automatic charger operation shall resume after loss of ac power supply for any interval.
   7. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. Device shall regulate charging current but shall not disconnect charger from either battery or ac supply.
   8. Charger's Audible Noise: Less than 26 dB.

2.12 INSTRUMENTATION AND CONTROL

A. Power Distribution Equipment shall be web enabled, direct connected to the Local Area Network (LAN) or Intranet.

B. Ethernet Connectivity:
   1. Install a multipoint, RS-485 Modbus serial communications network within the switchgear to interconnect all breaker trip units, protective relays, drives, and metering devices equipped with communications.
   2. Serial communications network shall be wired to an Ethernet gateway in the switchgear. Gateway shall be web enabled, with integral network port and embedded web server with factory-configured firmware and HTML-formatted web pages for viewing of power monitoring and equipment status information from switchgear devices equipped with digital communication ports.
   3. LAN shall consist of a multipoint, RS-485 Modbus serial communication network to interconnect all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network shall be connected to Ethernet server that functions as a gateway and server, providing data access via LAN.
   4. Server Configuration:
      a. Initial network parameters set using a standard web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.

b. Network server shall be factory programmed with embedded HTML-formatted web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard web browser.
c. Password-protected login, with password administration accessible from the LAN using a standard web browser.
d. Operating Software: Suitable for local access; firewall protected.

5. All serial communications devices within the equipment shall be addressed at the factory and tested.

C. Instrument Transformers: Comply with IEEE C57.13. Instrument transformers may not be used to power space conditioning equipment associated with outdoor switchgear, of for power to convenience receptacles and lighting.
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 Accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and Accuracy class suitable for connected relays, meters, and instruments.

D. Analog Instruments: Rectangular, 4-1/2 inches square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.
1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
a. Operation: Counts and records a succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.

E. Power Monitoring: Separately mounted, modular, permanently installed, solid-state, digital I/O multifunction metering instrument for power and energy metering and monitoring, complying with UL 61010-1.
1. Capable of metering four-wire Y, three-wire Y, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue-related metering from unauthorized and accidental changes.
3. Comply with IEC 60529 degree of protection code of IP65 for the front of meter, and code of IP30 for the body.
4. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
5. Accuracy:
a. Comply with ANSI C12.20, Class 0.5.
b. Neutral Current Measurement: Not more than 0.65 percent.

c. Power Factor: 1.0 percent.
d. Frequency: 0.1 percent.
e. THD: 1.0 percent.
f. Waveform Sampling: 64 per cycle.

6. Data Link: Ethernet connectivity specified in this article.
7. Meter Physical Characteristics:
   a. Display: Backlit LCD with antiglare and scratch-resistant lens.
   b. Display of Metered Values: One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:
      1) All meters.
      2) Measurements.
      3) THD.
      4) Energy.
      5) Demand.
      6) Minimum and maximum values.
      7) Power demand.
8. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.
9. Meters:
   a. Instantaneous, rms:
      1) Current: Each phase, neutral and three-phase average.
      2) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
      3) Active Power (kW): Each phase and three-phase total.
      4) Reactive Power (kVAr): Each phase and three-phase total.
      5) Apparent Power (kVA): Each phase and three-phase total.
      6) Power Factor: Each phase and three-phase total.
   b. Energy:
      1) Active Energy (kWh): Three-phase total.
   c. Demand, Derived from Instantaneous rms Meters:
      1) Current: Present and maximum.
      2) Active: Present and maximum.
      3) Reactive: Present and maximum.
      4) Apparent: Present and maximum/
   d. Power Quality Measurements:
      1) THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.
10. I/O: Two optically isolated digital outputs for KYZ pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
    a. KYZ Pulse: Generate standard KYZ pulses for a user-defined increment of metered active energy as follows:
       1) User-defined pulse output, associated with kWh.
       2) User-defined pulse output, associated with kVArh.
11. Capacities and Characteristics:
    a. Circuit Connections:

1) Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect to instrument-grade potential transformers secondary at 120 V. Meter impedance shall be 2 Mohms L-L or greater.
2) Overload Tolerance: 1500-V ac, rms, continuously.
3) Current: Connect to instrument-grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
4) Frequency: 45 to 65 Hz.
5) Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.13 POWER TRANSFER CONFIGURATIONS

A. Field-installed and -tested controls of Service Entrance Switchgear (SES) "main" and "PV" circuit breakers to accomplish remotely managed automatic transfer controls for switchgear having two power sources.

B. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

C. Control Wiring:
1. Internal control wiring is factory installed, complete with bundling, lacing, and protection.
2. Remote control wiring is field installed.
3. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
4. Install plugs in control wiring at shipping splits.
5. Remote control wiring for Service Entrance Switchgear (SES) "main" and "PV" circuit breaker control via auxiliary contacts. See 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers.
   a. Closed
   b. Open
   c. Tripped
   d. Cradle Position (connected/disconnected/test)
   e. Remote Close (signal & return)
   f. Remote Trip (signal & return)
   g. Ground Fault Alarm
   h. Normal After Trip (NAT)

D. Two-Breaker Transfer Control: Remotely managed by the multiple-generator and PV paralleling microgrid monitoring and control system. See Section 262313 "Paralleling Low-voltage Switchgear" for remote control circuit breaker management.

1. Two-breaker transfer control shall provide for the local SES switchgear "PV" circuit breaker to be electrically interlocked with a remote a separate switchgear (GMDB) "PV" circuit breaker to restrict the closing the "PV" circuit breaker pair simultaneously. SES "PV" circuit breaker shall be designated "normal" for supply to the SES bus load and GMDB "PV" circuit breaker shall be designated "standby," to supply the GMDB bus load during emergency and service outage conditions. Circuit breakers connecting the two power sources to the load bus shall be controlled by a remote microprocessor-based multiple-generator and PV paralleling microgrid monitoring and control system. Power for the transfer control shall be from the emergency system.
2. In automatic mode, the utility source is healthy and the SES load bus is connected to the SES "PV" source as normal operation. . When the utility source fails, the control shall automatically open the SES "PV" (normal) power source before closing the GMDB "PV" (standby) source circuit breaker.
3. Sequence of Operation:
    a. See Section 262313 "Paralleling Low-voltage Switchgear" for remote control circuit breaker management.
4. Field-Adjustable Transfer Parameters:
    a. Delay the transfer from the SES "PV" (normal) power source to the GMDB "PV" (standby) power source and from the GMDB "PV" (standby) power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
    b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Minimum Delay range: zero seconds to 120 seconds.
    c. Delay the transfer from the standby power source to the normal power source. Delay range: zero seconds to 30 minutes.
    d. A relay with contact that changes state when the power is available on the normal source and a relay with contact that changes state when the power is available on the standby source.
    e. Manual close of SES "PV" circuit breaker shall be restricted when associated GMDB "PV" circuit breaker pair is closed.
5. Controls and Indicators: Besides the delay setting controls, provide the following:
    a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers are tripped due to overcurrent or ground fault.
    b. Transfer-control automatic and manual selector.
        1) Interlock shall prevent paralleling of the two power sources in manual mode.
    c. Open-close control switch for manual electrical operation of each controlled circuit breaker.
    d. Selector to place control into programming mode.
    e. Circuit-breaker control switch for each of the normal and standby source breakers, providing open and close operation.
    f. Push button to initiate manual retransfer to the normal source when the transfer controller is in automatic mode.
6. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.

7. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/32R/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.
   a. Manufacturer: Subject to compliance with requirements, provide products by the following:
      1) Schweitzer Engineering Laboratories (SEL), Inc.

2.14 DIFFERENTIAL GROUND-FAULT PROTECTION

A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources shall be devised by manufacturer to insure that the proper main or PV breaker(s) operate properly in normal and emergency conditions. Switchgear shall include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to the main bus of the switchgear. Ensure that the following occurs on the main bus:
   1. A ground fault at any location in the switchgear shall trip the system.
   2. Combination of normal current flow and ground-fault current flow shall trip the system.
   3. Circulating currents through the neutral due to multiple grounds and sources external to the immediate low-voltage power sources shall not trip the system.
   4. System shall not trip if there is no ground fault, during normal current flow.
   5. System shall not trip due to large single-phase currents.

B. Relays: Comply with IEEE C37.90, with test blocks and plugs.

C. Control Wiring:
   1. Factory installed, complete with bundling, lacing, and protection.
   2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   3. Install plugs in control wiring at shipping splits.

2.15 MAINTENANCE TOOLS

A. Description: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

B. Include the following:
   1. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   2. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
   3. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   4. Racking handle to move circuit breaker manually between connected and disconnected positions.

C. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

D. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

E. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.16 IDENTIFICATION

A. Compartment Nameplates: Engraved, melamine plastic, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   2. Medium: Painted graphics, as selected by Architect.
   3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

C. Arc-Flash Warning Labels:
   1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
   2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
      a. 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) Flash protection boundary.
         4) Hazard risk category.
         5) Incident energy.
         6) Working distance.
         7) Engineering report number, revision number, and issue date.
      b. Labels shall be machine printed, with no field-applied markings.

2.17 SOURCE QUALITY CONTROL

A. Testing: Test and inspect low-voltage switchgear according to IEEE C37.20.1. Drawout circuit breakers need not be tested in the assembly if they are tested separately.
   1. Dielectric Tests: Perform power-frequency withstand tests to demonstrate the ability of the insulation system to withstand the voltages listed in IEEE C37.20.1. The voltage is to be increased gradually from zero to the required test value within 5 to 10 seconds and shall be held at that value for one minute.
   2. Perform mechanical operation tests to ensure proper functioning of operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
   3. Test the effectiveness of grounding of each metal-case instrument transformer frame or case.

4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of component devices to ensure that they function properly and in the intended sequence. Verify remote control of Service Entrance Switchgear (SES) "main" and "PV" circuit breakers.
5. Perform the control wiring insulation tests.
6. Verify correct polarity of the connections between instrument transformers and meters and relays.

B. All serial communications devices within the equipment shall be addressed at the factory and tested to verify reliable communications to the equipment's Ethernet gateway.

C. Low-voltage switchgear assembly will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross the section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions where switchgear will be installed.

D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be five ohms at the switchgear location.

E. On delivery of switchgear and prior to unloading, inspect equipment for damage.
1. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's written instructions.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories comply with manufacturer's written instructions and Shop Drawings. If the shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.

6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

F. Handling:
1. Handle switchgear, according to manufacturer's written instructions; avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Protect switchgear compartments against the entrance of dust, rain, and snow.
3. Transport switchgear upright, to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
5. Do not damage structure when handling switchgear.

G. Proceed with installation only after examinations are complete and unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3.

B. Comply with requirements for vibration isolation and seismic-control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Connections at Exterior Locations:
1. Install tinned bare copper conductors not smaller than No. 4/0 AWG, for ground conductors buried not less than 30 inches below grade interconnecting the grounding electrodes.
2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as indicated.
3. Keep lead lengths as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.
5. Fence and equipment connections shall not be smaller than No. 4 AWG.
6. Ground fence at each gate post and corner post and at intervals not exceeding 10 feet.
7. Bond each gate section to the fence post using 1/8-by-1-inch tinned, flexible braided copper strap and clamps.

C. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.

D. Complete switchgear grounding and surge-protector connections prior to making any other electrical connections.

E. Connect to remote data monitoring and control systems including but not limited to Building Automation System (BAS) networks, multiple-generator and PV paralleling microgrid monitoring and control system networks and PV control system network.

3.4 IDENTIFICATION

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
   1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter and of NETA ATS.
   2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   4. Visual and Mechanical Inspection:
      a. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study, as well as to the circuit breaker's address in the control network.
      b. Verify that current and voltage transformer ratios correspond to Drawings.
      c. Inspect bolted electrical connections for high resistance using one of the following two methods:
         1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
      d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
         1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
         2) Make key exchange with devices operated in off-normal positions.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Inspect insulators for evidence of physical damage or contaminated surfaces.
g. Verify correct barrier and shutter installation and operation.
h. Exercise active components.
i. Inspect mechanical indicating devices for correct operation.
j. Verify that filters are in place and that vents are clear.
k. Perform visual and mechanical inspection of instrument transformers according to "Instrument Transformer Field Tests" Paragraph.
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 and grounding contacts and interlocks.

5. Electrical Tests:
    a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the bus temperature is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
        1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
        2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
    b. Perform a dielectric withstand voltage test on each bus section, phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
        1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
    c. Perform insulation-resistance tests on control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's written instruction.
        1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.
    d. Control Power Transformers:

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Insulation-resistance values of winding insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

e. Voltage Transformers:
1) Perform secondary wiring integrity test. Verify correct potential at all devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

f. Perform current-injection tests on the entire current circuit in each section of switchgear.
1) Perform current tests by secondary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

g. Perform system function tests according to "System Function Tests" Article.
h. Verify operation of space heaters.
i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

C. Circuit-Breaker Field Tests:
1. Visual and Mechanical Inspection:
a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that all maintenance devices are available for servicing and operating the breaker.
d. Verify the unit is clean.
e. Verify that the arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
i. Verify cell fit and element alignment.

j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings according to coordination study provided by Owner.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:
   a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than Table 100.1 or manufacturer's written instructions shall be investigated.
   b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in manufacturer's published data. In the absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
   d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
   g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
   h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
   i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
k. Verify operation of charging mechanism. Charging mechanism shall operate according to manufacturer's published data.

D. Instrument Transformer Field Tests:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data complies with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Verify correct connection of transformers with system requirements.
d. Verify that adequate clearances exist between primary and secondary circuit wiring.
e. Verify that the unit is clean.
f. Inspect bolted electrical connections for high resistance using one of the following two methods:
1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
g. Verify that required grounding and shorting connections provide contact.
h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
i. Verify correct primary and secondary fuse sizes for voltage transformers.
j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests of Current Transformers:
a. Perform insulation-resistance test of each current transformer and its secondary wiring for ground at 1000-V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
c. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by manufacturer or be according to IEEE C57.13.1.
d. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. Measured burdens shall be compared to, and shall match, instrument transformer ratings.

e. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.5.
f. Perform dielectric withstand tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.9.
g. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.
h. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by Engineer in Project Drawings.

3. Electrical Tests of Voltage Transformers:
a. Perform insulation-resistance tests, winding-to-winding and winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
b. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable. Polarity results shall agree with transformer markings.
c. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
d. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. Dielectric voltage shall be according to NETA ATS, Table 100.9. Test voltage shall be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary windings are considered to have passed the test.
e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
f. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

E. Ground-Resistance Test:
1. Visual and Mechanical Inspection:
a. Verify that ground system complies with the Contract Documents and with NFPA 70, Article 250, "Grounding and Bonding."
b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
c. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

d. Inspect anchorage.

2. Electrical Tests:
   a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. Resistance between the main grounding electrode and ground shall be no more than 5 ohms.
   b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with the Contract Documents.
   c. Inspect physical and mechanical condition.
   d. Inspect bolted electrical connections for high resistance using one of the following two methods:
      1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

F. Metering Devices Field Tests:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect bolted electrical connections for high resistance using one of the following two methods:
         1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
      c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
      d. Verify that the unit is clean.

e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:
   a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
   b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
   c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
   d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

G. Microprocessor-Based Protective Relay Field Tests:
1. Visual and Mechanical Inspection:
   a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
   b. Verify operation of LEDs, display, and targets.
   c. Record passwords for each access level.
   d. Clean the front panel and remove foreign material from the case.
   e. Check tightness of connections.
   f. Verify that the frame is grounded according to manufacturer's written instructions.
   g. Set the relay according to sequence of operations in Section 262313 "Paralleling Low-Voltage Switchgear" and results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
   h. Incorporate relay logic per the sequence of operations described in Section 262313 "Paralleling Low-Voltage Switchgear" and Section 262300 "Low-Voltage Switchgear".
   i. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.
2. Electrical Tests:
   a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
   b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
   c. Check functional operation of each element used in the protection scheme as follows:
      1) ANSI No. 2/62, Timing Relay:
         a) Determine time delay.
         b) Verify operation of instantaneous contacts.
      2) ANSI No. 24, Volts/Hertz Relay:
         a) Determine pickup frequency at rated voltage.
         b) Determine pickup frequency at a second voltage level.
         c) Determine time delay.
      3) ANSI No. 25, Sync Check Relay:
         a) Determine closing zone at rated voltage.
         b) Determine maximum voltage differential that permits closing at zero degrees.

c) Determine set points of live line, live bus, dead line, and dead bus.
d) Determine time delay.
e) Verify control functions of dead bus/live line, dead line/live bus, and dead bus/dead line.

4) ANSI No. 27, Undervoltage Relay:
a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at a second point on the timing curve for inverse time relays.

5) ANSI No. 32, Directional Power Relay:
a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at a second point on the timing curve for inverse time relays.
f) Plot the operating characteristic.

6) ANSI No. 46, Current Balance Relay:
a) Determine pickup of each unit.
b) Determine percent slope.
c) Determine time delay.

7) ANSI No. 46N, Negative Sequence Current Relay:
a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on the I-two-squared-T curve.

8) ANSI No. 47, Phase Sequence or Phase Balance Voltage Relay:
a) Determine positive sequence voltage to close the NO contact.
b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.

9) ANSI No. 50, Instantaneous Overcurrent Relay:
a) Determine pickup.
b) Determine dropout.
c) Determine time delay.

10) ANSI No. 51, Time Overcurrent:
a) Determine minimum pickup.
b) Determine time delay at two points on the time current curve.

11) ANSI No. 64, Ground Detector Relay:
a) Determine maximum impedance to ground causing relay pickup.

12) ANSI No. 67, Directional Overcurrent Relay:
a) Determine directional unit minimum pickup at maximum torque angle.

b) Determine closing zone.
c) Determine maximum torque angle.
d) Plot operating characteristics.
e) Determine overcurrent unit pickup.
f) Determine overcurrent unit time delay at two points on the time current curve.

13) ANSI No. 87, Differential Relay:
a) Determine operating unit pickup.
b) Determine the operation of each restraint unit.
c) Determine slope.
d) Determine harmonic restraint.
e) Determine instantaneous pickup.
f) Plot operating characteristics for each restraint.

d. Control Verification:
1) Functional Tests:
a) Check operation of all active digital inputs.
b) Check output contacts or SCRs, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) On completion of testing, reset minimum/maximum recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.
2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

H. Ground-Fault Protection Field Tests: Evaluate the interconnected system according to switchgear manufacturer's written instructions.
1. Determine the proper location of the sensors around the bus of the circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.
2. Verify the grounding points of the system to determine that ground paths do not exist that would bypass the sensors. Use high-voltage testers and resistance bridges.
3. Test the installed system for correct response by application of full-scale current into the equipment to duplicate a ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:
a. A coil around the sensors.
b. A separate test winding in the sensors.
4. Record the test results on the test form provided with the instructions provided by manufacturer.

I. DC System VRLA Batteries Field Test:
1. Visual and Mechanical Inspection:
a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify that equipment nameplate data complies with the Contract Documents.

e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify that the units are clean.
h. Inspect spill containment installation.
i. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:
a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and verify that alarms comply with system manufacturer's written instructions.
c. Measure negative post temperature. This temperature shall comply with manufacturer's published data or IEEE 1188.
d. Measure charger float and equalizing voltage levels. These levels shall be according to battery manufacturer's published data.
e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation. Monoblock/cell voltages shall be according to manufacturer's published data.
f. Measure intercell connection resistances.
g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical cells that are in a fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
h. Perform a load test according to manufacturer's published data or IEEE 1188. Replace units that fail to pass the test.
i. Measure the battery system voltage from positive-to-ground and negative-to-ground. Voltage measured from positive-to-ground shall be equal in magnitude to the voltage measured from negative-to-ground.

J. Switchgear components will be considered defective if they do not pass tests and inspections.

K. Remove and replace defective units and retest.

L. Prepare test and inspection reports. Record as-left set points of adjustable devices.

3.6 SYSTEM FUNCTION TESTS

A. Systems function tests shall prove successful execution of full range of sequence of operations.
1. Develop tests to satisfy the sequence of operations and manufacturer recommended function tests.

B. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.
1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.

2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify protective relay database files and logic for execution of system function tests and the full range of sequence of operations.
4. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Test power transfer sequence of operation step by step for each mode.
1. Verify operation of Service Entrance Switchgear (SES) "main" and "PV" circuit breakers along with utility required protective relay setting for controlled circuit breakers.
2. See Section 262313 "Paralleling Low-voltage Switchgear" for additional remote control circuit breaker management testing and sequences of operation to be successfully completed by SES.

D. Switchgear will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, perform the following voltage monitoring:
1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each piece of switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
   a. Adjust switchgear taps.
   b. Prepare written request for voltage adjustment by electric utility.
3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
4. Report:
   a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to inspection.
1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and that lists the results as follows:
   a. Description of equipment to be tested.
   b. Discrepancies.
   c. Temperature difference between the area of concern and the reference area.
   d. Probable cause of temperature difference.

e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of the deficient area.

4. Act on inspection results according to recommendations in NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the 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 switchgear.

END OF SECTION

SECTION 262313 - PARALLELING LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Metal-enclosed, low-voltage, circuit-breaker switchgear rated 600 V and less, and associated monitoring and control systems for paralleling standby generators on an isolated bus and for distributing electrical power.

B. Related Requirements:
1. Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19 "Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication, monitoring, and metering requirements.
3. Section 262300 "Low-voltage Switchgear" for interfacing communication, monitoring, metering and remote circuit breaker control requirements.
4. Section 262413 "Switchboards" for interfacing communication, monitoring and metering requirements.
5. Section 262416 "Panelboards" for interfacing communication, monitoring and metering requirements.
6. Section 263100 "Photovoltaic Energy Systems" for interfacing communication, monitoring, production management, load sharing and synchronization requirements of distributed energy resources.
7. Section 263600 "Transfer Switches" for interfacing communication, monitoring, metering and remote circuit breaker control requirements.
8. Section 263213 "Engine Generators" for interfacing communication, monitoring, production management, load sharing and synchronization requirements of distributed energy resources.
9. Section 263233 "Rotary Uninterruptible Power Units" and Section 263353 "Static Uninterruptible Power Supply" for interfacing communication, monitoring and metering requirements.

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specification.

B. DDC: Direct digital control.

C. Legally Required: As used in this Section, it shall have the same meaning as used in NFPA 70.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of paralleling low-voltage switchgear.
1. Include technical data on features, performance, electrical characteristics, ratings, and finishes for programmable logic controllers, instrumentation, control devices, monitoring devices, SCADA interface devices, Ethernet interface,and display components.
2. Include rated capacities, operating characteristics, furnished specialties, factory settings, and accessories for individual circuit breakers.

3. Include time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For each type of paralleling low-voltage switchgear.
1. Include dimensioned plans, elevations, sections, details, shipping sections, weights of each assembled section, and required clearances and service space around equipment.
2. Include tabulation of installed devices with features and ratings.
3. Include enclosure types and details.
4. Detail locations for anchor bolts and leveling channels.
5. Show bus configuration with current rating, size, and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
6. Indicate short-time and short-circuit current rating of switchgear assembly.
7. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Detail nameplate legends.
9. Include mimic-bus diagram.
10. Include three-line power wiring diagrams for paralleling low-voltage switchgear, generators, and related equipment showing device terminal numbers.
11. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.
12. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers for the following:
    a. Engine generators.
    b. Photovoltaic Energy Systems.
    c. Transfer switches.
    d. Other load-control devices.
    e. Elevator controller in each elevator bank.
    f. BAS system for HVAC control.
    g. SCADA remote terminal unit.
    h. UPS.
    i. Battery systems.
    j. SES circuit breakers.

C. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

D. Delegated-Design Submittal: For paralleling low-voltage switchgear.
1. Include design calculations, signed and sealed by a qualified professional engineer, for selecting seismic restraints and for structural analysis of outdoor enclosures, including wind loading.
2. For the differential ground-fault protection scheme. Include wiring diagram of the differential system along with test procedure recommended by UL 1558, using high-current injection equipment.

E. Sequence of Operation: Description of sequence of operation for paralleling controls in automatic, manual, system test, and peak-shaving modes.
1. Include the following in the description of the automatic-mode sequence of operation:

a. Programmed sequence of initial generator starting and connection of generators to the isolated paralleling bus, including a description of how the proposed design complies with the requirements for redundancy.
   1) Programmed sequence describing PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time.
b. Programmed sequence of transferring loads to the isolated paralleling bus based on operator-adjustable preset priorities and preset loads. Include initial load settings.
c. Programmed sequence of starting and stopping generators based on actual real-time measured loads.
   1) The PV power contribution shall not impact the requirement to maintain a total connected generator capacity that exceeds the facility load at all times.
   2) Programmed sequence of connecting PV to the generator bus.
   3) Programmed sequence of connecting PV to the normal service entrance switchgear bus.
d. Programmed sequence of sending a load-shed signal to transfer switches, and to other devices when the generator frequency does not return to the normal frequency within the adjustable time period.
e. Programmed sequence of stopping generators based on no transfer switch or other device sending a start signal.
f. Programmed sequence of connecting and disconnecting PV from the generator bus.
g. Programmed sequence of connecting and disconnecting PV from the normal service entrance switchgear bus.

2. Include the following in the description of the system testing mode sequence of operation:
   a. Load.
   b. No load.
3. Include in the description, the peak-shaving-mode sequence of operation.
4. Include in the description, the manual-mode sequence of operation showing that the manual mode fulfills the requirement to permit the operator at the paralleling low-voltage switchgear to accomplish all automatic, system test, and peak-shaving functions.
5. Paralleling Low-Voltage Switchgear Redundancy: Identify any single points of failure.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
   1. Floor plans showing dimensioned layout, required working clearances, and required area above and around paralleling low-voltage switchgear where pipe and ducts are prohibited.
   2. Switchgear layout and relationships between components and adjacent structural and mechanical elements.
   3. Support locations, type of support, and weight on each support. Indicate field measurements.

B. Qualification Data: For testing.

C. Seismic Qualification Data: Certificates, for paralleling low-voltage switchgear, overcurrent protective devices, accessories, and components to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
   1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.

B. Operation and Maintenance Data: For paralleling low-voltage switchgear 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. Manufacturer's written instructions for sequence of operation.
      b. Manufacturer's system checklists, maintenance schedule, and maintenance log sheets complying with NFPA 110.
      c. Manufacturer's written instructions for testing and adjusting relays.
      d. Time-current curves, including selectable ranges for each type of overcurrent protective device.

C. Training Video: Copy of video recorded training.

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. Control Power Fuses: Six of each type and rating used. Include spares for the following:
      a. Potential transformers.
      b. Control power circuits.
   2. Indicating Lights: Six of each type installed.
   3. Draw-out Circuit Breakers: One of each type and rating used for circuit breaker in the paralleling low-voltage switchgear.

B. Maintenance Tools: Furnish tools and miscellaneous items required for paralleling low-voltage switchgear test, inspection, maintenance, and operation. Include the following:
   1. Floor-running transport or dockable dolly with manual lifting mechanism and all other items necessary to remove circuit breaker from housing and transport it to remote location.

2. Racking handle to move circuit breaker manually between connected and disconnected positions.

1.7 QUALITY ASSURANCE

A. Testing Qualifications: Accredited by NETA.
   1. Testing Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver paralleling low-voltage switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store paralleling low-voltage switchgear indoors in clean dry space with uniform temperature to prevent condensation.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
   1. Ambient temperature not exceeding 104 deg F.
   2. Altitude of 5,200 feet above sea level.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace paralleling equipment that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Two year(s) from date of Substantial Completion.

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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for paralleling low-voltage switchgear, including clearances between paralleling switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. The multiple-generator and PV paralleling microgrid monitoring and control enclosure shall monitor and control the following emergency and standby power system components:
   1. Paralleling low-voltage switchgear.
   2. Single-generator monitoring and control system.
   3. Single-generator paralleling monitoring and control systems that are part of the paralleling low-voltage switchgear.
   4. Engine generators.
   5. Photovoltaic arrays.
   6. Transfer switches.
   7. Remote Service Entrance Switchgear (SES) "main" and "PV" circuit breakers. See section 262300 "Low-voltage Switchgear" for additional remote circuit breaker control requirements.
   8. Remote circuit breakers.
   9. Other load-control devices.

10. Relay devices.
11. Distribution circuit breakers and trip units in paralleling low-voltage switchgear.
12. Uninterruptible power units and supply equipment.
13. Fuel tanks.
14. Comply with Section "260913 Electrical Power Monitoring and Control" requirements to establish the multiple-generator and PV paralleling microgrid monitoring and control system as the facility SCADA.

D. The multiple-generator and PV paralleling microgrid monitoring and control panel shall maintain uninterrupted power supply by the battery system for use as 24/7 facility SCADA. See Section 260913 "Electrical Power Monitoring and Control" for additional SCADA monitoring, control and operator display requirements.

E. Redundant Standby Power System:
1. Single generator with associated single-generator paralleling monitoring and control system.
2. Black-start controller with backup control in the multiple-generator paralleling monitoring and control system.
3. Multiple-generator and PV paralleling microgrid monitoring and control system shall automatically be performed by a backup system without degradation in the event that primary system fails to function for any reason (such as component failure or off-line maintenance), except for the following manually operated functions:
   a. Load management.
   b. Peak shaving.

F. Sequence of Operation for Normal Conditions:
1. Paralleling low-voltage switchgear, including controlled generators, controlled circuit breakers, and transfer switches, shall be in the automatic position and ready to operate on loss of power or other designated initiation conditions.
   a. The GMDB load circuit breakers are closed.
   b. The GMDB source circuit breakers are open (including generator, PV and docking station).
   c. The GMDB load (ATS & Fire Pump) feeder circuit breakers are closed.
   d. The SES "PV" and GMDB "PV" circuit breakers are electrically interlocked. The GMDB "PV" circuit breaker is electrically restricted from closing unless the associated SES "PV" circuit breaker is locked open.
2. Each single-generator monitoring and control system has not received a "start" signal from the following:
   a. Transfer switch.
   b. Multiple-generator and PV paralleling microgrid monitoring and control system.

G. Sequence of Operation for Loss of Normal Power Conditions:
1. Each single-generator monitoring and control system shall receive a start signal from a redundant system.
   a. Start signal may come from a transfer switch or other device directly wired to start each engine generator.
   b. Start signal may come from the multiple-generator paralleling monitoring and control system that monitors loss of normal source availability from one or more transfer switches or other device.

2. On receiving a start signal, each single-generator monitoring and control system shall start engine generators and achieve rated voltage and frequency.
3. If engine generator fails to start, after expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
4. Transfer Inhibit Control: Multiple-generator and PV paralleling microgrid monitoring and control system receives loss of normal source availability signal from transfer switch(es) or other device and sends transfer inhibit signals.
    a. Transfer switch(es) serving emergency loads shall not be sent a transfer-inhibit signal.
    b. Transfer switch(es) serving other than emergency loads that must transfer within a required time shall have the transfer-inhibit signal end at such a time as will permit transfer switch to operate within required time.
    c. Transfer switch(es) serving other than emergency loads that are not required to transfer within a required time shall be sent a transfer-inhibit signal.
    d. Transfer switch(es) serving loads that are to be disconnected after detecting loss of normal source availability shall signal the associated circuit breakers and other load devices to de-energize these predetermined loads.
    e. Transfer switch(es) serving HVAC loads that need to operate at a lower load by modifying the HVAC sequence of operation after detecting loss of normal source availability shall signal the BAS system for HVAC to change to the HVAC load-shed sequence of operation for the associated equipment.
    f. Transfer switch(es) serving elevator loads after detecting loss of normal source availability shall signal the associated elevator controllers that the elevators are connected to generator power and shall initiate the sequence of operation in the elevator control system to protect the elevators and to reduce elevator load demand.
    g. Distribution circuit breakers in the paralleling low-voltage switchgear, which are indicated in a priority-load schedule to transfer load by opening and closing the circuit breaker, receive an inhibit closing signal.
5. Black-Start Control: Prevent out-of-phase paralleling. After selecting the first generator to achieve 90 percent rated voltage and frequency, inhibit the connection of generator-controlled circuit breakers to the isolated paralleling bus, then close the circuit breaker connecting the first generator to the isolated paralleling bus.
    a. Redundant System: Multiple-generator paralleling monitoring and control system selects the first engine generator to connect to the isolated paralleling bus.
6. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to the isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
    a. PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time.

7. After the generators of a capacity greater than the connected load are connected to the isolated bus and all ATS have connected to the isolated emergency bus, the multiple-generator and PV paralleling microgrid monitoring and control system shall monitor available PV power via communication with the PV control system. After the gensets have been added to the isolated emergency bus, the GMDB PV source circuit breakers close to allow for PV system inverters to synchronize to the generators and contribute to the isolated emergency bus.
   a. The multiple-generator and PV paralleling microgrid monitoring and control system shall maintain a total connected generator capacity that exceeds the total connected demand load. PV contribution shall not shut down generators to a total connected generator capacity that is less than the total demand load.
8. When PV sources contribute to total backup source capacity, each generator shall assume its proportional share of total load to allow for PV contributions to reduce fuel consumption.
9. On closure of generator and PV sources to the isolated paralleling bus, each engine generator and PV source assumes it proportional share of total load.
10. Failure of an Engine Generator to Synchronize: If engine generator fails to synchronize, sound an alarm after a preset time delay, but continue to attempt to synchronize the engine generator until signaled to stop by manual operation.

H. Priority Controller Sequence of Operation:
   1. Programming from Human-Machine Interface for Priority Controller:
      a. Set priority blocks of load that indicate priority number and scheduled size of load from the Priority-Load Schedule. Set generator blocks of capacity that indicate the individual engine generators and their capacity.
      b. The signal to transfer loads to the engine generator source may be accomplished by one of the following:
         1) Signaling to transfer-inhibit enable the transfer switch associated with the priority load to transfer the load.
         2) Signaling the load-add relay at the transfer switch to transfer the priority load.
         3) Closing the distribution-feeder circuit breaker associated with the priority load.
         4) Enabling another device.
   2. When generator has transferred Priority 1 emergency load, send signal to transfer loads that must be transferred within a specific time according to the Priority-Load Schedule.
   3. When generator capacity is adequate to support next priority load, send signal to transfer next priority load to generator source until all priority loads have been transferred.
   4. Available PV source power is added after all load priorities have been added to the emergency bus and the generator system has established a stable system with a total generator capacity that exceeds the facility load.

I. Overload Sequence of Operation:
   1. Signal to shed loads from generator source may be accomplished by one of the following:
      a. Signaling load-shed relay in a transfer switch associated with the priority load.

b. Opening distribution-feeder circuit breaker associated with the priority load.
c. Disabling another device.

2. Overload sequence of operation sends signal to shed lowest connected load priority when isolated paralleling bus frequency does not return to normal frequency within its adjustable time period.
3. If isolated paralleling bus does not return to normal frequency after shedding lowest connected priority load within adjustable time period, additional load continues to be shed by signaling to load shed in reverse priority until isolated paralleling bus returns to normal frequency.
4. Loads shed can be reconnected to isolated paralleling bus automatically by manual reset at human-machine interface.

J. Load-Demand Sequence of Operation (Generator):
1. With load-demand sequence of operation activated, controller continuously monitors total isolated paralleling bus load.
2. If isolated paralleling bus load is below preset limits and after a preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating to cover (exceed) the total bus load, while the available PV power sources are contributing to reduce fuel consumption of online generators while the total connected generator capacity is always greater than total bus demand load. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
   a. PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time. Pre-set generator limits related to shutdown shall be independent of and unrelated to PV contribution.
3. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
   a. PV power contribution to the isolated paralleling bus shall not reduce connected generator capacity to less than total facility load at any given time. Pre-set generator limits related to shutdown shall be independent of and unrelated to PV contribution.

K. Load-Demand Sequence of Operation (Common Bus):
1. With load-demand sequence of operation activated, controller continuously monitors isolated paralleling bus load at points between sources and loads.
2. If isolated paralleling bus capacity is detected to be overloaded for a segment of bus, after a preset time delay the demand controller initiates overload sequence of operation for ATS associated with bus segment overload.
   a. Manufacturer shall recommend preset time delay based on generator damage and selective coordination performance characteristics. See Section 263213 "Engine Generators" and Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section260573.16 "Overcurrent Protective Device Coordination Study", and Section260573.19 "Overcurrent Protective Device Arc-Flash study" for power studyperformance requirements for equipment ratings and component adjusting.
3. On sensing available isolated bus capacity (after a preset time delay) for the previously overloaded segment of bus, the demand controller shall remove

overload sequence of operation signal and resume loss of normal power conditions and connect the shed load as described in the overload sequence of operation.

L. Individual Transfer Switch Return to Normal Condition Sequence of Operation: Enable individual transfer switches to return to normal power when normal power is available at the transfer switch.

M. Circuit Breakers in Paralleling Low-Voltage Switchgear Return to Normal Condition Sequence of Operation: When normal power is available at transfer switches served by feeder circuit breaker, open circuit breaker.
1. GMDB and SES PV circuit breaker pairs shall be open transition and electrically interlocked to restrict simultaneous closure of GMDB and SES PV circuit breaker pairs.
2. Control SES "main" circuit breaker as required to satisfy utility requirements.

N. Individual Circuit Breaker or Other Load Device for Loads Controlled Downstream from Transfer Switch Sequence of Operation: Return circuit breaker or other load device to closed position when transfer switch serving circuit breaker has returned to normal power.
1. Remotely managaed SES PV circuit breaker shall be closed only when the associated GMDB PV circuit breaker is open.

O. Return to Normal Condition Sequence of Operation:
1. Process starts on removal of start signals from system. Multiple-generator and PV paralleling microgrid monitoring and control system detects removal of loss of normal source availability signal and sequentially adds priority loads to the the SES bus to avoid overloading SES main circuit breaker. Coordinate the Transfer Inhibit Control for ATS for utility loss and restoration transfer avoid overload of SES and GMDB source circuit breakers.
2. When no load remains on isolated paralleling bus, all PV and generator breakers open, and the generators go through cool-down period, and shut down.
3. If start signal is received during cool-down period, one engine generator is reconnected to isolated paralleling bus, and system operation follows that of "loss of normal power."
4. After each ATS has connected to the SES isolated bus, the multiple-generator and PV paralleling microgrid monitoring and control system shall close the SES "PV" circuit breakers and allow for PV contribution to SES bus (normal operation).
    a. Remotely managaed SES PV circuit breaker shall be closed only when the associated GMDB PV circuit breaker is open.

P. Generator System Test Sequence of Operation:
1. Configure tests to comply with NFPA 110, Level 1 testing requirements for each generator. Automatically generate NFPA 110, Level 1 reports.
2. Single-generator test.
3. Multiple-generator test.
4. Start generators manually, by generator exerciser on user-defined schedule, or by remote contact from multiple-generator and PV paralleling microgrid monitoring and control system.
5. Engine generator(s) start and achieve rated voltage and frequency.

6. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
7. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to the isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
8. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
9. Manually select or automatically preselect whether test is a load or no-load test. If test is a load test, manually select or automatically preselect loads to be transferred according to schedule or by adjustable time delays at transfer switches. After generators are connected to isolated paralleling bus, transfer loads by sending signal to load-add relay that is connected to input for "remote transfer to generator source" of transfer switch controller or to other devices. If test is load-bank test, automatically operate load-bank breaker to connect load bank for testing generators based on number and configuration of generators.
10. On closure of generator and PV sources to the isolated paralleling bus, each engine generator and PV source assumes it proportional share of total load.
11. After adjustable period of time the system, allow engine generators to optimize down to only the required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
12. On sensing available bus capacity diminished to set point, controller starts and closes engine generators to the isolated paralleling bus to accommodate load.
13. After system test is completed, transfer loads back to normal power with transfer switches. Shut down system using sequence in automatic mode.
14. If there is an outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send load-shed signals to lower-priority loads until load is below generator capacity, signal any engine generator that is not currently operating to start, and cancel system test.

Q. Microgrid System Test Sequence of Operation:
1. Configure tests to comply with NFPA 110, Level 1 testing requirements for each generator. Automatically generate NFPA 110, Level 1 reports.
2. Multiple-generator and PV source test.
3. Start generators manually, by generator exerciser on user-defined schedule, or by remote contact from multiple-generator and PV paralleling microgrid monitoring and control system.
4. Engine generator(s) start and achieve rated voltage and frequency.
5. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.

6. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to the isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
7. Failure of Engine Generator to Synchronize: If engine generator fails to synchronize, sound alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
8. After the generators of a capacity greater than the connected load are connected to the isolated bus and all ATS have connected to the isolated emergency bus, the multiple-generator and PV paralleling microgrid monitoring and control system shall monitor available PV power via communication with the PV control system to achieve PV synchronization with gensets. Upon achieving in-sync voltage and frequency, the multiple-generator and PV paralleling microgrid monitoring and control system adds the available PV sources to the isolated paralleling bus by closing the associated circuit breaker in the paralleling switchgear.
9. Manually select or automatically preselect whether test is a load or no-load test. If test is a load test, manually select or automatically preselect loads to be transferred according to schedule or by adjustable time delays at transfer switches. After generators and PV are connected to isolated paralleling bus, transfer loads by sending signal to load-add relay that is connected to input for "remote transfer to generator source" of transfer switch controller or to other devices. If test is load-bank test, automatically operate load-bank breaker to connect load bank for testing generators based on number and configuration of generators.
10. On closure of generator and PV sources to the isolated paralleling bus, each engine generator and PV source assumes it proportional share of total load.
11. After adjustable period of time the system, allow engine generators to optimize down to only the required number to be online to avoid wet stacking. Set stopping and starting sequences through human-machine interface panel device and allow settings based on manual priorities or by engine run time.
    a. The multiple-generator and PV paralleling microgrid monitoring and control system shall maintain a total connected generator capacity that exceeds the total connected demand load. PV contribution shall not shut down generators to a total connected generator capacity that is less than the total demand load.
12. On sensing available bus capacity diminished to set point, controller starts and closes engine generators to the isolated paralleling bus to accommodate load.
    a. The multiple-generator and PV paralleling microgrid monitoring and control system shall maintain a total connected generator capacity that exceeds the total connected demand load. PV contribution shall not shut down generators to a total connected generator capacity that is less than the total demand load.

13. After system test is completed, transfer loads back to normal power with transfer switches. Shut down system using sequence in automatic mode.
14. If there is an outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send load-shed signals to lower-priority loads until load is below generator capacity, signal any engine generator that is not currently operating to start, and cancel system test.

R. Start engine generators manually through human-machine interface or by remote contact initiated from a peak-shaving command from BAS system for HVAC.
1. Engine generator(s) start and achieve rated voltage and frequency.
2. Failure of Engine Generator to Start: After expiration of overcrank time delay, engine generator shuts down and alarm is initiated.
3. Black-Start Control: Prevent out-of-phase paralleling. After selecting first generator to achieve 90 percent rated voltage and frequency, inhibit connection of generator-controlled circuit breakers to isolated paralleling bus, then close circuit breaker connecting first generator to isolated paralleling bus.
4. Each single-generator paralleling monitoring and control system synchronizes its associated engine generator and allows closure of respective generator paralleling low-voltage circuit breakers to isolated paralleling bus. On closure to isolated paralleling bus, each engine generator assumes its proportional share of total load.
5. Failure of Engine Generator to Synchronize: If generator set fails to synchronize, sound an alarm after preset time delay, but continue to attempt to synchronize engine generator until signaled to stop by manual operation.
6. Through human-machine interface manually select or on closure of contact from the peak-shaving command preselected loads to be automatically transferred to isolated paralleling bus. After engine generators are connected to isolated paralleling bus, transfer loads by sending signal to corresponding load-add relays that are connected to remote transfer to generator source control input at transfer switch or similar control devices. Add loads until contact closure from BAS system for HVAC opens.
7. After adjustable period of time, allow engine generators to optimize down to only required number to be online to avoid wet stacking. Set stopping and starting sequences through the human-machine interface panel device and allow settings based on manual priorities or by engine run time.
8. If the isolated paralleling bus load is below preset limits and after preset time delay, demand controller shuts down engine generators in predetermined order until minimum number of sets are operating. Set preset limits, predetermined order, and preset time delay, as well as choose manual operation, from human-machine interface.
9. On sensing available isolated paralleling bus capacity diminished to set point, controller starts and closes engine generators to isolated paralleling bus to accommodate load.
10. After peak shaving is completed, transfer loads back to normal power. Shut down system using sequence in automatic mode.
11. If there is an outage during this mode of operation, automatically change to requirements specified in "Sequence of Operation for Loss of Normal Power Conditions" Paragraph, send, send load-shed signals to lower-priority loads until

load is below the engine generator capacity, signal generators that are not currently operating to start, and cancel system peak-shaving operation.

12. Manual Sequence of Operation: Include functions indicated for automatic mode, except that operator shall be able to monitor parameters and manually perform the operations.

S. Comply with NFPA 110 for the following:
   1. Emergency: EPSS Level 1, Type 10.

T. Comply with NFPA 99 for healthcare applications.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Paralleling low-voltage switchgear shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Structural Performance: Paralleling low-voltage switchgear outdoor enclosures shall comply with locally adopted codes for gravity and wind loads.

C. During normal power conditions, the multiple-generator and PV paralleling microgrid monitoring and control system shall utilize available source PV production to reduce facility utility power consumption.

D. During normal loss of power conditions, the Load Demand sequence of operations and multiple-generator and PV paralleling microgrid monitoring and control system load sharing shall utilize available source PV production to reduce connected generator fuel consumption.

2.3 MULTIPLE-GENERATOR AND PV PARALLELING MICROGRID MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar, Inc.; Electric Power Division.
   2. Cummins Power Generation.

B. Source Limitations: Obtain multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
   1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.
   2. The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.
   3. The project shall have all circuit breakers supplied by the same manufacturer.

C. Components and Devices: Factory mounted in a metal-enclosed, paralleling low-voltage switchgear and master control section in separate switchboard.
   1. Paralleling Low-Voltage Switchgear Door-Mounted Control Devices: Industrial, oil-type devices.
   2. Indicator Lamps: High-intensity digital display.

D. Control Power for Multiple-Generator and PV Monitoring and Control System: Supplied from 24-V dc starting batteries of engine generators.
   1. Isolate each battery bank to prevent failure of one battery from disabling entire system.
   2. Includeseparate control power battery system rated 24-V dc for equipment due to unacceptable voltage drop that occurs during engine cranking between Gen-set and Multiple-Generator and PV Monitoring and Control System.

E. Multiple-generator monitoring and control system auto/manual selector switch.

F. Control switch for circuit breaker that serves load bank.

G. Full-Color, Touch-Screen, Human-Machine Interface Device:
   1. Minimum viewing area of 100 sq. in. shall be configurable in either U.S. standard or SI (metric) units.
   2. Main Menu: Include date, time, and system status messages. Configure screens so that no screen is more than three touches from any other screen.
      a. Individual engine generator data shall be accessed at the paralleling low-voltage switchgear from the main menu and each single-generator paralleling monitoring and control system.
   3. One-Line Diagram: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators.
      a. Conditions for Engine Generators, Buses, and Paralleling Circuit Breakers: Energized or de-energized.
      b. Engine Generator Modes:
         1) Auto.
         2) Lockout.
         3) Reset.
         4) Off.
         5) Cool down.
         6) Test off line.
         7) Test on load.
      c. Engine Generator Status: Normal, warning, shutdown, or load-demand stop.
      d. Paralleling Circuit-Breaker Status: Open, closed, or tripped.
      e. Bus Conditions: Energized or de-energized.
      f. Percent load.
   4. AC metering screen for isolated paralleling bus shall display the following:
      a. Phase, volts, and amperes.
      b. Kilowatts.
      c. Kilovolt amperes.
      d. Kilovolt-ampere rating.
      e. Power factor.
      f. Frequency.
      g. Kilowatt hour.
      h. Kilowatt demand.
      i. Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.
      j. A minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and a minimum duration of four hours.

k. Percent of available capacity of the engine generators that are operating in parallel on the bus.

5. Engine Generator Monitoring and Control Screen:
   a. Control:
      1) Engine generator manual start/stop control (functional only when the paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) Engine generator alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit controls.
      4) Engine function and timer settings.
      5) System function, testing, and timer settings.
      6) Engine generator optimization settings: automatically determine the priority of the engine generators based on engine run time and number of engine starts or manually assign engine priorities.
   b. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Engine run hours.
      3) Engine status.
      4) Number of generator circuit-breaker operations.
6. PV Monitoring and Control Screen:
   a. Control:
      1) PV manual start/stop (connect/disconnect) control (functional only when the paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) PV alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit controls.
      4) System function, testing, and timer settings.
   b. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Array and inverter status.
      3) Number of PV circuit-breaker (GMDB and SES) operations.
7. Circuit Breaker & Relay Monitoring and Control Screen:
   a. Screen shall include GMDB, SES and other low voltage power circuit breaker and molded case circuit breaker trip unit data as described in other specification sections and on Drawing E7.10 Matrix.
   b. Control:
      1) Circuit Breaker manual open/close control (functional only when the paralleling low-voltage switchgear mounted control switch is in "Auto" position).
      2) Circuit Breaker alarm reset.
      3) Manual paralleling and circuit-breaker enable/inhibit (open/close) controls.
      4) System function, testing, and timer settings.
   c. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Circuit-breaker status and circuit-breaker controls status.

3) Metering data.
4) Additional characteristics from Drawing E7.10 Matrix.

8. ATS Monitoring and Control Screen:
   a. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) Statuses: See Section "263600" Remote Annunciator and Monitoring Control System requirements.
         a) Inidication of sources available, as defined by actual pickup and dropout setting of transfer-switch controls.
         b) Indication of switch position.
         c) Indication of switch position.
         d) Indication of switch in test position.
         e) Indication of failure of digital communication link.
         f) Key-switch or user-code access to control functions of panel.
         g) Control of switch-test initiation.
         h) Control of switch operation in either direction.
         i) Control of time delay bypass for transfer to normal source.
      3) Alarms.
      4) Additional characteristics from Drawing E7.10 Matrix.
9. UPS Monitoring Screen:
   a. Status and Alarms:
      1) Power Metering: Watts, volt-ampere reactive, power factor, frequency, amperes, and voltage.
      2) UPS, circuit breaker and battery status.
         a) Mode of operation. See Section "263233" and Section "263353" for modes of operation to be displayed remote from UPS.
         b) Alarms. See Section "263233" and Section "263353" for alarms to be displayed remote from UPS.
      3) Additional characteristics from Drawing E7.10 Matrix.
10. System function, testing, and timer settings.
11. Three-Phase, Metering Screen: Graphical analog (270 electrical degree) metering representation with digital display. Display all generators and PV with the isolated paralleling bus and remotely managed ATS and SES circuit breakers (PV and Main) at the same time. Display graphical synchroscope when one generator and the isolated paralleling bus are selected.
    a. True rms, three-phase voltage, amperes, kilowatts, kilovolt amperes, kilovolt-ampere reactive, power factor, and frequency parameters.
    b. Engine battery voltage display.
12. Password-Protected System Control Screen:
    a. System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
    b. Test with Load: Starts and synchronizes engine generators on isolated paralleling bus and then synchronizes available PV sources on isolated paralleling bus; all loads are transferred to the isolated paralleling bus.
    c. Test without Load: Starts and synchronizes engine generators on isolated paralleling bus and then synchronizes available PV sources on isolated paralleling bus but does not transfer loads to the isolated paralleling bus.

d. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

13. Password-Protected, Peak-Shaving Control Screen:
    a. Peak-Shaving Modes: Manual start and transfer of loads; automatic start and transfer of loads by DDC system for HVAC peak-shaving relay closure.
    b. For automatic mode, set load priorities for peak-shaving function.
    c. Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.
14. Load-Demand Control Screen: Monitors total load on the isolated paralleling bus and controls number of engine generators running so that capacity tracks load demand (and maintains total connected generator capacity to exceed load demand regardless of PV contribution).
    a. Load-Demand Control: Enable/disable.
    b. Set engine generator shutdown sequence.
    c. Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
    d. Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.
15. Manual Load Control Screen: Allows operator to manually add or delete engine generators or PV sources from paralleled system in response to system load parameters.
    a. Indication of system available in kilowatts and amperes.
    b. Control functions allow manual addition/removal of engine generators on system, and activation of load-shed/load-restore functions.
    c. Control functions allow manual addition/removal of PV sources on system.
16. Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:
    a. Display sequence.
    b. Assigns "load-add sequence priority" to each load-control relay with designation for relay operation after a set number of engine generators are online.
    c. Assigns "load-shed sequence priority" to each load-control relay with designation for relay operation depending on number of engine generators online.
17. Alarm Summary and Run Report Screen:
    a. Lists most recent alarm conditions and status changes.
    b. Lists a minimum of the most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
    c. For each start signal, lists start time and date, stop time and date, maximum kilowatt and ampere load on system during run time, and start and stop times of individual engine generators.
    d. Lists generator circuit position and status.
    e. Access to trend all monitored automatic transfer switches.
    f. 16-gigabyte hard-disk space for storing the database file for multiple-generator paralleling monitoring and control panel trending and event logging. Trend and log data at a resolution of one second. If hard drive is full, overwrite in a first-in-first-out procedure.
        1) Trend up to eight monitored points simultaneously.

18. Load Status and Control Screen: Displays status of automatic transfer switches connected to the system for 64 transfer switches, and other controlled devices.
    a. Automatic transfer switch connected to normal.
    b. Automatic transfer switch connected to emergency.
    c. Controlled circuit breakers downstream from the automatic transfer switch device enabled or disabled.
    d. Engine start indication.
    e. Load-shed indication.
    f. Load-add indication.
    g. Inhibit to emergency source.
    h. Inhibit to normal source.
    i. Transfer Switch Power Metering Function: Total kilowatt, three-phase current, and three-phase voltage.
    j. Automatic Transfer Switch Load Priority: Ability to change priorities of automatic transfer switches (password protected).
    k. Display name, status, and priority of each load block (whether on or off) and the total load of that block.
    l. Allow for manually adding or shedding loads.
19. Automated email messages shall be transmitted when shutdowns occur and shall include time and date of alarm.
20. Based on either the number operations or the time since the last maintenance, suggest maintenance period for generator (run hours), controlled circuit breaker (number of operations), and transfer switches (number of transfers).
21. Status and Alarm Screen:
    a. Visual alarm status indicator and alarm horn with silence and acknowledge push button.
    b. Status, Light Only:
        1) "SYSTEM NOT IN AUTO" (red).
        2) Running Status: Display engine generator number and running-status light (green).
        3) Load-demand mode (green).
        4) Priority Load Status: Display load number with "LOAD ADD" (green) and "LOAD SHED" (red).
        5) System test (green).
        6) Remote system start (red).
        7) Monitoring of Each Transfer Switch:
            a) Normal source available for each (green).
            b) Connected to normal (green).
            c) Generator source available (green).
            d) Connected to generator source (green).
    c. Status Light and Alarm:
        1) Isolated paralleling bus under frequency (red).
        2) Isolated paralleling bus over frequency (red).
        3) Auxiliary power failure (red).
        4) Emergency start signal power failure (red).
        5) Load-Shed Level Status: Displays load number and red load-shed, status light.
        6) Generator Alarm Status: Displays generator number and red "Check Generator" status light.

7) Controller malfunction (red).
8) Check station battery (red).
9) Isolated paralleling bus overload (red).
10) System not in auto (red).
11) Main tank, low fuel (amber)
12) Main tank, high fuel (amber).
13) Main tank, fuel leak (red).

H. Remote Monitoring: Replicate human-machine interface monitoring functions at remote computer terminal via communication bus.

I. Remote Monitoring of Status and Alarms: Replicate human-machine interface status and alarms at BAS system for HVAC via isolated contacts and communication link via BACnet protocols.

J. Comply with Section "260913 Electrical Power Monitoring and Control" requirements to establish multiple-generator and PV paralleling microgrid monitoring and control system as the facility SCADA.

2.4 SINGLE-GENERATOR PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.

B. Source Limitations: Obtain single and multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.

C. Components and Devices: Factory mount in each single-generator section of the metal-enclosed, paralleling low-voltage switchgear.
1. Paralleling low-voltage switchgear door-mounted control devices shall be industrial oil-type devices. Indicator lamps shall be high-intensity digital display.

D. Control Power: Supply control power from the 24-V dc starting batteries from the controlled generator. Include separate control power battery system rated 24-V dc for any equipment unable to accept the voltage drop that occurs during engine cranking.

E. Programmable Logic Controller: Factory-mounted controller, separate from the multiple-generator paralleling monitoring and control system in each single-generator paralleling monitoring and control module of the metal-enclosed, paralleling low-voltage switchgear.

F. Single-Generator Paralleling Low-Voltage Switchgear Circuit Breaker:
1. Factory mount the circuit-breaker control switch.
2. Paralleling Circuit-Breaker Monitor and Control:
a. Monitors circuit-breaker auxiliary contacts.
b. Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).

c. Trips open and locks out paralleling circuit breaker on paralleling circuit breaker failure to close, until manually reset.

G. Generator Mode Selector Switch: Factory mounted in the single-generator paralleling monitoring and control system module of the metal-enclosed, paralleling low-voltage switchgear.
1. "Lockout/Reset" mode prevents generator from starting or immediately shuts down generator if running.
2. "Off/Cool-Down" mode stops engine after a cool-down period.
3. "Auto" mode allows generator to start on receipt of remote start signal. If the generator is already running and there is not a start signal, then "Auto" mode allows engine to run for predetermined cool-down period before stopping.
4. "Test Off-Line" allows engine to start and run as if a start signal were received, except it does not allow generator to connect to the isolated paralleling bus unless a start signal is received.
5. "Test Online" allows the engine to start, run, and connect to the isolated paralleling bus as if a start signal were received.

H. Engine Generator Controller: Woodward compatible.
1. Factory mount governor (speed control and load sharing) supplied in applicable engine generator Section in single-generator monitoring and control module.
2. Loading control interface to the governor system.
3. Automatic synchronizer.

I. Automatic Synchronizer:
1. Include sync mode selector switch with RUN-OFF-CHECK-PERMISSIVE positions. In RUN mode, enable active synchronization and sync-check function. In CHECK mode, perform the sync-check function. In PERMISSIVE mode, annunciate when generator and bus are synchronized but do not allow breaker closure.
a. Include discrete inputs in synchronizer to switch to each mode.
2. Bias the generator speed and voltage to match the paralleling isolated bus.
3. If the automatic synchronizer receives a permissive signal to allow closure to the paralleling isolated bus and the generator is within synchronizing limits, send a close signal to the single-generator paralleling circuit breaker.

J. Sync-switch, removable, keyed T-handle.

K. "Engine Generator Synchronized" Indication: Indicator lamp or digital-display indication of synchronization.

L. Voltage and Frequency Raise and Lower Switches: Allow plus or minus 5 percent adjustment when engine generator is operating but is not connected to the isolated paralleling bus.

M. Control and Reset Push Button: Have flashing lamp to indicate generator is locked out due to fault condition.

N. Lamp Test Push Button: Simultaneously tests all lamps on panel.

O. Control Panel Illumination: DC lamps illuminate panel when lighting from surrounding environment is unavailable.

P. Emergency Stop Push Button: Red mushroom-head switch maintains its position until manually reset.

Q. Alarm and Status Indicating Display:
1. Status and Alarm Indications:
a. Status, Light Only (Nonlatching):
1) Generator mode selector switch not in auto (red).
2) Generator mode selector switch in auto (green).
3) Start signal received (green).
4) Emergency stop activated (red).
5) Demand mode standby (green).
6) Timing for start (green).
7) Timing for shutdown (green).
8) Generator circuit breaker closed (red).
9) Generator circuit breaker open (green).
a) Generator circuit breaker locked out (white).
b) Generator circuit breaker racked out (white)
10) Remote generator breaker is open (red).
11) Engine stopped (green).
12) Time-delay start (green).
13) Engine running (red).
14) Engine cool-down (green).
b. Pre-Alarm, Light and Horn (Nonlatching):
1) Pre-high coolant temperature (amber).
2) Pre-low oil pressure (amber).
3) Low coolant temperature (amber).
4) Engine low battery (amber).
5) Battery charger failure (amber).
6) Auxiliary power failure (amber).
7) Low fuel-day tank (amber).
8) Paralleling low-voltage switchgear generator breaker failed to close (amber).
9) Paralleling low-voltage switchgear generator breaker failed to open (amber).
10) Overcurrent alarm (amber).
11) Day tank low-fuel alarm (amber).
12) Ground-fault alarm (amber).
c. Shutdown Alarm, Light and Horn (Latching):
1) Engine overcrank (red).
2) Engine overspeed (red).
3) Engine low oil pressure (red).
4) Engine high coolant temperature (red).
5) Engine low coolant level (red).
6) Engine remote emergency shutdown (red).
7) Generator fail to synchronize shutdown (red).
8) Generator circuit breaker tripped (red).
9) Generator circuit breaker failure (red).
10) Generator not in auto (red).
11) Generator loss of field (red).
12) Generator reverse power (red).
13) Generator undervoltage (red).
14) Generator overvoltage (red).

15) Generator underfrequency (red).
16) Generator overfrequency (red).
17) Phase rotation (red).
18) Generator short circuit (red)
19) Day tank low-fuel shutdown (red).
20) Air damper activated, shutdown (red).

R. Paralleling Controls and Protection:
1. Engine Generator Governor (Speed Control and Load Sharing): Comply with requirements in applicable engine generator Section. Components shall be Woodward compatible.
2. Kilowatt Load Sharing Control and Interface:
   a. Operates engine generator governors during synchronizing and provides isochronous load sharing when paralleled.
   b. Allows engine generator to ramp up to kilowatt load level signaled by multiple-generator and PV paralleling microgrid monitoring and control controller.
3. Load-Demand Governing Control:
   a. Causes engine generator to ramp down at an operator-adjustable rate to zero load when signaled to shut down in load-demand mode.
   b. Causes engine generator to ramp up at an operator-adjustable rate to a proportional share of total isolated paralleling bus load when signaled to restart.
4. Kilovolt-Ampere-Reactive Load Sharing Control:
   a. Operates alternator excitation system while engine generator is paralleled.
   b. Causes sharing of reactive load among engine generators to within 1 percent of equal levels without voltage drop.
5. Paralleling Monitor and Control:
   a. Monitors and verifies that engine generator has reached 90 percent of nominal voltage and frequency before closing to the isolated paralleling bus.
   b. Prevents accidental closure of the breaker with the engine generator out of phase with the bus.
   c. Prevents out-of-phase closure to the isolated paralleling bus due to errant manual or automatic operation of synchronizer.
   d. System of diagnostic digital displays to assist in analyzing synchronization.
6. Synchronizer Control:
   a. Adjusts engine governor to match voltage, frequency, and phase angle of the isolated paralleling bus.
   b. Maintains engine generator voltage within 1 percent of the isolated paralleling bus voltage, and phase angle within 20 electrical degrees of the isolated paralleling bus for 0.5 seconds before circuit-breaker closing.
   c. Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down engine generator on failure condition.
7. Reverse Power Monitor and Control:
   a. Prevents sustained reverse power flow in engine generator.

b. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse power condition exceeds 10 percent of engine generator kilowatt for three seconds.
c. Trips generator paralleling circuit breaker and initiates engine generator shutdown when reverse kilovolt-ampere conditions exceeds 20 percent of generator kilovolt-ampere rating.

8. Phase Rotation Monitor and Control: Verifies engine generator and isolated paralleling bus phase rotation match prior to closing paralleling circuit breaker.
9. Electronic Alternator Overcurrent Alarm and Shutdown Control:
   a. Monitors current flow at engine generator output terminals.
   b. Initiates alarm when load current on engine generator is more than 110 percent of rated current for more than 60 seconds.
   c. Overcurrent shutdown function matched to thermal damage curve of alternator.
10. Electronic Alternator Short-Circuit Protection: Shuts down generator, without instantaneous-trip function, when load current is more than 175 percent of rated current and combined time/current approaches thermal damage curve of alternator.
11. Loss of Excitation Monitor: Displays alarm on single-generator paralleling monitoring and control panel when generator controls sense loss of excitation to alternator while paralleled to the isolated paralleling bus.
12. Cool-Down, Time-Delay Control: Adjustable, zero to 600 seconds.
13. Start Time-Delay Control: Adjustable, zero to 300 seconds.
14. Frequency Control: Initiate an alarm condition when engine generator is below 90 percent of rated frequency for more than 20 seconds or is over the frequency.
15. Under- and Overvoltage Control: Initiate an alarm condition when the engine generator is at 90 percent voltage for more than 20 seconds or is over the voltage.

2.5 SINGLE-PHOVOLTAIC (PV) PARALLELING MONITORING AND CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar, Inc.; Electric Power Division.
   2. Cummins Power Generation.

B. Source Limitations: Obtain single-PV and multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
   1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.
   2. The multiple-generator and PV paralleling microgrid monitoring and control system shall fully integrate the PV monitoring and control system for load sharing and synchronizing distributed energy resources including but not limited to diesel gensets and the utility sources. See Section 263100 "Photovoltaic Energy Systems" for system integration requirements.

C. Synchronizer (Load Sharing) Control: Per PV requirements. Comply with Section "263100 Photovoltaic Energy Systems" for system integration requirements.

D. Reverse Power Monitor and Control:
1. Prevents sustained reverse power flow in engine generator or PV.
2. Trips PV paralleling circuit breaker and initiates PV shutdown when reverse power condition exceeds PV system tolerance.
3. Trips PV paralleling circuit breaker and initiates PV shutdown when reverse kilovolt-ampere conditions exceeds PV system tolerance.

2.6 METAL-ENCLOSED, CIRCUIT-BREAKER SWITCHGEAR (600 V AND LESS)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.

B. Source Limitations: Obtain multiple-generator and PV paralleling microgrid monitoring and control system and paralleling low-voltage switchgear from same manufacturer as required for engine generator.
1. Refer to Section 2.1 System Description Multiple-Generator and PV Paralleling Microgrid Monitoring and Control System power system components and provide a fully functional control system for all system components provided by other manufacturers. See Section 1.1.B Related Requirements.
2. The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.
3. All project circuit breakers shall be by the same manufacturer.

C. Description: Factory assembled and tested, and complying with IEEE C37.20.1 and UL 1558.

D. Ratings: Suitable for application in three-phase, 60-Hz, solidly grounded neutral system.

E. Nominal System Voltage:As shown on Drawings.

F. Isolated Paralleling Bus: Rating as shown on Drawings.
1. Phase-, Neutral-, and Ground-Bus Materials:
a. Phase and Neutral Bus: Copper, tin plated.
b. Ground Bus: Copper, tin plated; minimum size 1/4 by 2 inches.
c. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with compression connectors for outgoing circuit conductors.
2. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
a. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing neutral conductors.
b. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.

G. Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

1. See Section 1.1.B Related Requirements. Switchgear shall be rated for fault current conditions.
2. As shown on Drawings.

H. Switchgear Fabrication:
1. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
2. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
3. Auxiliary Compartments: Match and align with basic switchgear assembly.
   a. Bus transition sections.
   b. Pull sections.
   c. Hinged front panels for access to accessory and blank compartments.
   d. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
   e. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
   f. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
      1) Sprayed Insulation Thickness: 3 mils, minimum.
      2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
4. Circuit-Breaker Terminals for Cable Connections: Silver-plated copper bus extensions equipped with compression connectors for conductors.

I. Circuit Breakers: Comply with IEEE C37.13, IEEE C37.16, and IEEE C37.17.
1. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   a. Normal Closing Speed: Independent of both control and operator.
   b. Slow Closing Speed: Optional with operator for inspection and adjustment.
3. Stored-Energy Mechanism: Electrically charged, with optional manual charging and operation counter.
4. Trip Devices:
   a. Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, and a release mechanism.
   b. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   c. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
   d. Time-Current Characteristics: Field adjustable.
   e. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
   f. Long-Time- and Short-Time-Delay Functions: Three bands, minimum; marked "minimum," "intermediate," and "maximum."
   g. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-t operation.
   h. Pickup Points: Five minimum, for instantaneous-trip functions.

i. Ground-fault protection alarm with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
   1) Three-wire circuit or system.
   2) Four-wire circuit or system.
   3) Four-wire, double-ended substation.

j. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

5. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
6. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions.
   a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed.
   b. Circuit-Breaker Positioning:
      1) An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed, unless live parts are covered by a full dead-front shield.
      2) An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open.
      3) Status for connection devices for different positions includes the following:
         a) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
         b) Disconnected Position: Primary and secondary devices and ground contact disengaged.
7. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position; arranged to permit inspection of contacts without removing circuit breaker from switchgear.
8. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
9. Operating Handle: One for each circuit breaker capable of manual operation.
   a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with the isolated paralleling bus.
10. Electric Close Button: One for each electrically operated circuit breaker.
    a. Generator Paralleling Circuit Breakers: Interlocked with system control so that circuit breaker does not close unless mode selector switch is in "Auto" position and engine generator is synchronized with the isolated paralleling bus.
11. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

12. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
13. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.
14. Shunt-Trip Devices:
    a. 24-V dc for generator paralleling circuit breakers and for distribution paralleling switchgear circuit breakers.
    b. Where indicated.
15. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

J. Metering:
1. Type and Locations:
    a. Isolated Paralleling Bus: Multifunction digital-metering monitor; on door of separate metering compartment.
    b. Generator Circuit Breakers: Multifunction digital-metering monitor; on circuit-breaker door.
    c. Distribution Circuit Breakers: Multifunction digital-metering monitor; on circuit-breaker door.
2. Instrument Transformers:
    a. Comply with IEEE C57.13.
    b. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
    c. Current Transformers:
        1) Burden and accuracy class suitable for connected relays, meters, and instruments.
        2) Size for the maximum momentary current amperage based on calculation or the momentary rating of the circuit breaker protecting the conductor.
        3) Include shorting-type terminal blocks.
3. Multifunction Digital-Metering Monitor:
    a. Microprocessor-based unit suitable for three- or four-wire systems.
    b. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
    c. Switch-selectable digital display with the following features:
        1) Phase Currents, Each Phase: Plus or minus 1 percent.
        2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
        3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
        4) Three-Phase Real Power: Plus or minus 2 percent.
        5) Three-Phase Reactive Power: Plus or minus 2 percent.
        6) Power Factor: Plus or minus 2 percent.
        7) Frequency: Plus or minus 0.5 percent.
        8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
        9) Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
    d. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Section 260913 "Electrical Power Monitoring and Control."

e. Mounting: Display and control unit that is flush or semirecessed mounted in instrument compartment door.

K. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.
1. Manufacturer: Subject to compliance with requirements, provide products by Schweitzer Engineering Laboratories (SEL) Co.
2. Functions: As shown on Drawings.

L. Door-Mounted Control Components: Industrial-type oiltight devices and digital-display indicator lamps.

M. Control Power Supply:
1. Control power transformer shall supply 120-V ac control circuits from the generator source through secondary disconnect devices.
2. Include a control power transformer for each generator paralleling switchgear circuit breaker connected to the generator side of the circuit breaker.
3. Include a control power transformer for each distribution paralleling switchgear circuit breaker.
4. Dry-type transformers shall be in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
5. Control Power Fuses: Primary and secondary fuses shall provide current-limiting and overload protection.

N. Control Wiring:
1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Conductors shall be sized according to NFPA 70 for duty required.

O. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

P. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems" for electrical identification devices and installation.
1. Identify units, devices, controls, and wiring.
2. Mimic Bus: Continuous mimic bus, applied to front of paralleling low-voltage switchgear, arranged in one-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
a. Mimic-bus segments coordinated with devices in paralleling low-voltage switchgear sections to which applied, to produce a concise visual presentation of principal paralleling switchgear components and connections.
b. Medium: Painted graphics, as selected by Architect.
c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

Q. Indoor Enclosure Material: Steel.

R. Access: Fabricate enclosure with hinged, rear cover panels to allow access to rear interior of paralleling low-voltage switchgear.

S. Finish: Manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

T. Accessories:

1. Tools for circuit-breaker and switchgear tests, inspections, maintenance, and operation.
2. Racking handle to manually move circuit breaker between connected and disconnected positions.
3. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
4. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

U. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of draw-out circuit breaker installed.

V. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

W. Storage for Manual: Rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 CONTROL POWER SUPPLY, 24-V DC

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Battery system capacity shall be as recommended by switchgear manufacturer to operate the circuit breakers for intended duty.

B. Battery: Premium VRLA batteries, with battery disconnect and overcurrent protective device.

C. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. Rate battery rack, cell supports, and anchorage for seismic requirements.

D. Accessories:
1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz.
1. DC ammeter.
2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell, and equalizing charge at 2.33 V per cell.

5. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation shall be automatic until manually reset.
6. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. Automatic charger operation shall resume after loss of ac power supply for any interval.
7. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. Device shall regulate charging current but shall not disconnect charger from either battery or ac supply.
8. Charger's Audible Noise: Less than 26 dB.

2.8 DIFFERENTIAL GROUND-FAULT PROTECTION

A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources shall be devised by manufacturer to insure that the proper generator or PV breaker(s) operate properly in emergency conditions. Switchgear shall include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to the main bus of the switchgear. Ensure that the following occurs on the main bus:
   1. A ground fault at any location in the switchgear shall alarm the system and not trip the system.
   2. Combination of normal current flow and ground-fault current flow shall alarm the system and not trip the system.
   3. Circulating currents through the neutral due to multiple grounds and sources external to the immediate low-voltage power sources shall not trip the system.
   4. System shall not trip if there is no ground fault, during normal current flow.
   5. System shall not trip due to large single-phase currents.

B. Relays: Comply with IEEE C37.90, with test blocks and plugs.

C. Control Wiring:
   1. Factory installed, complete with bundling, lacing, and protection.
   2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   3. Install plugs in control wiring at shipping splits.

2.9 IDENTIFICATION

A. Compartment Nameplates: Engraved, laminated acrylic , as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Source labeling: Use unique label to distinguish source (generator, PV) circuit breakers and load (ATS) distribution circuit breakers.

C. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   2. Medium: Painted graphics, as selected by Architect.
   3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

D. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
    a. 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) Flash protection boundary.
        4) Hazard risk category.
        5) Incident energy.
        6) Working distance.
        7) Engineering report number, revision number, and issue date.
    b. Labels shall be machine printed, with no field-applied markings.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect paralleling low-voltage switchgear, with generators and transfer switches, at paralleling low-voltage switchgear manufacturer's or suppliers factory.
1. Paralleling Low-Voltage Switchgear:
    a. NETA ATS, 7.6.1.2, "Circuit Breaker, Air, Low-Voltage Power Switchgear."
    b. Factory test with simulated inputs. Test control and relay functions for proper operation.
2. Engine Generator:
    a. NETA ATS, 7.22.1, "Emergency Systems, Engine Generator."
    b. NETA ATS, 7.15.1, "Rotating Machinery, AC Motors & Generator."
3. Automatic Transfer Switches:
    a. NETA ATS, 7.22.3, "Emergency System, Automatic Transfer Switches."

B. Verification of Performance: Rate paralleling low-voltage switchgear, with generators and transfer switches, according to operation of functions and features specified.

C. Factory test control of paralleling low-voltage switchgear, generators, automatic transfer switches and simulate control of PV and remote (SES "main and "PV") low voltage power circuit breakers to demonstrate successful operation of full range of sequence of operations.

D. Paralleling low-voltage switchgear, with generators and transfer switches, will be considered defective if it does not pass tests and inspections.

E. Coordinate scheduling of the factory witness test with Architect and Owner. Perform successfully tests prior to witness test.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, where paralleling low-voltage switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and applicable portions in NECA 400.

B. Equipment Mounting:
   1. Install paralleling low-voltage switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3.
   2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from paralleling low-voltage switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagrams and Instructions:
   1. Frame and mount under clear acrylic plastic on front of paralleling low-voltage switchgear.
      a. Operating Instructions: Printed basic instructions for paralleling low-voltage switchgear, including control and key-interlock sequences and emergency procedures.
      b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
   2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.
   3. Use unique label to distinguish source (generator, PV) circuit breakers and load (ATS) distribution circuit breakers.

3.4 CONNECTIONS

A. Comply with grounding and bonding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with wire and cable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Provide all control, distribution, monitoring, and start signal connections as required between relevant equipment.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.
3. Inspect paralleling switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
4. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing.
5. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
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 each of the following NETA categories:
   a. AC generators and emergency systems.
   b. Switchgear.
   c. Circuit breakers.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.
2. Perform NFPA 100 tests for Type 1 essential power systems.

D. Paralleling low-voltage switchgear will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Test sequence of operation step by step for each mode.

H. Test the graphical user interfaces for all monitoring points and graphics described in specification and as indicated on Drawings.

3.6 ADJUSTING

A. Set field-adjustable, electronic circuit-breaker trip characteristics according to results specified in Section 260573.16 "Coordination Studies."

B. Set field-adjustable, electronic circuit-breaker trip characteristics.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of paralleling low-voltage switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to paralleling low-voltage switchgear, according to manufacturer's written instructions, throughout periods when paralleling switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain paralleling low-voltage switchgear.

B. Record the training and provide a video copy to the Owner.

END OF SECTION

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Accessory components and features.
6. Identification.

B. Related Requirements
1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
3. Section 262313 "Paralleling Low-voltage Switchgear" for remote monitoring and metering requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards 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. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and store in a way that prevents condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and 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 104 deg F.
      b. 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 Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards 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. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer agrees to repair or replace surge protection devices 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 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. SIEMENS Industry, Inc.; Energy Management Division.
4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Section Alignment: Front aligned.

J. Front- and Rear-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel Fixed, individually Fixed and individually compartmented Individually compartmented and drawout mounted.
3. Sections front and rear aligned.

K. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

L. Indoor Enclosures: Steel, NEMA 250, Type 1.

M. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

N. Barriers: Between adjacent switchboard sections.

O. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

P. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

R. Fire Pump Tap Section: Full height section, matched and aligned with adjacent switchboard sections.
1. Tap section shall be sized to accommodate tap for size of fire pump service conductors as indicated on the Drawings.
2. Tap shall be located on the line side of the service disconnecting means and on the load size of the utility current transformer connections.
3. Tap section shall contain only the fire pump service tap and conductors and shall not contain any overcurrent protective devices or disconnects.
4. Tap section shall be labeled with permanent identification plaque which reads "FIRE PUMP SERVICE TAP" using white lettering on a red background and shall comply with Section 260533 "Identification of Electrical Systems".
5. Top or bottom entry as indicated on Drawings or as required to coordinate with the location of the outgoing fire pump service conductors.

S. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

T. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

U. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
3. Copper feeder circuit-breaker line connections.

4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:
   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. SIEMENS Industry, Inc.; Energy Management Division.
4. Square D; by Schneider Electric.

B. SPDs: Comply with UL 1449, Type 1 Type 2.

C. Features and Accessories:
1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.

D. 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.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V 1000 V for 208Y/120 V.

F. SCCR: Equal or exceed 200 kA.

G. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long and short time adjustments.
    d. Ground-fault pickup level, time delay, and I squared t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. MCCB Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Integral trip unit multifunction metering as required by Drawings. See Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting requirements.
        1) Values shall be rms average over a period of one second.
            a) Current: Each phase, neutral and three-phase average.
            b) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
            c) Active Power (kW): Each phase and three-phase total.
            d) Reactive Power (kVAr): Each phase and three-phase total.
            e) Apparent Power (kVA): Each phase and three-phase total.
            f) Power Factor: Each phase and three-phase total.
            g) Active Energy (kWh): Three-phase total.
    f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
k. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard -function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
a. Instantaneous trip.
b. Time adjustments for long- and short-time pickup.
c. Ground-fault pickup level, time delay, and I squared t response.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Section 262813 "Fuses."

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
d. Megawatts: Plus or minus 1 percent.
e. Megavars: Plus or minus 1 percent.
f. Power Factor: Plus or minus 1 percent.
g. Frequency: Plus or minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Instrument Switches: Rotary type with off position.

E. Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

F. Watt-Hour Meters and Wattmeters:
1. Comply with ANSI C12.1.

G. Impulse-Totalizing Demand Meter:
1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15 -minute integrated demand of totalized system.

2.6 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker.

120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

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 switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

D. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

E. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 3

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies."

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems."

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
   1. Acceptance Testing:
      a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
      b. Test continuity of each circuit.
   2. Test ground-fault protection of equipment for service equipment per NFPA 70.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   5. 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 switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 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 260573.16 "Coordination Studies."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

SECTION 262413 – SWITCHBOARDS - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Accessory components and features.
6. Identification.

B. Related Requirements
1. Section 260573.19, OVERCURRENT PROTECTION DEVICE ARC-FLASH STUDY - WWTP for arc-flash analysis and arc-flash label requirements.
2. Section 260913, ELECTRICAL POWER MONITORING AND CONTROL - WWTP for interfacing communication and metering requirements.
3. Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR for remote monitoring and metering requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards 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. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and store in a way that prevents condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and 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 104 deg F.
      b. 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 Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards 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. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices 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 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Section Alignment: Front aligned.

J. Front- and Rear-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel Fixed, individually Fixed and individually compartmented Individually compartmented and draw out mounted.
   3. Sections front and rear aligned.

K. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

L. Indoor Enclosures: Steel, NEMA 250, Type 1.

M. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

N. Barriers: Between adjacent switchboard sections.

O. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

P. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

R. Fire Pump Tap Section: Full height section, matched and aligned with adjacent switchboard sections.
1. Tap section shall be sized to accommodate tap for size of fire pump service conductors as indicated on the Drawings.
2. Tap shall be located on the line side of the service disconnecting means and on the load size of the utility current transformer connections.
3. Tap section shall contain only the fire pump service tap and conductors and shall not contain any overcurrent protective devices or disconnects.
4. Tap section shall be labeled with permanent identification plaque which reads "FIRE PUMP SERVICE TAP" using white lettering on a red background and shall comply with Section 260533 "Identification of Electrical Systems".
5. Top or bottom entry as indicated on Drawings or as required to coordinate with the location of the outgoing fire pump service conductors.

S. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

T. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

U. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
3. Copper feeder circuit-breaker line connections.

4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:
   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. SIEMENS Industry, Inc.; Energy Management Division.
4. Square D; by Schneider Electric.

B. SPDs: Comply with UL 1449, Type 1 Type 2.

C. Features and Accessories:
1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.

D. 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.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V 1000 V for 208Y/120 V.

F. SCCR: Equal or exceed 200 kA.

G. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long and short-time pickup levels.
    c. Long and short-time adjustments.
    d. Ground-fault pickup level, time delay, and I squared t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. MCCB Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application;. Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Integral trip unit multifunction metering as required by Drawings. See Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR and Section 260913, ELECTRICAL POWER MONITORING AND CONTROL - WWTP for metering and monitoring reporting requirements.
        1) Values shall be rms average over a period of one second.
            a) Current: Each phase, neutral and three-phase average.
            b) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
            c) Active Power (kW): Each phase and three-phase total.
            d) Reactive Power (kVAr): Each phase and three-phase total.
            e) Apparent Power (kVA): Each phase and three-phase total.
            f) Power Factor: Each phase and three-phase total.
            g) Active Energy (kWh): Three-phase total.
    F. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR and Section 260913, ELECTRICAL POWER MONITORING AND CONTROL - WWTP.

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
k. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard -function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
a. Instantaneous trip.
b. Time adjustments for long- and short-time pickup.
c. Ground-fault pickup level, time delay, and I squared t response.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913, ELECTRICAL POWER MONITORING AND CONTROL - WWTP.
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Section 262813, FUSES - WWTP.

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
d. Megawatts: Plus or minus 1 percent.
e. Megavars: Plus or minus 1 percent.
f. Power Factor: Plus or minus 1 percent.
g. Frequency: Plus or minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Instrument Switches: Rotary type with off position.

E. Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

F. Watt-Hour Meters and Wattmeters:
1. Comply with ANSI C12.1.

G. Impulse-Totalizing Demand Meter:
1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15-minute integrated demand of totalized system.

2.6 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker.

120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

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 switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

D. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

E. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP or manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 3.

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500, ENCLOSED BUS ASSEMBLIES.

B. Comply with requirements for terminating cable trays specified in Section 260536, CABLE TRAYS FOR ELECTRICAL SYSTEMS - WWTP.

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
   1. Acceptance Testing:
      a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
      b. Test continuity of each circuit.
   2. Test ground-fault protection of equipment for service equipment per NFPA 70.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   5. 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 switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 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 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY-WWTP.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements
   1. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. Section 262313 "Paralleling Low-voltage Switchgear" for remote monitoring and metering requirements.

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

1.4 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.

1.5 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. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and GFEP Types: Equal to 1 percent of quantity installed for each size and type, but no fewer than two of each size and type Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; storage in a dry space with adequate heating to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 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.

PART 2 - PRODUCTS

2.1 PANELBOARDS GENERAL REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. 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.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, as indicated, 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. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
      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. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
   a. Panels and Trim: 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.

G. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated aluminum for 400 Amp and below; Hard-drawn copper, 98 percent conductivity for 600 Amp and above.
   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. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. 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.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Same as buses.
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. Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

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 minimum short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical where supplied from transformers rated less than 75kVA and not less than 22,000 A rms symmetrical where supplied from transformers rated 112.5kVA or greater. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573.13 "Short-Circuit Study".
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have minimum short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573.13 "Short-Circuit Study".

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD. Provide Type 1 for service entrance equipment; Type 2 for other panelboards as indicated or specified.

2.3 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated.

E. Branch Overcurrent Protective Devices for Circuit-Breaker:Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal or fused switches as indicated.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. 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, provide products by one of the following
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. 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.
      c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic Trip 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:
         1) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "I" subscript on a circuit breaker:
            a) Instantaneous trip.
         2) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "L" subscript on a circuit breaker:
            a) Long-time pickup level.
            b) Long-time time adjustment.
         3) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "S" subscript on a circuit breaker:
            a) Short-time pickup levels.
            b) Short-time time adjustment.

4) Where indicated on Drawings with "G" subscript on a circuit breaker or where required by NEC for circuit breakers with frame sizes rated 1000A and greater on 480V and 480Y/277V circuits:
   a) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. Subfeed Circuit Breakers: Vertically mounted.
7. 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: Mechanical 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. Integral trip unit multifunction metering as required by Drawings. See Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting requirements.
      1) Values shall be rms average over a period of one second.
         a) Current: Each phase, neutral and three-phase average.
         b) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
         c) Active Power (kW): Each phase and three-phase total.
         d) Reactive Power (kVAr): Each phase and three-phase total.
         e) Apparent Power (kVA): Each phase and three-phase total.
         f) Power Factor: Each phase and three-phase total.
         g) Active Energy (kWh): Three-phase total.
   h. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting as required by Drawings.
   i. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   j. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
   k. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.

l. 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.
m. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
n. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
o. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
p. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
q. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
r. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. Provide one for each branch circuit overcurrent device serving fire alarm equipment. Handle clamps installed for fire alarm overcurrent devices shall have a red finish.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories:
a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: OneTwo normally open and normally closed contact(s) that operate with switch handle operation.

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: 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 NEMA PB 1.1.

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 NEMA PB 1.1.

D. Equipment Mounting:
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
   2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 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. Install handle clamps on all branch circuit overcurrent devices serving fire alarm equipment.

N. Stub three 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub three1-inch empty conduits into raised floor space or below slab not on grade.

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; 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. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, 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 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.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. 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 per 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 262416 – PANELBOARDS - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements
1. Section 260913, ELECTRICAL POWER MONITORING AND CONTROL - WWTP for interfacing communication and metering requirements.
2. Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR for remote monitoring and metering requirements.

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

1.4 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.

1.5 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. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Equal to 1 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; storage in a dry space with adequate heating to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 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.

PART 2 - PRODUCTS

2.1 PANELBOARDS GENERAL REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP.

B. 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.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, as indicated, 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. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
      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. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
   a. Panels and Trim: 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.

G. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated aluminum for 400 Amp and below; Hard-drawn copper, 98 percent conductivity for 600 Amp and above.
   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. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. 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.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Same as buses.
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. Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

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 minimum short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical where supplied from transformers rated less than 75kVA and not less than 22,000 A rms symmetrical where supplied from transformers rated 112.5kVA or greater. Short-Circuit current rating shall be greater than the

maximum available fault current as determined in the power system study specified in Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY - WWTP.

2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have minimum short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY - WWTP.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD. Provide Type 1 for service entrance equipment; Type 2 for other panelboards as indicated or specified.

2.3 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated.

E. Branch Overcurrent Protective Devices for Circuit-Breaker: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal or fused switches as indicated.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. 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, provide products by one of the following
   1. Eaton.
   2. ABB.
   3. SIEMENS Industry, Inc.; Energy Management Division.
   4. Square D; by Schneider Electric.

B. 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.
      c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic Trip 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:
         1) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "I" subscript on a circuit breaker:
            a) Instantaneous trip.
         2) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "L" subscript on a circuit breaker:
            a) Long-time pickup level.
            b) Long-time time adjustment.
         3) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "S" subscript on a circuit breaker:
            a) Short-time pickup levels.
            b) Short-time time adjustment.
         4) Where indicated on Drawings with "G" subscript on a circuit breaker or where required by NEC for circuit breakers with frame sizes rated 1000A and greater on 480V and 480Y/277V circuits:

a) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. Subfeed Circuit Breakers: Vertically mounted.
7. 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: Mechanical 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. Integral trip unit multifunction metering as required by Drawings. See Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting requirements.
      1) Values shall be rms average over a period of one second.
         a) Current: Each phase, neutral and three-phase average.
         b) Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
         c) Active Power (kW): Each phase and three-phase total.
         d) Reactive Power (kVAr): Each phase and three-phase total.
         e) Apparent Power (kVA): Each phase and three-phase total.
         f) Power Factor: Each phase and three-phase total.
         g) Active Energy (kWh): Three-phase total.
   h. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 262313 "Paralleling Low-voltage Switchgear" and Section 260913 "Electrical Power Monitoring and Control" for metering and monitoring reporting as required by Drawings.
   i. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   j. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
   k. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
   l. 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.
   m. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

n. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
o. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
p. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
q. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
r. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. Provide one for each branch circuit overcurrent device serving fire alarm equipment. Handle clamps installed for fire alarm overcurrent devices shall have a red finish.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813, FUSES - WWTP.
2. Fused Switch Features and Accessories:
a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: OneTwo normally open and normally closed contact(s) that operate with switch handle operation.

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: 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 NEMA PB 1.1.

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 NEMA PB 1.1.

D. Equipment Mounting:
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
   2. Comply with requirements for seismic control devices specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 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. Install handle clamps on all branch circuit overcurrent devices serving fire alarm equipment.

N. Stub three 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub three 1-inch empty conduits into raised floor space or below slab not on grade.

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; 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 - WWTP.

D. Install warning signs complying with requirements in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, 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 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.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. 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 per 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 262419 – MOTOR CONTROL CENTERS – WWTP

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers work for furnishing and installing motor control centers (MCCs) for use with ac circuits rated 600 Volts and less, as shown on the Drawings for this project, complete. This section includes MCCs with combination controllers and having the following factory installed components:
   1. Automatic power transfer.
   2. Feeder-tap units.
   3. Measurement and control.
   4. Variable Frequency Drives.

1.2 SUMMARY OF WORK

A. This section consists of the Contractor procuring and installing low voltage MCC(s) and/or MCC components. The Contractor and their electrical sub-contractor is responsible for all power wiring to and from all MCC sections as indicated on the Drawings. The Contractor and their electrical sub-contractor shall also coordinate all start-up and commissioning timelines.

B. Installation and testing shall be accomplished according to all appropriate Division 26, ELECTRICAL specification sections, the Drawings, and the manufacturer's written instructions. This specification also defines the minimum requirements for the manufacturer.
   1. Coordinate all new MCC buckets with the Drawings. New control logic diagrams are provided in the Drawings to indicate the desired operation and control of each component in the system.

1.3 GENERAL REQUIREMENTS

A. Also see the GENERAL CONDITIONS, Division 01, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

B. Like items of equipment or materials provided hereunder shall be the end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement, and shall include all necessary appurtenances for a complete and working system. The equipment or materials shall be the product of a manufacturer regularly engaged in the production of equipment or materials for the specified use. The manufacturer shall have the sole responsibility for the proper functioning and coordination of the equipment or materials as furnished.

C. The Contractor or their sub-contractors shall provide all required miscellaneous equipment and materials, as shown on the Drawings and in accordance with these Specifications. The Contractor or their sub-contractors shall furnish all equipment and material items, whether specified or not, as necessary to provide a complete, operable electrical system.

1.4 SUBMITTALS

A. Submittals shall be provided as specified in Section 013300, SUBMITTAL PROCEDURES.

B. Submit product data and product certificates for each motor control center product and component used on this project. Include data for each type of controller.

C. Shop Drawings: Provide shop drawings for each MCC and related equipment, with the manufacturer's approval and custom drawings as defined in UL 845, "Motor Control Centers". In addition to the requirements specified in UL 845, include the following:
   1. Include dimensioned plans, elevations, sections, and details, including conduit entry locations and sizes, mounting arrangements, and required clearances and service space around equipment.
   2. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Factory installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
      f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
      g. Specified optional features and accessories.
      h. UL listing for series rating of overcurrent devices in combination controllers.
   3. Vertical and horizontal bus capacities.
   4. Schematic and Connection Wiring Diagrams: Include schematic and wiring diagrams for power, signal, and control wiring for each installed controller and each type of MCC.
   5. Features, characteristics, ratings, and factory settings of each installed unit.
   6. MCC Ethernet Network Architecture drawing complete with TCP/IP address for devices shown in the construction drawings.

D. Seismic Qualification Certificates: Provide certificates for MCCs, accessories, and components, from the manufacturer.
   1. Basis for Certification: Indicate whether the "withstand" certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Provide detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Provide copies of all source quality control and field quality control reports.

F. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

H. Provide all required operation and maintenance data for motor control centers, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700, CLOSEOUT PROCEDURES include the following:

1. Routine maintenance requirements for motor control centers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, National Electrical Code by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 2, ICS 3, ICS 5, and ICS 7. Fabricate and label MCCs to comply with NEMA ICS 18 and UL 845.

C. Installer Qualifications: Workers qualified as defined in NEMA PB 2.1; General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; and trained in electrical safety as required by NFPA 70E.

D. Manufacturer Qualifications: A qualified manufacturer regularly engaged in the manufacture of MCCs. Maintain, within 300 miles of the project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

E. Source Limitations: Obtain motor control centers and controllers of a single type through one source from a single manufacturer.

F. Testing Agency Qualifications: Accredited by NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures as necessary to provide pathway for moving MCCs into place. Coordinate all work with the Contractor.

B. Environmental Limitations:
1. Do not deliver or install MCCs until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above MCCs is complete, and temporary or permanent 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 Rating: Between 23 degrees F to plus 104 degrees F.
   b. Ambient Storage Temperature Rating: Note less than minus 4 degrees F and not exceeding 140 degrees F.
   c. Altitude Rating: Not exceeding 3300 feet.
   d. Humidity Rating: Less than 95 percent, noncondensing.

C. Service Conditions: NEMA ICS 2, usual service conditions, or as noted above.

1.7 COORDINATION

A. Coordinate layout and installation of MCCs and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, ductwork, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels in accordance with NEC 110.26.

B. Coordinate layout and installation of MCCs and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03, CONCRETE.

D. Coordinate features of motor control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect. Refer to wiring diagrams on the Drawings and the P&ID Drawings for more clarification.

E. Provide all local operator stations including wiring and mounting hardware as shown on the P&ID Drawings for Division 40 and Division 26. Coordinate wiring and mounting hardware for all Division 43 and/or Division 46 local operator stations.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace MCC enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within the specified warranty period.
   1. Warranty Period: 24 months from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fabricate and test MCCs according to IEEE 344 to withstand the seismic forces as defined in Section 250548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP and as determined according to ASCE/SEI 7.
   1. Basis for Certification: Indicate whether “withstand” certification is based on an actual test of assembled components or on calculation. Shake table testing shall comply with ICC-ES AC156.
   2. The term "withstand" means "the MCC system will remain in place without separation of any parts when subjected to the seismic forces specified."
   3. Component Importance Factor: 1.5.
   4. Component Amplification Factor: 2.5.
   5. Component Response Modification Factor: 6.0.

2.2 MOTOR CONTROL CENTERS

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

1. Rockwell Automation, Inc.; Allen Bradley.
2. Eaton Corporation.
3. Square D; by Schneider Electric.
4. ABB/U.S. Electrification.
5. Or equal.

B. Source Limitations: Obtain MCCs, overcurrent protective devices, components, and accessories from a single source from a single manufacturer.

C. Capacities and Characteristics:
1. Integrated Short Circuit Rating for MCC:
   a. Fully rated; as shown on the Drawings.
2. Integrated Short Circuit Rating for Each Unit:
   a. Fully rated; as shown on the Drawings.
   b. Wiring Class: NEMA ICS 2 or 3, Class II, Type B.
   c. Bus:
      1. Horizontal Bus: 1200 A.
      2. Vertical Bus: 600A or 300 A.
      3. Neutral Bus: Full size for 3-phase, 4-wire.
3. Automatic Power Transfer:
   a. As shown on the Drawings.
4. Magnetic Controllers:
   a. As shown on the Drawings.
5. Reduced Voltage Solid State Controllers:
   a. As shown on the Drawings.
6. Variable Frequency Drives (VFDs):
   a. As shown on the Drawings.
7. Controller Mounted Auxiliary Devices:
   a. As shown on the Drawings.
8. Panelboards:
   a. As shown on the Drawings.
9. Transformer(s):
   a. As shown on the Drawings.

2.3 ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated on the Drawings. NEMA 250, Type 12 unless otherwise indicated to comply with environmental conditions at installed location. Ensure metal thickness for enclosure is no less than specified in NEMA ICS 6.
1. Finish: Factory applied finish in manufacturer's standard gray finish over a rust inhibiting primer on treated metal surface.

2.4 ASSEMBLY

A. Structure:
1. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor control center.
2. Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.

a. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical section buses while being racked into their normal, energized positions.
b. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
c. Provide units with short circuit current ratings equal to or greater than short circuit current rating of motor control center section.

3. Pull Boxes:
a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
b. Set the box back from front to clear circuit breaker removal mechanism.
c. Covers: Removable covers forming top, front, and sides.
d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.
f. When equipped with barriers, supply with access to check bus bolt tightness.

B. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners.
1. Interlock compartment door to require that the disconnecting means is "Off" before door can be opened or closed, except by operating a concealed release device.
2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC. Provide pass through bussing on main on all sections.

D. Owner's Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include PTs having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

E. Interchangeability: Compartments shall be constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments shall be provided to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

F. Wiring Spaces:
1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

G. Provisions for Future:
   1. Compartments marked "Future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
   2. Compartments marked "Spare" shall include provisions for connection to the vertical or horizontal bus.

H. Integrated Short Circuit Rating:
   1. Short Circuit Current Rating for Each Unit: Fully rated; as shown on the Drawings.
   2. Short Circuit Current Rating of MCC: Fully rated with its main overcurrent device; as shown on the Drawings.

I. Control Power:
   1. 120 Volt ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   2. Control Circuits: 24 Volt dc, supplied centrally from two redundant, automatically switched power supplies. Provide a 24 Volt dc UPS to back up power on the 24 Volt dc power supplies. Provide 1 minute of back-up supply.
   3. CPT Spare Capacity: 100 VA.

J. Factory Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
   1. Wiring Class: NEMA ICS 18, Class I Type B-T, for starters Size 3 and smaller.
   2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

K. Bus:
   1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
   2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
   3. Phase Bus and Neutral Bus Material: Hard-drawn copper of 98 percent minimum conductivity or silver or tin-plated alloy, with mechanical or compression connectors for outgoing conductors.
   4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-inch by 2 inches. Equip with mechanical or compression connectors for outgoing conductors.
   5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-inch by 2-inch copper bus, arranged to connect neutral bus to ground bus.
   6. Bus Bar Insulation: Factory applied, flame retardant, tape wrapping of individual bus bars or flame retardant, spray applied insulation. Insulation temperature rating shall not be less than 105 degrees C.

2.5 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. Molded Case Circuit Breaker (MCCB; to 1600 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.
   1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free; its position shall be shown by the position of the handle, and manual push-to-trip push button.

2. Solid state monitoring and tripping system shall be provided to show system status monitoring, adjustable time-current protection, and shunt trip.
    a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
    b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. Provide with neutral ground-fault sensor.
    c. Time-current adjustments to achieve protective device coordination as follows:
        1. Adjustable long-time delay.
        2. Adjustable short-time setting and delay to shape the time-current curve.
        3. Adjustable instantaneous setting.
        4. Individually adjustable ground-fault setting and time delay.
    d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
    e. Built-in digital ammeter display, showing load current and tripping cause.
3. Switch operator power shall be from the control power specified in the "Assembly" article hereinbefore.

B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD latest edition.

2.6 MAGNETIC CONTROLLERS

A. Controller Units: Combination controllers.

B. Disconnects:

C. MCP:
1. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: For three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4. NO alarm contact that operates only when MCP has tripped.
5. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
6. Controllers: Comply with UL 508.

D. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS2, NEMA ICS 18 and NFPA 70, general purpose, Class A.
1. Classification: Non-reversing.

E. Solid-State Overload Relays: preferred model is the Allen Bradley E300:
1. Switch or dial selectable for motor-running overload protection.
2. Sensors in each phase.
3. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5. Analog communication module (optional).

6. Motor load CTs as required by manufacturer to provide motor current.
7. NO isolated overload alarm contact.
8. External overload reset push button.

2.7 VARIABLE FREQUENCY DRIVE(S) OR CONTROLLER(S)

A. Drive or Controller Units: Combination controllers, consisting of variable frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection. Normal Duty current shall be suitable for the application. Listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable speed control of one or more three phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and UL 508E.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable Voltage or Adjustable Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
   4. Listed and labeled for single phase use by an NRTL acceptable to authorities having jurisdiction.
   5. Provide drives with Ethernet/IP communications module matching control logic diagrams in the Drawings. See Division 40 specifications for more information on the communication protocol.

B. Disconnects:
   1. MCCB:
      a. UL 489, with interrupting capacity to comply with available fault currents; thermal magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
      b. Front mounted, adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
      c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
      d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
      e. Normally Open alarm contact that operates only when MCCB has tripped.

C. Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 5 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary Side Power Factor: 98 percent under any load or speed condition.
   6. Overload Capability:
      a. For variable torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

b. For constant torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
8. Speed Regulation: Plus or minus 5 percent.
9. Output Carrier Frequency: Field selectable.
10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
11. Internal Adjustability Capabilities:
    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: 0.1 to 999.9 seconds.
    d. Deceleration: 0.1 to 999.9 seconds.
    e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
12. Self-Protection and Reliability Features:
    a. Capable of riding through intermittent communication failures.
    b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
    c. Undervoltage and overvoltage trips.
    d. Inverter overcurrent trips.
    e. VFD and Motor Overload/Overtemperature Protection: Microprocessor based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
    f. Critical frequency rejection, with three selectable, adjustable deadbands.
    g. Instantaneous line-to-line and line-to-ground overcurrent trips.
    h. Loss of phase protection.
    i. Reverse phase protection.
    j. Short circuit protection.
    k. Motor over temperature fault.
13. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
14. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Operator Station:
1. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.
2. Isolated Control Interface: Allows VFDs to follow remote control signal over a minimum 40:1 speed range.
3. Panel mounted, manufacturer's standard front accessible, sealed keypad and plain English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
    a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
    b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

E. Displays:
   1. Historical Logging Information and Displays:
      a. Real-time clock with current time and date.
      b. Running log of total power versus time.
      c. Total run time.
      d. Fault log, maintaining minimum last four faults with time and date stamp for each.
   2. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including the following:
      a. Output frequency (Hz).
      b. Motor speed (rpm).
      c. Motor status (running, stop, fault).
      d. Motor current (amperes).
      e. Motor torque (percentage).
      f. Fault or alarming status (code).
      g. PID feedback signal (percentage).
      h. DC link voltage (V dc).
      i. Set-point frequency (Hz).
      j. Motor output voltage (V ac).

F. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

G. Power Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto-speed Search" feature is available and engaged.

H. Bidirectional Auto-speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

I. Input and Output Filter: Provide input filtering with a minimum 3 percent line reactor. Provide output filtering for each motor. Size output filter as recommended by the manufacturer for the ampere rating to suit the service factor ampacity of the driven motor. The manufacturer may choose between a 5 percent line reactor or dv/dt filtering to suit the length requirements between the motor and the VFD.

J. Communication Port: Ethernet or equivalent connection capable of connecting the VFD to an Ethernet/IP controlled network. Direct communications through Ethernet/IP. No converter modules that allow the drives to connect to Ethernet/IP like Modbus will be allowed.

2.8 CONTROLLER MOUNTED AUXILIARY DEVICES

A. Control Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oil-tight type.
      a. Push Buttons: Covered types; maintained and momentary contact as indicated in the Drawings.
      b. Pilot Lights: LED types; Red, Green, and Amber; push to test. Coordinate with Logic Diagrams.

c. Selector Switches: Rotary type.

B. Elapsed Time Meters: Heavy-duty with digital readout in hours; non-resettable.

C. Meters: Panel type, 2-1/2-inch minimum size with 90 degree or 120 degree scale and plus or minus 2 percent accuracy, with selector switches having an Off position.

D. Auxiliary Dry Contacts: Reversible Normally Closed/Normally Open.

E. Control Relays:
1. Time Delay: Auxiliary and adjustable solid state time delay relays.
2. Phase Failure, Phase Reversal, and Undervoltage and Overvoltage Relays: Solid state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time delay settings.

F. EtherNet/IP Devices:
1. Motor control center assemblies shall be provided with a factory assembled EtherNet/IP communications network providing direct connectivity between MCC devices and the plant control system.
2. Motor control centers shall provide all required Ethernet 10/100 auto negotiate managed industrial switches per lineup. The Ethernet switches shall have sufficient ports available to connect to each EtherNet/IP device and have at least 2 open ports for a customer connection to the Plant Control Network and a PC connection for maintenance.
3. The EtherNet/IP system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be 600V Cat 6 and consist of home run connections from the device to a switch located in the MCC and in accordance with the ODVA specification. Non-standard, non-shielded cable will not be accepted.
4. All cabling shall be securely supported and attached to the MCC structure in accordance with the Drawings and the manufacturer's recommendations.
5. EtherNet/IP communications modules shall be provided at each device interfacing to the EtherNet/IP networks. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the EtherNet/IP Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated EtherNet/IP device.
6. The MCC Ethernet Switch(es) shall have dual 24VDC power supply. One 24VDC power supply unit shall be powered by a dedicated UPS device installed in the MCC and the other shall be powered from a dedicated 120VAC circuit coming from a Local Control Panel.
7. All Ethernet cables shall be labeled.
8. Each MCC device with Ethernet/IP communication protocol shall have a static TCP/IP address.

2.9 MEASUREMENT AND CONTROL DEVICES

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
1. Potential Transformers (PTs): IEEE C57.13; 120 Volt, 60 Hz, double secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers (CTs): IEEE C57.13; 5 Amp, 60 Hz, secondary; wound type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control Power Transformers (CPTs): Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker and ground fault protection.

B. Multifunction Digital Metering Monitor: Microprocessor based unit suitable for three-wire or four-wire systems and with the following features:
1. Listed or recognized by a nationally recognized testing laboratory.
2. Inputs from sensors or 5 Amp current transformer secondaries, and potential terminals rated to 600 Volts.
3. Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:
a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Three Phase Real Power (Megawatts): Plus or minus 2 percent.
e. Three Phase Reactive Power (Megavars): Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
j. Contact devices shall operate remote impulse totalizing demand meter.
4. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
5. Control Power Fuses: Primary and secondary fuses for current limiting and overload protection of transformer and fuses for protection of control circuits.

2.10 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: Comply with the requirements in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP or the manufacturer's instructions for anchors, mounting channels, bolts, washers, and other mounting accessories.

2.11 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for MCCs (as applicable) with one or more service disconnecting and overcurrent protective devices.
1. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

2.12 MAINTENANCE MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing the contents.
1. Keys: Two spares for each type of MCC enclosure lock.

2. Potential Transformer Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
3. Control Power Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
4. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
5. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
6. Fuses for Fused Power Circuit Devices: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
7. Indicating Lights: Equal to 10 percent of amount installed for each size and type, but no fewer than 1 of each size and type.

PART 3 - EXECUTION

3.1 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing for all MCCs in accordance with NEMA ICS 18 and IEEE C37.20.7.

B. MCCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports and submit to the Engineer.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in sections or shipping splits of lengths that can be moved past obstructions in the delivery path, individually wrapped for protection, and mounted on shipping skids.

B. Handle motor control centers according to the following:
   1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
   2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

C. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

D. If stored in areas subjected to weather, cover MCCs to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside MCCs; install electric heating (250 W per section) to prevent condensation.

3.3 EXAMINATION

A. Receive, inspect, handle, and store MCCs according to NECA 402 and NEMA ICS 2.3.

B. Examine MCCs before installation. Reject MCCs that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive MCCs for compliance with installation tolerances and other conditions affecting performance of the work.

D. Examine all OCPDs before installation. Reject any that are moisture damaged or physically damaged.

E. Examine utilization equipment nameplates and installation instructions. Install OCPDs of sizes and with characteristics appropriate for each piece of equipment.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSTALLATION

A. Comply with NECA 1, IEEE C2, and NFPA 70.

B. Install and start-up MCCs and accessories according to applicable parts of NEMA ICS 2.3 and NEMA 7.1.

C. Equipment Floor Mounting:
   1. Seismic Bracing: Comply with mounting and anchoring requirements specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.
   2. Install MCCs on a concrete base, 4-inch nominal thickness where shown on the Drawings. Comply with the requirements for concrete bases specified in the Division 03, CONCRETE specifications and details shown on the Drawings.
   3. Install conduits entering underneath the MCC, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend conduits 2 inches above the concrete base after the switchboard is anchored in place.
   4. Prepare interface surface between slab and pad, install rebar and install dowel rods to connect concrete base to concrete floor in accordance with the details on the Drawings. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the concrete base.
   5. For supported equipment, install epoxy coated anchor bolts that extend through the concrete base and anchor into the structural concrete floor.
   6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with the items to be embedded.
   7. Install anchor bolts to elevations required for proper attachment to MCCs.
   8. Anchor MCC to building structure at the top of the MCC if required or recommended by the manufacturer.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from enclosures and components.

E. Install filler plates in unused spaces of panel mounted sections.

F. Tighten accessible bus connections and mechanical fasteners after placing motor control centers.

G. Install fuses in control circuits if not factory installed. Comply with the requirements in Section 262813, FUSES.

H. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

I. Install, connect, and fuse thermal protector monitoring relays furnished with motor driven equipment.

3.5 IDENTIFICATION

A. Identify field installed conductors, interconnecting wiring, and components; provide warning signs for MCCs and MCC components complying with the requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

B. Circuit Directory: Directory card mounted in transparent card holder, or each breaker can be labeled separately.

C. MCC Nameplates: Label each MCC and each cubicle with an engraved nameplate complying with the requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP. Include: MCC name and/or number, cubicle name, voltage, amperage, number of phases and wires, source and available fault current with date calculated.

D. Device Nameplates: Label each enclosure mounted control and pilot device with a nameplate complying with the requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

E. Operating Instructions: Frame and mount the printed basic operating instructions for MCCs, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with the requirements in Section 260523, CONTROL VOLTAGE ELECTRICAL POWER CABLES-WWTP.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control selection devices where applicable.

1. Connect selector switches to bypass only those manual control devices and automatic control devices that have no safety functions when the switch is in manual control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety type control devices such as low pressure and high-pressure cutouts, high temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Comply with the requirements for installation of conduit in Section 260533, RACEWAYS AND BOXES-WWTP. The Drawings indicate the general arrangement of conduit, fittings, and specialties.

B. Comply with the requirements in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory authorized service representative:

1. Acceptance Testing Preparation:
   a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   b. Test continuity of each circuit.
2. Perform each visual and mechanical inspection and electrical test stated in the NETA Acceptance Testing Specification (ATS). Certify compliance with test parameters.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
5. Mark up a set of the manufacturer's drawings with all field modifications incorporated during construction; return to the manufacturer for inclusion in O&M Manuals and return to the Contractor and the Engineer for inclusion in Record Drawings.

B. MCCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, and submit to the Engineer.

3.9 ADJUSTING

A. Set field adjustable switches, auxiliary relays, time delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full load amperes and attempt to start motors several times, allowing for motor cool down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Engineer and Owner before increasing settings.

D. Set field adjustable switches and program microprocessors for required start and stop sequences in reduced voltage, solid state controllers.

E. Program microprocessors in VFDs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

F. Set field adjustable circuit breaker trip ranges as specified in Section 260573.16, OVERCURRENT PROTECTION DEVICE COORDINATION STUDY-WWTP, when applicable.

3.10 CLEANING

A. On completion of installation, inspect interior and exterior of MCCs. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

B. Vacuum clean to remove all dirt and debris; do not use compressed air to assist in cleaning.

3.11 DEMONSTRATION

A. Engage a factory authorized service representative to train the Owner's maintenance personnel:
   1. How to adjust, operate, and maintain enclosed controllers, overcurrent protective devices, instrumentation, and accessories.
   2. How to use and re-program microprocessor based, reduced voltage, solid state controllers.

END OF SECTION

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electricity metering.

1.2 DEFINITIONS

A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. For each type of meter.
   2. For metering infrastructure components.
   3. For metering software.

B. Shop Drawings: For electricity-metering equipment.
   1. Include elevation views of front panels of control and indicating devices and control stations.
   2. Include diagrams for power, signal, and control wiring.
   3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
   4. Include series-combination rating data for modular meter centers with main disconnect device.
   5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in Section 260913 "Electrical Power Monitoring and Control."
   1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
   2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Application and operating software documentation.
   2. Software licenses.
   3. Software service agreement.
   4. Device address list.
   5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
   6. Meter data sheet for each meter, listing nameplate data and serial number, accuracy certification, and test results.
   7. Meter installation and billing software startup report.

1.6 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. Construction Manager shall be notified and issued written permission no fewer than fourteen days in advance of proposed interruption of electrical service.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Damage from transient voltage surges.
   2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
   3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.8 COORDINATION

A. Electrical Service Connections:
   1. Coordinate with utility companies and utility-furnished components.
      a. Comply with requirements of utility providing electrical power services.
      b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

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 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.
   1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:
   1. Comply with requirements of electrical-power utility company.
   2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only disconnect device, wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. General Electric Company.
      c. SIEMENS Industry, Inc.; Energy Management Division.
      d. Square D; by Schneider Electric.
   2. Comply with requirements of utility company for meter center.
      a. Comply with UL 67.
   3. Housing: NEMA 250, Type 1 enclosure.
   4. Meter Socket Rating: Coordinated with connected feeder circuit rating.
   5. Minimum Short-Circuit Rating: Shall be matched to source panel symmetrical at rated voltage.
   6. Steady-state and short-circuit current ratings shall have ratings that match connected circuit ratings.
   7. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having an adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers shall be operable from outside the enclosure to disconnect the unit. Configure cover so it can be opened only when the disconnect switch is open.
   8. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have interrupting capacity equal to or greater than source panel.
      a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
      b. Physical Protection: Tamper resistant, with hasp for padlock.
   9. Surge Protection for Main Disconnect: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

10. Surge Protection at Main Disconnect: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
11. Surge Protection at Main Terminal Box: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels;
1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
   a. The 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) Flash protection boundary.
      4) Hazard risk category.
      5) Incident energy.
      6) Working distance.
      7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. E-Mon.
3. Leviton Manufacturing Co., Inc.
4. SIEMENS Industry, Inc.; Energy Management Division.
5. Square D; by Schneider Electric.
6. Comply with ANSI C12.1 and ANSI C12.20, 0.2 accuracy class.
7. Ambient Temperature: Minus 22 deg F to plus 158 deg F.
8. Humidity: Zero to 95 percent, noncondensing.
9. Capacities and Characteristics:
   a. Circuit: 120/240-V ac, 100 A.
   b. Measure: kWh, onboard LED display.
   c. Remote-Reading Options: None.

C. General Requirements for Meters:
1. Meters Certification: Certified by as complying with 4 CCR 4027, Article 2.2.

2. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
3. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 minimum, with provisions for locking or sealing.
4. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
5. Onboard Nonvolatile Data Storage: kWh, until reset.
6. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
    a. Type: Split and solid core, complying with recommendation of meter manufacturer.

D. kWh Meter: Electronic three-phase meters, measuring electricity use.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kWh.

E. KY and KYZ Pulse Totalizer:
1. Pulse Totalizer: An instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. The instrument shall totalize kWh accumulated over the user-selected period and shall log the maximum and minimum kWhd for that period. Record each period with a date/time stamp. Time period shall be user selected from one to 60 minutes.
    a. Pulse Input: One, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width shall be field adjustable, set for the pulse stream provided by the utility revenue meter.
    b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
    c. Instrument Power: User selectable, 120-V and 277-V ac.
    d. Clock: Line frequency.

F. Remote Reading Options:
1. Pulse Output: KY KYZ, complete with optical sensor and interface devices.
2. Serial Interface: RS-232.
3. Serial Interface: RS-485, with Modbus RTU protocol.
4. USB interface.
5. TCP/IP adapter.

G. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

H. Uninterruptible Power Supply: Single phase, 120-V ac, sized and rated to provide continuous power to meter for operations of 48 Insert number hours after interruption of normal power.

1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
2. Battery: Maintenance free, sealed, lead acid, and leakproof.
3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."

I. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

J. Software: PC based, a product of meter manufacturer, suitable for calculating utility cost allocation.
1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:
a. For all meters shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to switchboard installation requirements in NECA 400.

D. Install arc-flash labels as required by NFPA 70.

E. Wiring Method:
1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
3. Minimum conduit size shall be 1/2 inch.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. Equipment and Software Setup:
      a. Set meter date and time clock.
      b. Test, calibrate, and connect pulse metering system.
      c. Set and verify billing demand interval for demand meters.
      d. Report settings and calibration results.
      e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.
   2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
   3. Turn off circuits supplied by metered feeder and secure them in off condition.
   4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
   5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
   6. Generate test report and billing for each tenant or activity from the meter reading tests.

D. Electricity metering will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION

SECTION 262713 - ELECTRICITY METERING - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electricity metering.

1.2 DEFINITIONS

A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. For each type of meter.
   2. For metering infrastructure components.
   3. For metering software.

B. Shop Drawings: For electricity-metering equipment.
   1. Include elevation views of front panels of control and indicating devices and control stations.
   2. Include diagrams for power, signal, and control wiring.
   3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
   4. Include series-combination rating data for modular meter centers with main disconnect device.
   5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in Section 260913, ELECTRICAL POWER MONITORING AND CONTROL - WWTP.
   1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
   2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823, OPERATION AND MAINTENANCE DATA, include the following:
   1. Application and operating software documentation.
   2. Software licenses.
   3. Software service agreement.
   4. Device address list.
   5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
   6. Meter data sheet for each meter, listing nameplate data and serial number, accuracy certification, and test results.
   7. Meter installation and billing software startup report.

1.6 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. Construction Manager shall be notified and issued written permission no fewer than fourteen days in advance of proposed interruption of electrical service.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Damage from transient voltage surges.
   2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
   3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.8 COORDINATION

A. Electrical Service Connections:
   1. Coordinate with utility companies and utility-furnished components.
      a. Comply with requirements of utility providing electrical power services.
      b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

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 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.
   1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523, CONTROL-VOLTAGE ELECTRICAL POWER CABLES - WWTP.

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:
   1. Comply with requirements of electrical-power utility company.
   2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only disconnect device, wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. General Electric Company.
      c. SIEMENS Industry, Inc.; Energy Management Division.
      d. Square D; by Schneider Electric.
   2. Comply with requirements of utility company for meter center.
      a. Comply with UL 67.
   3. Housing: NEMA 250, Type 1 enclosure.
   4. Meter Socket Rating: Coordinated with connected feeder circuit rating.
   5. Minimum Short-Circuit Rating: Insert number A symmetrical at rated voltage.
   6. Steady-state and short-circuit current ratings shall have ratings that match connected circuit ratings.
   7. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having an adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers shall be operable from outside the enclosure to disconnect the unit. Configure cover so it can be opened only when the disconnect switch is open.
   8. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have Insert number-A interrupting capacity.
      A. Identification: Complying with requirements in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.
      b. Physical Protection: Tamper resistant, with hasp for padlock.
   9. Surge Protection for Main Disconnect: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313, SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS - WWTP.

10. Surge Protection at Main Disconnect: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313, SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS - WWTP.
11. Surge Protection at Main Terminal Box: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313, SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS - WWTP.

F. Arc-Flash Warning Labels;
1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19, OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY - WWTP. Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP. Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
   a. The 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) Flash protection boundary.
      4) Hazard risk category.
      5) Incident energy.
      6) Working distance.
      7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. E-Mon.
3. Leviton Manufacturing Co., Inc.
4. SIEMENS Industry, Inc.; Energy Management Division.
5. Square D; by Schneider Electric.
6. Comply with ANSI C12.1 and ANSI C12.20, 0.2 accuracy class.
7. Ambient Temperature: Minus 22 deg F to plus 158 deg F.
8. Humidity: Zero to 95 percent, noncondensing.
9. Capacities and Characteristics:
   a. Circuit: 120/240-V ac, 100 A.
   b. Measure: kWh, onboard LED display.
   c. Remote-Reading Options: None.

C. General Requirements for Meters:
1. Meters Certification: Certified by as complying with 4 CCR 4027, Article 2.2.

2. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
3. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 minimum, with provisions for locking or sealing.
4. Identification: Comply with requirements in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.
5. Onboard Nonvolatile Data Storage: kWh, until reset.
6. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
    a. Type: Split and solid core, complying with recommendation of meter manufacturer.

D. kWh Meter: Electronic three-phase meters, measuring electricity use.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kWh.

E. KY and KYZ Pulse Totalizer:
1. Pulse Totalizer: An instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. The instrument shall totalize kWh accumulated over the user-selected period and shall log the maximum and minimum kWhd for that period. Record each period with a date/time stamp. Time period shall be user selected from one to 60 minutes.
    a. Pulse Input: One Insert number, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width shall be field adjustable, set for the pulse stream provided by the utility revenue meter.
    b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
    c. Instrument Power: User selectable, 120-V and 277-V ac.
    d. Clock: Line frequency.

F. Remote Reading Options:
1. Pulse Output: KY KYZ, complete with optical sensor and interface devices.
2. Serial Interface: RS-232.
3. Serial Interface: RS-485, with Modbus RTU protocol.
4. USB interface.
5. TCP/IP adapter.

G. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

H. Uninterruptible Power Supply: Single phase, 120-V ac, sized and rated to provide continuous power to meter for operations of 48 Insert number hours after interruption of normal power.

1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
2. Battery: Maintenance free, sealed, lead acid, and leakproof.
3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."

I. Data Transmission Cable: Comply with requirements in Section 260523, CONTROL-VOLTAGE ELECTRICAL POWER CABLES - WWTP.

J. Software: PC based, a product of meter manufacturer, suitable for calculating utility cost allocation.
1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:
a. For all meters shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to switchboard installation requirements in NECA 400.

D. Install arc-flash labels as required by NFPA 70.

E. Wiring Method:
1. Comply with requirements in Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES - WWTP.
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513, COMMUNICATIONS COPPER HORIZONTAL CABLING.
3. Minimum conduit size shall be 1/2 inch.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.
1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Equipment and Software Setup:
   a. Set meter date and time clock.
   b. Test, calibrate, and connect pulse metering system.
   c. Set and verify billing demand interval for demand meters.
   d. Report settings and calibration results.
   e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.
2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from the meter reading tests.

D. Electricity metering will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.2 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.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
   2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two .

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. RoHS compliant.

D. Comply with NEMA WD 1 and NEMA WD 6.

E. Devices indicated as "tamper-resistant" shall have integral shutters that operate only when both prongs of a plug are inserted in the receptacle.

F. Devices indicated as "weather-proof" or "weather-resistant" shall have the following:
   1. Spring-loaded, gasketed, metallic, "weather-proof-in-use" cover.
   2. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

G. Switches indicated as Key-switch shall have factory-supplied key in lieu of switch handle.

H. Devices indicated or specified as anti-microbial shall have contact surfaces treated with a factory-applied coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.

I. Devices indicated or specified as decorator style shall have a rectangular face opening.

J. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

K. Device Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

L. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD RECEPTACLES, 125 V, 20 A

A. 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. Configuration: Heavy-duty, NEMA 5-20R
3. Standards: Comply with UL 498 and FS W-C-596.

B. Isolated-Ground 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: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
3. Configuration: Heavy-duty, NEMA 5-20R
4. Standards: Comply with UL 498 and FS W-C-596.

2.3 USB RECEPTACLES

A. USB Charging Receptacles:
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:
a. Receptacle: Duplex 20A, 125V receptacle, configuration 5-20R, with tamper-resistant shutters.
b. USB Ports: One USB Type A and one USB Type C port with total available charging current of 3.1A or greater at 5 VDC.
3. Standards: Comply with UL 498, UL 1310 and USB 3.0 devices.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI 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: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Non-feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.5 HOSPITAL-GRADE RECEPTACLES, 125 V, 20 A

A. Hospital-Grade, 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: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Standards: Comply with UL 498 Supplement sd and FS W-C-596.
   5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

B. Hospital-Grade, Duplex GFCI 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: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Single-piece, rivetless, nickel-plated, all-brass grounding system.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Type: Non-feed through.
   5. Standards: Comply with UL 498 supplement sd, UL 943 Class A, and FS W-C-596.
   6. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, amperage, voltage, and NEMA configuration as indicated on the Drawings: Comply with NEMA WD 1 and UL 498.
   1. Products: Subject to compliance with the requirements, provide products by one of the following manufacturers:
      a. Cooper

b. Hubbell
c. Leviton
d. Pass & Seymour

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (Arrow Hart).
2. Hubbell Premise Wiring.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour/Legrand (Pass & Seymour).

C. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

D. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

E. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Standards: Comply with FS W-C-596.

2.8 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES, 120/277 V, 20 A

A. Snap Switches, 120/277 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. Standards: Comply with UL 20 and FS W-S-896.

B. Pilot-Light, Snap Switches: 120/277 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: Illuminated when switch is on.
3. Standards: Comply with UL 20 and FS W-S-896.

C. Lighted Snap Switches, 120/277 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton (Arrow Hart).
b. Hubbell Premise Wiring.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Handle illuminated when switch is on.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.10 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: Smooth, high-impact thermoplastic, color as selected by Architect 0.035-inch- thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.11 FLOOR BOXES

A. Description: Floor-mounted box with cover enclosing multiple outlets in a single assembly.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB (Electrification Products Division).
2. Wiremold; Legrand North America, LLC.
3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.
3. Compartments: Barrier separates power from voice and data communication cabling.
4. Concrete Floor Boxes:
a. Provide floor boxes classified for use in fire rated concrete floors. Match floor box fire rating to floor assembly. Boxes indicated in floors in contact with the earth must be protected by epoxy paint or must be made of a suitable material to prevent oxidation and deterioration such as cast iron.

b. Floor boxes must provide a minimum of four inches of adjustment prior to concrete pour and a minimum of 1/2 inch after concrete is set.

E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

F. Floor Box Types :
1. As specified in the Drawings refer to electrical for power only and ICT drawings for multi-service box requirements.

G. |Covers: Flanged cover for use in tile or carpet, with brushed cable pass-through.
a. Finish: As selected by Architect.

2.12 POKE-THRU ASSEMBLIES

A. Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB (Electrification Products Division).
2. Wiremold; Legrand North America, LLC.
3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
2. Provide separate paths for management of telecommunications and power cables.
3. Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.

E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

F. Poke-Through Types :
1. As specified in the Drawings refer to electrical for power only and ICT drawings for multi-service box requirements.

G. |Covers: Flanged for use in tile or carpet.
1. Finish: As Selected by Architect.

2.13 SURFACE RACEWAYS

A. Description: Two-piece, aluminum construction multioutlet assembly with brushed natural or satin anodized natural finish with devices, junction fittings, and other matching accessories as required for a complete system and per UL 5.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold / Legrand.

C. General:
1. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
2. Provide continuous one-piece cover plates, minimum four feet long.
3. Provide GFCI receptacles for sections of multioutlet assemblies that are indicated within 6'-0" of the edge of a sink.
4. Wiring: Minimum no. 12 AWG solid, Type THHN copper. Provide larger conductor sizes where receptacles with ampacities greater than 20-amperes are indicated.

D. Surface Raceway
1. Multioutlet assembly with prewired, 20-ampere, 125-volt, 2-pole, 3-wire duplex receptacles spaced and circuited as noted on Drawings. on 18-inch centers, alternately connected to two 20-ampere circuits, 120-volt circuits with ground.
2. Receptacle Finish: As noted on Drawings or by Architect.

2.14 SERVICE POLES

A. Dual-Channel Service Poles
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hubbell Premise Wiring.
b. Panduit Corp.
c. Wiremold / Legrand.
2. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
3. Poles: Nominal 2.5-inch- square cross-section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
4. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
5. Material: As noted on Drawings.
6. Finishes: As noted on Drawings.
7. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
8. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.

PART 3 - Data Communication Outlets: Blank insert with bushed cable opening.
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. Receptacle Type:
1. Install GFCI receptacles for all receptacles supplied by single-phase branch circuits rated 150V or less to ground in the following spaces/locations:
   a. Bathrooms.
   b. Kitchens or similar areas with a sink and permanent provisions for either food preparation or cooking.
   c. Buffet serving areas with permanent provisions for food serving, beverage serving, or cooking.
   d. Where the receptacle is installed within 6 feet of the edge of a sink.

e. Outdoors.
f. Indoor damp and wet locations.
g. Locker rooms with associated showering facilities.
h. Garages, accessory buildings, service bays, and similar areas.
i. Laundry areas.

2. Install GFCI receptacles at the following equipment supplied by single-phase branch circuits rated 150V or less to ground and 60 amperes:
   a. Automotive vacuum machines
   b. Drinking water coolers and bottle fill stations
   c. High-pressure spray washing machines
   d. Tire inflation machines
   e. Vending machines
   f. Sump pumps
   g. Dishwashers
   h. Electric Ranges
   i. Wall-mounted ovens
   j. Counter-mounted cooking units
   k. Clothes dryers
   l. Microwave ovens
3. Where GFCI receptacles cannot be installed in a readily accessible location or are not available in the receptacle configuration required to serve a specific load, provide equivalent ground fault circuit interrupter protection by installing a GFCI type circuit breaker as the branch circuit overcurrent protective device for the load.
4. Install tamper-resistant versions of the specified receptacles for all 20A, 125V and 250V nonlocking-type receptacles in the following areas:
   a. All spaces in educational facilities.
   b. Business offices, corridors, waiting rooms, and similar spaces in clinics, medical and dental offices, and outpatient healthcare facilities.
   c. Dormitory units.
   d. Gymnasiums.
   e. Auditoriums.
   f. All spaces in assisted living facilities.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. 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.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Floor boxes and poke-thru assemblies: For each floor box and poke-thru with communications devices or provisions, provide a conduit stubbed into the accessible ceiling space above the room served by the floor mounted device. Stubbing conduits into the ceiling space below is not permitted.

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each wiring device with panelboard identification and circuit number. In spaces where low voltage lighting control wall stations are utilized, identify panelboard and circuit number of the lights controlled by the low voltage device. In spaces with multiple lighting circuits, provide multiple lables to indicate each lighting branch circuit serving the space. Use hot, stamped, or engraved machine printing with black-filled lettering on front face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 262726 - WIRING DEVICES - WWTP

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.2 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.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
   2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two .

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. RoHS compliant.

D. Comply with NEMA WD 1 and NEMA WD 6.

E. Devices indicated as "tamper-resistant" shall have integral shutters that operate only when both prongs of a plug are inserted in the receptacle.

F. Devices indicated as "weather-proof" or "weather-resistant" shall have the following:
   1. Spring-loaded, gasketed, metallic, "weather-proof-in-use" cover.
   2. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

G. Switches indicated as Key-switch shall have factory-supplied key in lieu of switch handle.

H. Devices indicated or specified as anti-microbial shall have contact surfaces treated with a factory-applied coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.

I. Devices indicated or specified as decorator style shall have a rectangular face opening.

J. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

K. Device Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

L. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD RECEPTACLES, 125 V, 20 A

A. 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. Configuration: Heavy-duty, NEMA 5-20R
3. Standards: Comply with UL 498 and FS W-C-596.

B. Isolated-Ground 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: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
3. Configuration: Heavy-duty, NEMA 5-20R
4. Standards: Comply with UL 498 and FS W-C-596.

2.3 USB RECEPTACLES

A. USB Charging Receptacles:
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:
   a. Receptacle: Duplex 20A, 125V receptacle, configuration 5-20R, with tamper-resistant shutters.
   b. USB Ports: One USB Type A and one USB Type C port with total available charging current of 3.1A or greater at 5 VDC.
3. Standards: Comply with UL 498, UL 1310 and USB 3.0 devices.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI 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: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Type: Non-feed through.
   5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.5 HOSPITAL-GRADE RECEPTACLES, 125 V, 20 A

A. Hospital-Grade, 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: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Standards: Comply with UL 498 Supplement sd and FS W-C-596.
   5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

B. Hospital-Grade, Duplex GFCI 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: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Single-piece, rivetless, nickel-plated, all-brass grounding system.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Type: Non-feed through.
   5. Standards: Comply with UL 498 supplement sd, UL 943 Class A, and FS W-C-596.
   6. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, amperage, voltage, and NEMA configuration as indicated on the Drawings: Comply with NEMA WD 1 and UL 498.

1. Products: Subject to compliance with the requirements, provide products by one of the following manufacturers:
   a. Cooper
   b. Hubbell
   c. Leviton
   d. Pass & Seymour

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton (Arrow Hart).
   2. Hubbell Premise Wiring.
   3. Leviton Manufacturing Co., Inc.
   4. Pass & Seymour/Legrand (Pass & Seymour).

C. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

D. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

E. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Standards: Comply with FS W-C-596.

2.8 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES, 120/277 V, 20 A

A. Snap Switches, 120/277 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. Standards: Comply with UL 20 and FS W-S-896.

B. Pilot-Light, Snap Switches: 120/277 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: Illuminated when switch is on.
   3. Standards: Comply with UL 20 and FS W-S-896.

C. Lighted Snap Switches, 120/277 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Premise Wiring.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Handle illuminated when switch is on.
   3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.10 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: Smooth, high-impact thermoplastic, color as selected by Architect 0.035-inch- thick, satin-finished, Type 302 stainless steel.
   3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.11 FLOOR BOXES

A. Description: Floor-mounted box with cover enclosing multiple outlets in a single assembly.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB (Electrification Products Division).
   2. Wiremold; Legrand North America, LLC.
   3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

D. General Characteristics:
   1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
   2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.

3. Compartments: Barrier separates power from voice and data communication cabling.
4. Concrete Floor Boxes:
   a. Provide floor boxes classified for use in fire rated concrete floors. Match floor box fire rating to floor assembly. Boxes indicated in floors in contact with the earth must be protected by epoxy paint or must be made of a suitable material to prevent oxidation and deterioration such as cast iron.
   b. Floor boxes must provide a minimum of four inches of adjustment prior to concrete pour and a minimum of 1/2 inch after concrete is set.

E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

F. Floor Box Types :
1. As specified in the Drawings refer to electrical for power only and ICT drawings for multi-service box requirements.

G. |Covers: Flanged cover for use in tile or carpet, with brushed cable pass-through.
   a. Finish: As selected by Architect.

2.12 POKE-THRU ASSEMBLIES

A. Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB (Electrification Products Division).
2. Wiremold; Legrand North America, LLC.
3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
2. Provide separate paths for management of telecommunications and power cables.
3. Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.

E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.

F. Poke-Through Types :
1. As specified in the Drawings refer to electrical for power only and ICT drawings for multi-service box requirements.

G. |Covers: Flanged for use in tile or carpet.
1. Finish: As Selected by Architect.

2.13 SURFACE RACEWAYS

A. Description: Two-piece, aluminum construction multioutlet assembly with brushed natural or satin anodized natural finish with devices, junction fittings, and other matching accessories as required for a complete system and per UL 5.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold / Legrand.

C. General:
   1. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
   2. Provide continuous one-piece cover plates, minimum four feet long.
   3. Provide GFCI receptacles for sections of multioutlet assemblies that are indicated within 6'-0" of the edge of a sink.
   4. Wiring: Minimum no. 12 AWG solid, Type THHN copper. Provide larger conductor sizes where receptacles with ampacities greater than 20-amperes are indicated.

D. Surface Raceway
   1. Multioutlet assembly with prewired, 20-ampere, 125-volt, 2-pole, 3-wire duplex receptacles spaced and circuited as noted on Drawings. on 18-inch centers, alternately connected to two 20-ampere circuits, 120-volt circuits with ground.
   2. Receptacle Finish: As noted on Drawings or by Architect.

2.14 SERVICE POLES

A. Dual-Channel Service Poles
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Premise Wiring.
      b. Panduit Corp.
      c. Wiremold / Legrand.
   2. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   3. Poles: Nominal 2.5-inch- square cross-section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
   4. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
   5. Material: As noted on Drawings.
   6. Finishes: As noted on Drawings.
   7. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
   8. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.

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. Receptacle Type:
   1. Install GFCI receptacles for all receptacles supplied by single-phase branch circuits rated 150V or less to ground in the following spaces/locations:
      a. Bathrooms.
      b. Kitchens or similar areas with a sink and permanent provisions for either food preparation or cooking.
      c. Buffet serving areas with permanent provisions for food serving, beverage serving, or cooking.
      d. Where the receptacle is installed within 6 feet of the edge of a sink.
      e. Outdoors.
      f. Indoor damp and wet locations.
      g. Locker rooms with associated showering facilities.
      h. Garages, accessory buildings, service bays, and similar areas.
      i. Laundry areas.
   2. Install GFCI receptacles at the following equipment supplied by single-phase branch circuits rated 150V or less to ground and 60 amperes:
      a. Automotive vacuum machines
      b. Drinking water coolers and bottle fill stations
      c. High-pressure spray washing machines
      d. Tire inflation machines
      e. Vending machines
      f. Sump pumps
      g. Dishwashers
      h. Electric Ranges
      i. Wall-mounted ovens
      j. Counter-mounted cooking units
      k. Clothes dryers
      l. Microwave ovens
   3. Where GFCI receptacles cannot be installed in a readily accessible location or are not available in the receptacle configuration required to serve a specific load, provide equivalent ground fault circuit interrupter protection by installing a GFCI type circuit breaker as the branch circuit overcurrent protective device for the load.
   4. Install tamper-resistant versions of the specified receptacles for all 20A, 125V and 250V nonlocking-type receptacles in the following areas:
      a. All spaces in educational facilities.
      b. Business offices, corridors, waiting rooms, and similar spaces in clinics, medical and dental offices, and outpatient healthcare facilities.
      c. Dormitory units.
      d. Gymnasiums.
      e. Auditoriums.
      f. All spaces in assisted living facilities.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
   1. Install dimmers within terms of their listing.
   2. Verify that dimmers used for fan-speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. 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.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Floor boxes and poke-thru assemblies: For each floor box and poke-thru with communications devices or provisions, provide a conduit stubbed into the accessible ceiling space above the room served by the floor mounted device. Stubbing conduits into the ceiling space below is not permitted.

3.2 IDENTIFICATION

A. Comply with Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

B. Identify each wiring device with panelboard identification and circuit number. In spaces where low voltage lighting control wall stations are utilized, identify panelboard and circuit number of the lights controlled by the low voltage device. In spaces with multiple lighting circuits, provide multiple lables to indicate each lighting branch circuit serving the space. Use hot, stamped, or engraved machine printing with black-filled lettering on front face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 262743 - ELECTRIC-VEHICLE SERVICE EQUIPMENT - AC LEVEL 1 AND LEVEL 2

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes EVSE that provides AC Level 1 and Level 2 EV charging.

1.2 DEFINITIONS

A. EV: Electric vehicle.

B. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.

C. EV Charger or EV Charging Equipment: See "EVSE."

D. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.

E. EV Coupler: A mating EV inlet and connector set.

F. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.

G. EVSE: Electric-Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

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 for EV charging equipment.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For EVSE.
   1. Include plans, elevations, sections, and mounting details.
   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. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
   4. Include diagrams for power, signal, and control wiring.

5. Include verification of wired and wireless communications service at each location of EVSE.

C. Product Schedule: For EVSE. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for EVSE, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For EVSE to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:
1. Software operating manuals.
2. Program Software Backup: On USB, CD, Cloud, or approved media, complete with configuration files.
3. Device address and password list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials for field replaceable components, 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. Provide 1 spare component per installed charger.

1.8 FIELD CONDITIONS

A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

B. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not exceeding minus 22 to plus 122 deg F.
2. Altitude: Not exceeding 5300 feet.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Inc.
   2. ChargePoint.
   3. Eaton.
   4. Schneider Electric USA, Inc.
   5. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain EVSE from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: EVSE shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event"

B. Ambient Temperature: 5 to 104 deg F.

C. Relative Humidity: Zero to 95 percent.

D. Altitude: Sea level to 5300ft.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

F. Surge Withstand: 6 kV at 3000 A.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

H. EV Charging Levels:
   1. Single vehicle, AC Level 2 at up to 19.2 kW per vehicle.
   2. Dual vehicles, AC Level 2 at up to19.2 kW per vehicle.

2.3 EVSE DESCRIPTION

A. Comply with NFPA 70.

B. Comply with ADA-ABA Accessibility Guidelines.

C. Metering: Not required as units are for facility use.

D. Control Power: 20 A, 110/120-V ac, 60 Hz, single phase per charger.

E. Integral GFCI.

F. Auto-GFCI fault retry.

G. EVSE Mounting: As indicated on Drawings.

H. Enclosures:
   1. Rated for environmental conditions at installed location.
      a. Outdoor Locations: NEMA 250, Type 3R.
      b. Stainless steel.

c. Powder coat.
d. Lockable.
e. Tamper resistant.

I. EV Cable and Connectors:
1. SAE J1772 connector.
2. Single or Double connectors as shown on Drawings with locking holster.
3. 24-foot cable with cable management system.
4. Field-replaceable connector and cable assembly.

J. Status Indicators:
1. LEDs to indicate power, charging, charging complete, system status, faults, and service.

K. Display Screen:
1. Daylight viewable, UV-protected display with human-machine interface capability.
2. Displays power, charging, charging complete, remote control, system status, faults, and service.

L. Networking:
1. WAN Communications: Cellular GSM/GPRS.
2. LAN Communications: 10/100/1000 Base T Ethernet.
3. Capable of remote configuration and reporting.

M. Payment System:
1. Contactless credit card reader.
2. PCI compliant.
3. Capable of remote control and authorization.

N. Charging Network: Compatible with all major industry available networks. .
1. Multiple units shall independently connect to charging network.
2. Multiple units shall have one unit designated as a master unit that is configured as a gateway unit between the EVSE and the charging network.
3. Individual units shall be capable of indicating station status and availability.

2.4 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by utilizing cushioning materials or foam or by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for EVSE electrical conduit to verify actual locations of conduit connections before equipment installation.

C. Examine pavement for suitable conditions where EVSE will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 413.

B. Concrete Base Mounting:
   a.
   2. Install EVSE on 12-inch nominal-diameter and 48-inch- deep concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
      a. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      b. Install anchor bolts to elevations required for proper attachment to supported equipment.
      c. Secure EVSE to concrete base according to manufacturer's written instructions.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Wiring Method: Install cables in raceways and cable trays. 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."
   2. Comply with requirements for underground raceways and enclosures specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems."

E. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

F. Circuit Breakers: Comply with Section 262816 "Enclosed Switches and Circuit Breakers."

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking from enclosures and components.

H. Secure covers to enclosure.

I. Cybersecurity:
   1. Software:
      a. Coordinate security requirements with IT department.
      b. Ensure that latest stable software release is installed and properly operating.
      c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters, numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.
   2. Hardware:
      a. Coordinate location and access requirements with IT department .
      b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
      c. Disable dual network connections.

3.3 CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Comply with grounding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

D. 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.

E. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.

F. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

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. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspectionswith the assistance of a factory-authorized service representative.

C. Tests and Inspections:
   1. For each unit of EVSE, perform the following tests and inspections:
      a. Unit self-test.
      b. Operation test with load bank.
      c. Operation test with EV.
      d. Network communications test.

D. EVSE will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain EV charging equipment.

END OF SECTION

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Control circuits.
      b. Panelboards.
      c. Switchboards.
      d. Enclosed controllers.
      e. Enclosed switches.
   2. Spare-fuse cabinets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
   4. Coordination charts and tables and related data.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bussmann, an Eaton business.
   2. Edison; a brand of Bussmann by Eaton.
   3. Littelfuse, Inc.
   4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   1. Type RK-1: 250 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   2. Type RK-5: 250 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

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 FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 25 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Provide fuses from the same manufacturer to insure retention of selective protective device coordination.
   2. Fuses rated 600 amperes and less: UL Class RK1 unless otherwise indicated or specified, current-limiting, time-delay, per UL 198E, with an interrupting rating of 100,000 amperes rms.
      a. Provide UL Class RK5 fuses current-limiting, time-delay, per UL 198E, with an interrupting rating of 100,000 amperes rms, as follows:
         1) Motor starters size 3 and smaller.
         2) Panelboard main fuses where the amperage ratio between the main fuse to the largest feeder fuse is at least 2:1.
   3. Fuses rated greater than 600 amperes: UL Class L, current-limiting, per UL 198C, with an interrupting rating of 200,000 amperes RMS.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in locations as indicated in the field by Construction Manager in available wall space in back of house service areas near equipment / facility personnel work areas

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 262813 – FUSES - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Control circuits.
      b. Panelboards.
      c. Switchboards.
      d. Enclosed controllers.
      e. Enclosed switches.
   2. Spare-fuse cabinets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700, CLOSEOUT PROCEDURES, Section 017823, OPERATION AND MAINTENANCE DATA, include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
   4. Coordination charts and tables and related data.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bussmann, an Eaton business.
   2. Edison; a brand of Bussmann by Eaton.
   3. Littelfuse, Inc.
   4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   1. Type RK-1: 250 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   2. Type RK-5: 250 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

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 FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 25 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Provide fuses from the same manufacturer to insure retention of selective protective device coordination.
   2. Fuses rated 600 amperes and less: UL Class RK1 unless otherwise indicated or specified, current-limiting, time-delay, per UL 198E, with an interrupting rating of 100,000 amperes rms.
      a. Provide UL Class RK5 fuses current-limiting, time-delay, per UL 198E, with an interrupting rating of 100,000 amperes rms, as follows:
         1) Motor starters size 3 and smaller.
         2) Panelboard main fuses where the amperage ratio between the main fuse to the largest feeder fuse is at least 2:1.
   3. Fuses rated greater than 600 amperes: UL Class L, current-limiting, per UL 198C, with an interrupting rating of 200,000 amperes RMS.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in locations as indicated in the field by Construction Manager in available wall space in back of house service areas near equipment / facility personnel work areas

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Include 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.

B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

B. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. ABB.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty:
1. Single throw unless otherwise indicated.
2. Three pole, unless otherwise indicated.
3. 240 or 600-V ac.
4. Ampacity as indicated or scheduled.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses.
6. 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. Early Break Auxiliary Contacts: 1 set of normally open contacts that has an early break feature which breaks the contacts prior to the disconnect switch being fully placed in the OFF position.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Arc-Energy Reduction Relay: For switches rated 1200A and over, provide internally mounted device compliant with NFPA 70 article 240.67 requirements, with external display containing pushbutton and visual indicator for maintenance mode.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
2. Littelfuse, Inc.
3. Mersen USA.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: Capacity as shown on Drawings. UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: Capacity as shown on Drawings. UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Accessories:
1. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
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.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
1. Eaton.
2. ABB.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. Series ratings are not permitted.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Long- and short-time pickup levels.

2. Long- and short-time time adjustments.
3. Ground-fault pickup level, time delay, and I-squared t response.

K. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
5. Arc-Energy Reduction: For circuit breakers rated 1200A or greater, provide circuit breaker compliant with NFPA 70 article 240.87 requirements, with external display containing pushbutton and visual indicator for maintenance mode.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be as follows:
1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1);
2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12)
3. Brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel);
4. copper-free cast aluminum alloy (NEMA 250 Types 7, 9).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1); directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R); externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Kitchen, Wash-Down, and Sterile Processing Areas: NEMA 250, Type 4X , stainless steel .
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4 .
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 with cover attached by Type 316 stainless steel bolts.

3.2 INSTALLATION

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.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Install control wiring as required including VFC 'make-before-break' contacts as required based on system dynamics (i.e. local disconnect downstream of VFC).

G. Comply with NFPA 70 and NECA 1.

H. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Study."

I. Where motor disconnect switches are installed downstream of a variable frequency drive (VFD), provide 2#12 AWG conductors from the disconnect switch to the VFD. Terminate wiring in disconnect switch at early break auxiliary contacts and coordinate programming and terminating of conductors at VFD with VFD installer.

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. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections. Testing shall be coordinated with Owner for 3rd party observation.

B. Perform tests and inspections.

C. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      e. Verify that fuse sizes and types match the Specifications and Drawings.
      f. Verify that each fuse has adequate mechanical support and contact integrity.
      g. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter.
            a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
            a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
      h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
      i. Verify correct phase barrier installation.
      j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
   2. Electrical Tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
      b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:
1) Use a low-resistance ohmmeter.
a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.
1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS - WWTP

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Include 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.

B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

B. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. ABB.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty:
1. Single throw unless otherwise indicated.
2. Three pole, unless otherwise indicated.
3. 240 or 600-V ac.
4. Ampacity as indicated or scheduled.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses.
6. 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. Early Break Auxiliary Contacts: 1 set of normally open contacts that has an early break feature which breaks the contacts prior to the disconnect switch being fully placed in the OFF position.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Arc-Energy Reduction Relay: For switches rated 1200A and over, provide internally mounted device compliant with NFPA 70 article 240.67 requirements, with external display containing pushbutton and visual indicator for maintenance mode.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
2. Littelfuse, Inc.
3. Mersen USA.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: Capacity as shown on Drawings. UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: Capacity as shown on Drawings. UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Accessories:
1. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
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.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. ABB.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. Series ratings are not permitted.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Long- and short-time pickup levels.
2. Long- and short-time time adjustments.

3. Ground-fault pickup level, time delay, and I-squared t response.

K. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
5. Arc-Energy Reduction: For circuit breakers rated 1200A or greater, provide circuit breaker compliant with NFPA 70 article 240.87 requirements, with external display containing pushbutton and visual indicator for maintenance mode.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be as follows:
1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12).
3. Brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).
4. Copper-free cast aluminum alloy (NEMA 250 Types 7, 9).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1); directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R); externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Kitchen, Wash-Down, and Sterile Processing Areas: NEMA 250, Type 4X, stainless steel.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 with cover attached by Type 316 stainless steel bolts.

3.2 INSTALLATION

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.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS - WWTP.

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Install control wiring as required including VFC 'make-before-break' contacts as required based on system dynamics (i.e. local disconnect downstream of VFC).

G. Comply with NFPA 70 and NECA 1.

H. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY - WWTP.

I. Where motor disconnect switches are installed downstream of a variable frequency drive (VFD), provide 2#12 AWG conductors from the disconnect switch to the VFD. Terminate wiring in disconnect switch at early break auxiliary contacts and coordinate programming and terminating of conductors at VFD with VFD installer.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS - WWTP.
   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. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform tests and inspections.

D. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      e. Verify that fuse sizes and types match the Specifications and Drawings.
      f. Verify that each fuse has adequate mechanical support and contact integrity.
      g. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter.
            a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
            a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
      h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
      i. Verify correct phase barrier installation.
      j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
   2. Electrical Tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
      b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:
1) Use a low-resistance ohmmeter.
a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.
1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Include mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.
   1. Certificate of compliance.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs 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. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
      b. Manufacturer's written instructions for setting field-adjustable overload relays.
      c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
      f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following all VFD's on the project whether packaged or seperately provided shall be the sourced by the same manufacturer:
   1. ABB Low Voltage HVAC Drives.
   2. Danfoss Inc.
   3. Emerson Industrial Automation.
   4. Yaskawa Electric America, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 61800-5-1.

B. Application: variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 5 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: As scheduled in the Drawings.

7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 10 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 2.5 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.

I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2 as required.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. Alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Control Signal Interfaces:
1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: Operator-selectable "x"- to "y"-mA dc.
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. BACNET IP.
3. Output Signal Interface: A minimum of programmable analog output signal(s) , which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

E. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
   a. Monitoring: On-off status, as specified in control drawings/sequences.
   b. Control: On-off operation, as specified in control drawings/sequences.
2. Communication Interface: Comply with ASHRAE 135 and control drawings/sequences. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. Output Filtering: As required to comply with connected load.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

D. EMI/RFI Filtering: As required to comply with connected load / surrounding space.

2.6 BYPASS SYSTEMS

A. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

B. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

2.7 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
   1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
   2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
   3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end-of-travel feedback capability.

C. Remote digital operator kit.

D. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

E. Where VFC is located remote from controlled load and ahead of local disconnecting means, VFC and and disconnect shall be be provided with 'make-before-break' contacts to initiate VFC shutdown before local disconnect is opened to prevent damage to VFC.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 4X.
   3. Kitchen, Wash-Down, or Sterile Processing Areas Areas: Type 4X stainless steel.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

F. Spare control-wiring terminal blocks unwired.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in .
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Coordinate connection of control and 'make-before-break' control wiring as required by installation dynamics.

K. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

F. Set field-adjustable pressure switches.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS - WWTP

PART 1 - GENERAL

1.1 SUMMARY

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C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Include mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.
   1. Certificate of compliance.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs 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. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
      b. Manufacturer's written instructions for setting field-adjustable overload relays.
      c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
      f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following all VFD's on the project whether packaged or seperately provided shall be the sourced by the same manufacturer:
   1. ABB Low Voltage HVAC Drives.
   2. Danfoss Inc.
   3. Emerson Industrial Automation.
   4. Yaskawa Electric America, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 61800-5-1.

B. Application: variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 5 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: As scheduled in the Drawings.

7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 10 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 2.5 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.

I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2 as required.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. Alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Control Signal Interfaces:
1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: Operator-selectable "x"- to "y"-mA dc.
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. BACNET IP.
3. Output Signal Interface: A minimum of programmable analog output signal(s) , which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

E. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
   a. Monitoring: On-off status, Insert monitoring point.
   b. Control: On-off operation, Insert control point.
2. Communication Interface: Comply with ASHRAE 135 Insert type of interface. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. Output Filtering: As required to comply with connected load.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

D. EMI/RFI Filtering: As required to comply with connected load / surrounding space.

2.6 BYPASS SYSTEMS

A. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

B. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

2.7 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
   1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
   2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
   3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end-of-travel feedback capability.

C. Remote digital operator kit.

D. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

E. Where VFC is located remote from controlled load and ahead of local disconnecting means, VFC and and disconnect shall be be provided with 'make-before-break' contacts to initiate VFC shutdown before local disconnect is opened to prevent damage to VFC.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 4X.
   3. Kitchen, Wash-Down, or Sterile Processing Areas Areas: Type 4X stainless steel.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

F. Spare control-wiring terminal blocks unwired.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in .
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529, HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS-WWTP.

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
1. Curbs and roof penetrations are specified in Section 077200, ROOF ACCESSORIES.
2. Structural-steel channels are specified in Section 260529, HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS-WWTP.

D. Seismic Bracing: Comply with requirements specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813, FUSES-WWTP.

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Coordinate connection of control and 'make-before-break' control wiring as required by installation dynamics.

K. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523, CONTROL-VOLTAGE ELECTRICAL POWER CABLES-WWTP.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY-WWTP.

F. Set field-adjustable pressure switches.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 263100 - PHOTOVOLTAIC ENERGY 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.

B. Section 262313 "Paralleling Low-voltage Switchgear" for synchronization and load sharing requirements with facility distributed energy resources including but not limited to diesel gensets and utility power sources.

1.2 SUMMARY

A. Section Includes:
1. Carport Photovoltaic (PV) Modules
2. Mounting structures
3. Inverters
4. Balance of System Components
5. Monitoring and Control System
6. DC Conductors
7. Grounding of PVs
8. Lightning Protection of PVs

B. Related Requirements:
1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.
2. Section 055000 "Metal Fabrications"
3. Section 260519 “Low-Voltage Electrical Power Conductors and Cables"
4. Section 260553 “Identification for Electrical Systems”.
5. Section 260573.13 "Short-Circuit Studies"
6. Section 260573.16 "Coordination Studies"
7. Section 260573.19 "Arc-Flash Hazard Analysis"
8. Section 262313 "Paralleling Low-voltage Switchgear" for synchronization and load sharing requirements with facility distributed energy resources including but not limited to diesel gensets and utility power sources.
9. Section 262413 "Switchboards"
10. Section 262416 "Panelboards"
11. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits"
12. Section 262813 "Fuses"
13. Section 262816 "Enclosed Switches and Circuit Breakers"
14. Section 265600 "Exterior Lighting"

1.3 DEFINITIONS

A. CEC: California Energy Commission.

B. ETFE: Ethylene tetrafluoroethylene.

C. FEP: Fluorinated ethylene propylene.

D. IP Code: Required ingress protection to comply with IEC 60529.

E. MPPT: Maximum power point tracking.

F. PTC: USA standard conditions for PV.

G. PV: Photovoltaic.

H. STC: Standard Test Conditions defined in IEC 61215.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Manufacturer's product data and specifications.
2. Photovoltaic glass configuration.
3. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV modules.
4. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For PV modules.
1. Include plans, elevations, sections, and mounting details for PV array, , structure, and associated equipment and components.
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 and roof penetration.
3. Include a carport plan indicating the mounting structure and supports with roof load calculations including wind load.
4. Detail fabrication and assembly.
5. Size and weight of individual shipping units.
6. List of recommended spare parts.
7. List of preventative maintenance routines.
8. Include diagrams for power, grounding, signal, and control wiring.
9. Include calculations for series string sizing, conductor sizing, overcurrent protection sizing, voltage drop and structural calculations for array racking construction.
10. Include detailed signage plan indicating type and location for all Code required signage, labeling, marking and directories.
    a. Particular attention shall be paid to NEC articles 690 and 705.
    b. Include in signage plan specific wording, graphics and coloring.
11. Samples: Submit three sets of 6" x 6" samples of selected finish color on aluminum substrate of same thickness required for final product. Color samples shall show the full range of color variations expected.

C. Delegated-Design Submittal: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
1. Provide delegated design submittals for the following:
    a. Carport PV array racking system and carport structure.
        1) Structural Calculations: Submit a comprehensive analysis of design loads, including dead loads, live loads, wind loads and thermal movement. Design calculations shall identify the moment and shear forces transferred to the supports through the installation

connections. The structural calculations shall be stamped and signed by a Structural Engineer holding a current and valid license in the State of Arizona.

2) Include structural details of foundation design and coordinate requirements with soils on the site.
3) Ensure compliance with architectural drawings and details for carport design details and dimensions.
4) All components and dimensions of the structural design shall be coordinated with the submitted PV electrical components and equipment.
5) Coordinate placement and lighting fixture selections with site electrical plan and site lighting fixture schedule.

b. PV Electrical System Components:
1) Electrical Calculations: Submit calculations for series string sizing, conductor sizing, inverter sizing, DC/AC overcurrent protection sizing, voltage drop calculations and grounding. The electrical calculations shall be stamped and signed by an Electrical Engineer holding a current and valid license in the State of Arizona.
2) Include 3-line diagrams of PV system in coordination with Navopache

D. Include PV system in power system studies (Short-Circuit Study, Coordination Study, and Arc-Flash Hazard Analysis). Provide power system studies concurrently with PV submittal.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

C. Product Certificates: Signed by manufacturers of major components or parts. The photovoltaic glass, as a customized product, could be certified by families of product.

D. Contractor NABCEP certificate

E. Contractor manufacturer authorized installer certificate.

F. Submit manufacturer's installation instructions.

G. Best effort to supply components with the highest available percentage of post-consumer recycled content.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For PV modules, inverters, combiner boxes and monitoring system to include in operation and maintenance manuals.

B. Continuing Maintenance Proposal: From PV assembly Installer to Owner, in the form of a standard five-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options. To include, but not limited to options for annual services, such as inspections, cleaning, and other recommended services to maintain the system for optimal performance and operation.

1.7 WARRANTY

A. Manufacturer's Special Materials and Workmanship Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
   1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:
      a. Faulty operation of PV modules.
      b. Faulty operation of PV inverter.
      c. Faulty operation of DC-to-DC converters.
      d. Faulty operation of PV balance of system components.
   2. Minimum Warranty Period: Minimum five years for all balance of system components, materials and equipment and for Contractor workmanship from date of Substantial Completion.
   3. PV Module Warranty Period: 25 years.
   4. Extended Inverter Warranty Period: 20 years.
   5. Mounting System Warranty Period: 25 years.

B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
   1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:
      a. Specified minimum power output to 95 percent or more, for a period of 5 years.
      b. Specified minimum power output to 90 percent or more, for a period of 10 years.
      c. Specified minimum power output to 85 percent or more, for a period of 25 years.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification section "Electrical Testing".

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 NFPA 70, Article 690: Solar Photovoltaic Systems.

D. The photovoltaic system point of connection shall be in accordance with NEC article 705, including specifically 705.12.

E. Comply with International Electrical Commission (IEC):
   1. IEC 61215 (1998) Crystalline terrestrial Photovoltaic Modules - Design qualification and type approval.
   2. IEC 61730-1 International Standard - Photovoltaic (PV) module safety qualification - Part 1 - Requirements for construction
   3. UL 1703
   4. For dedicated or customized projects, as an alternative to IEC or UL, provide a Field-Evaluation Test from a recognized CB Laboratory (TUV, Intertek, UL, etc.).

F. Comply with American National Standards Institute (ANSI):

1. ANSI/UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels.
2. ANSI Z97.1 Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings

G. Comply with all state and local codes and ordinances. Coordinate requirements with local AHJ and utility company prior to construction.

H. Inverter and dc-to-dc converter combinations shall meet NEC requirements for module level shutdown. Inverter and dc-to-dc converter equipment shall have the ability to communicate with each other and shall be SunSpec certified.

I. Contractor shall be NABCEP certified and shall possess a current NABCEP certificate.

J. Contractor shall be a manufacturer certified commercial installer and shall possess a manufacturer authorized installer certificate.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NRTL (Nationally Recognized Testing Laboratory) Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and fire safety, Class A, according to UL 1703.

B. FM approved for NFPA 70, Class 1, Division 2, Group C and Group D hazardous locations.

C. Insurance underwriter approved.

D. Tests and Certifications:
1. Standard Tests: UL 1703 (type 2 fire rating), IEC 61215, IEC 6173
2. Management System Certifications: ISO 9001, ISO 14001
3. EHS Compliance: RoHS, OHSAS 18001, lead free, REACH SVHC-163, PV Cycle
4. Ammonia Test: IEC 62716
5. Desert Test: 10.1109/PVSC.2013.6744437
6. Salt Spray Test: IEC 61701 (maximum severity)
7. PID Test: 1000V: IEC 62804, PVEL 600hr duration

E. Listings: UL, CEC.

F. The Construction Documents are based on the following:
1. Carport array of module quantity (1840) 590-watt modules for a total nominal 1,085,600 dc rated watts. The year one estimated annual system output shall meet or exceed 1.996 GWh.

2.2 SYSTEM DESCRIPTION

A. Grid-Tied PV System:
1. Connected via a utility approved disconnecting means to the building electrical distribution system as indicated.
2. If required by local utility company or inspector, provide a utility meter and CT cabinet. Coordinate with utility and inspector prior to construction and provide allowance in bid for this item.
3. All components shall be listed and identified for use in 1000 volt system applications.

4. System Components:
    a. Cell materials.
    b. PV modules.
    c. Array frame.
    d. Inverter.
    e. Overcurrent protection.
    f. Combiner box and disconnect switches.
    g. Mounting structure, mounting hardware.
    h. Utility meter and utility disconnecting means.
    i. Conductors.
    j. Grounding and bonding.
    k. Raceway and boxes.
    l. Cable management.
    m. Rapid shutdown system.
    n. Monitoring system.
    o. Identification, signage, labels, and directories.
    p. All additional miscellaneous hardware and accessories for a complete and functional system.
5. During normal power conditions, available PV power shall synchronize with the grid (utility) source to reduce utility energy consumption. See Section 262313 "Paralleling Low-voltage Switchgear" for synchronization and load sharing requirements with facility distributed energy resources including but not limited to diesel gensets and utility power sources.

B. Microgrid-Tied PV System:
1. Connected via a utility approved disconnecting means to the building emergency and standby electrical distribution system as indicated.
2. All components shall be listed and identified for use in 1000 volt system applications.
3. System Components:
    a. Cell materials.
    b. PV modules.
    c. Array frame.
    d. Inverter.
    e. Overcurrent protection.
    f. Combiner box and disconnect switches.
    g. Mounting structure, mounting hardware.
    h. Utility meter and utility disconnecting means.
    i. Conductors.
    j. Grounding and bonding.
    k. Raceway and boxes.
    l. Cable management.
    m. Rapid shutdown system.
    n. Monitoring and control system.
    o. Identification, signage, labels, and directories.
    p. All additional miscellaneous hardware and accessories for a complete and functional system.

4. During disruption to normal power conditions, available PV power shall synchronize with microgrid distributed energy resources (diesel gensets and other PV array) to reduce utility energy consumption. See Section 262313 "Paralleling Low-voltage Switchgear" for synchronization and load sharing requirements with facility distributed energy resources including but not limited to diesel gensets and utility power sources.

2.3 CARPORT PHOTOVOLTAIC (PV) MODULES

A. Performance Characteristics:
   1. The estimated annual system output must meet or exceed xx kWh.

B. Cell Materials: Monocrystalline Maxeon Gen III, 156 cell.

C. Module Construction:
   1. Nominal Size: 95.1"L x 44.7"W (Refer to architectural drawings for dimensions and quantities)
   2. Thickness: 1.38"
   3. Frame: Class 2 silver anodized
   4. Weight: 75.8 lbs
   5. Capable of withstanding 1" diameter hail at 52mph
   6. Maximum Load:
      a. Wind: 2400 Pa front and back
      b. Snow: 5400 Pa front

D. Front Module: Fully tempered, high transmission glass with anti-reflective coating

E. Junction Box:
   1. IP Code: IP65
   2. MC4 compatible

F. Output Cabling: Listed PV wire with quick connects for landscape module orientation

G. Electrical Specifications:
   1. Maximum Power at STC (Pmax): 585 W
   2. Maximum System Voltage: 1000 Vdc
   3. Rated Open Circuit Voltage (Voc): 53.59 Vdc
   4. Rated Short-Circuit Current (Isc): 13.57 A
   5. Maximum Power Point Voltage (Vmpp): 45.10 Vdc
   6. Maximum Power Point Current (Impp): 12.97 A
   7. Current Temperature Coefficient: +0.04 %/K
   8. Open Circuit Voltage Temperature Coefficient: -0.27 %/K
   9. Power Temperature Coefficient: -0.34 %/K
   10. Module Efficiency: 21.4 %
   11. Maximum Series Fuse Rating: 25 A
   12. Operating Temperature Range: -40 deg C to 85 deg C

2.4 CARPORT PV ARRAY CONSTRUCTION

A. Description: Framing system consisting of PV module support rails designed to capture PV modules and adjacent perforated metal panels, and route wiring in a clean and discrete manner. PV framing system shall be mounted to structural steel framing system to elevate system above roof.

1. See structural drawings and Section 051200 "Structural Steel Framing" and Section 055000 "Metal Fabrications" for structural and supplemental steel framing to support the PV modules and racking system.

B. Structural Performance: Provide exterior sun control assemblies capable of withstanding the effects of loads and stresses from dead loads, live loads, wind loads and thermal movement without evidence of permanent deformation of assembly or components including blades, frames and supports; noise or metal fatigues caused by rattle or flutter; or permanent damage to fasteners and anchors.
   1. Thermal movement: Provide assemblies that allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components and other detrimental effects:
      a. Temperature Change (Range): 120 degrees F ambient; 180 degrees F for material surfaces.

C. Delegated Design:
   1. Refer to Section 1 of this specification for delegated design submittal requirements.
   2. Engage a registered design professional as defined in Section 013573 "Delegated Design Requirements and Procedures" to design and construct the array racking and mounting system in coordination with the structural and supplemental steel framing to support the PV modules, perforated metal panels, and racking system.
      a. Material properties indicated in this Section shall be considered as minimum properties.
   3. Coordinate installation with other trades prior to construction.
   4. Coordinate location of any and all building components or systems penetrating and located on the roof. Building components and/or systems shall not interfere with PV array and shall be coordinated and located prior to construction.

D. PV Tilt Angle: 5 degrees facing south

E. PV Row Spacing: 0 feet

F. Perforated Metal Panel Row Spacing: Align with PV rows

G. Tests and Certifications:
   1. Standard Tests: UL 2703
   2. Wind Tunnel Tests: ASCE 7-10, SEAOC PV2 compliant.

H. Materials: Corrosion-resistant marine-grade aluminum and stainless steel hardware. Coordinate final materials and connections with structural and supplemental steel framing support system.
   1. Finish: TBD

I. All structures, including array structure shall be designed to resist dead load, live load, plus wind and seismic loads to the geographic area.

J. The array racking and mounting system shall be certified by a structural professional possessing relevant experience and knowledge with photovoltaic system designs and installations.

K. The PV system and mounting/racking system must be able to withstand wind pressures of at least 2400 Pa. Refer to structural drawings for all wind and exterior pressure loading on system.

L. All structural components, including array structures shall be designed in a manner commensurate with attaining a 30 year design life. Particular attention shall be given to the prevention of corrosion at the connections between dissimilar metals.

M. The array shall be constructed/mounted in a manner where PV modules shall be capable of being removed from the front (top) and bottom of the array.

2.5 Retain subparagraphs below to suit ProjectINVERTER

A. Manufacturers:
1. Basis-of-Design Product: SMA Solar Technology.
2. Manufacturers: Subject to compliance with requirements, provide compatible product by one of the following:.
   a. Yaskawa Solectra Solar
3. General: Self-synchronizing inverter with available power source.
4. Topology: Transformerless.
5. Control Type: Maximum power point tracker control.
6. Cooling: Forced convection, variable speed fans.
7. Surge Protection: Provide surge protection device(s) for inverters.
   a. Refer to Specification Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits".

B. Protection and Safety Features:
1. Ground-fault detection and interruption.
2. Arc-fault circuit protection.
3. SunSpec PLC signal for rapid shutdown.
4. DC reverse polarity protection.
5. AC short circuit protection.

C. Inverter Electrical Characteristics:
1. Input:
   a. Maximum Input Power: As required.
   b. Maximum Voltage: 1000 V.
   c. MPPT Voltage Range: 330 - 800 V.
   d. Start Voltage: 188 V.
   e. Operating Voltage: 150 - 1000 V.
   f. MPP Trackers: 6.
   g. Strings per MPP Input: 2
   h. Maximum Operating Input Current: 120A.
2. Output:
   a. Nominal Output Voltage: 480/277 Vac, 3 phase, 4 wire.
   b. Continuous Output Current: As required.
   c. Minimum CEC Weighted Efficiency: 97.5%.
   d. Frequency: 60 Hz.
   e. Power Factor: 1.0.
   f. Total Harmonic Distortion: <3%.

D. Operating Conditions:
   1. Operating Ambient Temperatures: -13 to plus +140 deg F.
   2. Storage Temperature: -40 deg F to plus 158 deg F.
   3. Relative Humidity: 0 to 100 percent, non-condensing.

E. Enclosure:
   1. NEMA 4X.
   2. Nominal weight: Maximum 185 lbs.
   3. Dimensions: TBD.
      a. Coordinate final equipment placement and sizes with other trades.

F. Disconnect Switches:
   1. Standard, fully integrated forward facing disconnect switches.
      a. DC disconnect switch.
      b. AC disconnect switch.

G. Network Connection
   1. Ethernet or Modbus/RTU.
   2. Inverter software shall be compatible with the building management system and owner's local area network capable of remote monitoring.

H. Regulatory Approvals:
   1. FCC Part 15 Class A.
   2. HECO Rule 14H.
   3. IEEE 519.
   4. IEEE 1547.
   5. IEEE 1547.1.
   6. PV Rapid Shutdown Equipment.
   7. SunSpec Certified.
   8. UL 1741 SA - CA Rule 21.

I. Mounting
   1. Inverters shall be elevated a minimum of 8' above the ground and mounted to carport structure (underneath canopy).
   2. Inverter shall be accessible and all required working clearance shall be provided to all access doors/panels.

2.6 BALANCE OF SYSTEM COMPONENTS

A. All PV fuses and circuit breakers shall be rated for AC and DC power and back fed applications. Sizes as indicated on Drawings.
   1. Refer to Specification Sections 262300 "Low-Voltage Switchgear", 262413 "Switchboards", 262416 "Panelboards", 262813 "Fuses" and 262816 "Enclosed Switches and Circuit Breakers" for additional information regarding overcurrent protective devices.

B. The photovoltaic system shall be protected by a listed (dc) arc-fault circuit interrupter. The PV arc-fault protection means shall comply with the 2023 NEC.

C. Coordinate with local utility and inspector for additional photovoltaic system disconnect means, overcurrent protection or other component and signage requirements.

D. Combiner Box:
   1. Manufacturers:

a. Basis-of-Design Product: SolarBOS, or approved equal per compliance with requirements.
2. Listed as suitable for 2023 NEC article 690 applications up to 600 Vd Circuit Breakers:
a. AC rated.
b. Size as indicated.
3. Integral heavy-duty, load-break, AC rated disconnect switch with external switch handle.
4. Surge protection device.
5. Internal touch-safe clear protective cover to protect from energized parts.
6. NEMA 3R enclosure suitable for vertical or horizontal mounting orientation.
7. Provide quantity of input circuits suitable for the installation.
8. Mounting
a. Mount AC combiner box to carport structure.
b. Provide required bollards to protect combiner box but ensure proper NEC working clearance is provided

E. Pass Through/Load Break Contactor
1. Manufacturers:
a. DC Sun Volt
2. Listed as suitable for 2023 NEC article 690 applications up to 600 Vd.
3. UL listed and labeled.
4. Upon shutdown via the service disconnecting means, DC disconnecting means or a rapid shutdown initiation device, all PV conductors shall be de-energized in accordance with NEC article 690.12 requirements.
5. NEMA 3R enclosure.

F. Wire Management:
1. Plastic cable (zip) ties are prohibited.
2. Metal cable clips: Corrosion resistant with smooth edge design for PV system cable management.
3. Metal cable tray: Cable management for wiring below modules, corrosion resistant metal and flexible with built-in mounting rings.
a. Manufacturers:
1) Snake Tray.
2) Or pre-approved equal.

G. Labels, Signage and Markings:
1. All PV system labeling and signage shall be in accordance with the NEC and applicable Codes, specifically NEC articles 690 and 705.
2. Refer to Specification Section 260553 "Identification for Electrical Systems" and drawings.

2.7 MONITORING AND CONTROL SYSTEM

A. Manufacturers:
1. Basis-of-Design Product: SMA Data Manager M
2. Manufacturers: Subject to compliance with requirements, provide compatible product by one of the following:
a. Yaskawa Solrenview.
b. Or pre-approved equal.

B. Description: Advanced monitoring system to track module-level performance, PV system energy output and overall annual energy performance.
   1. Integrated with the multiple-generator and PV paralleling microgrid monitoring and control system. See Section 262313 "Paralleling Low-voltage Switchgear" for synchronization and load sharing requirements with facility distributed energy resources including but not limited to diesel gensets and utility power sources.

C. Software:
   1. Real-time module-level monitoring and energy management software with graphical dashboard for assessing the operation and energy production of the system via the Internet.
   2. Module-level granularity.
   3. Capable of storing and tracking historical data.
   4. Safety and performance alerts.
   5. Trending data charts.
   6. Performance analytics.
   7. Ability to generate and download reports.

D. Operating Conditions: -20 deg F to +140 deg F.

E. Enclosure: NEMA 1.

F. Power Requirements: 24V DC, 8W

G. Surge Protection: Provide surge protection device(s) for monitoring system and equipment.
   1. Refer to Specification Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits".

H. Communications: Capable of the following communication methods.
   1. RS-485.
   2. Ethernet.
   3. WiFi.
   4. Cellular.

I. Warranty: 10 years minimum.

J. Certifications: FCC Part 15, Class A, UL.

K. Service Agreement: 2 year service agreement, extendable.

2.8 DC CONDUCTORS

A. The photovoltaic source circuit conductors shall be listed and identified as photovoltaic wire (PV wire). Both the positive and negative DC conductor insulation shall be continuously and permanently colored; red for positive, black for negative. Equipment grounding conductor insulation shall be green.

B. Ensure cabling length is adequate for landscape module orientation. Provide additional wiring, extension cables and rated connectors, as required, for installation.

C. PV wiring must be weather resistant and otherwise suitable for the environment. Ensure wiring is sized in accordance with the NEC including all derating requirements.

D. Refer to Division 26 Section 260519 “Low-Voltage Electrical Power Conductors and Cables" for additional requirements and manufacturers.

2.9 EQUIPMENT GROUNDING

A. An equipment grounding conductor between the PV array and other equipment shall be required.

B. Exposed non-current carrying metal parts of PV module frames, electrical equipment and conductor enclosures shall be grounded in accordance with the NEC.

C. Metallic mounting structures used for mounting PV modules shall be bonded to the PV module frames with an approved and listed device or method. Separate metallic sections and adjacent PV modules shall be bonded together.

D. All photovoltaic source and output circuit conductors (positive and negative) must include disconnecting means, overcurrent protection and ground-fault protection in accordance with the NEC.

E. In addition to the general labeling requirements, the photovoltaic power source shall be labeled with warning signage at each junction box, combiner box, disconnect and device where energized, ungrounded circuits may be exposed during service.

2.10 LIGHTNING PROTECTION

A. Refer to Specification Section 264113 "Lighting Protection for Structures for additional information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

G. Field verify site and prepare/submit a fall protection plan to the construction site safety manager prior to start of construction.

3.2 INSTALLATION

A. The installing PV Contractor shall be NABCEP certified.

B. The installing PV Contractor shall be a manufacturer registered authorized commercial installer.

C. Equipment and components installed on roof shall be rated for such applications. Outdoor equipment shall be weatherproof.

D. Coordinate layout and installation of photovoltaic system and components with other construction that penetrates roof and walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Ensure modules are not shaded by other types of equipment or building elements. Maintain required workspace clearances and required clearances for equipment access doors and panels.

E. All photovoltaic circuit conductors not directly beneath the PV modules shall be installed in metal conduit. Open wiring directly below the PV modules in accordance with the NEC is permitted.

F. Plastic cable ties are prohibited. Provide corrosion-resistant metal clips, cable tray or another permanent method of wire management for PV wire routed directly beneath the PV modules.

G. Ensure rooftop wires or conduit exposed to direct sunlight and elevated ambient temperatures are properly sized and derated in accordance with the NEC.

H. Photovoltaic wiring installed beneath roofs shall not be installed within 12 inches of the roof decking or structural ceiling. Route in conduit parallel or perpendicular to structural members and walls. Conduits shall be permanently marked and identified in accordance with the NEC.

I. The photovoltaic system inverter and monitoring system shall be capable of exporting PV system performance data to the building management system or local area network. Provide a data connection for the inverter and monitoring system. Coordinate requirements with the controls Contractor.

J. Consult with inspector to verify if there are any special requirements for the PV installation prior to the start of construction.

K. Exposed non-current carrying metal parts of PV frames, array racking, mounting rails, structural and supplemental steel framing system, and electrical equipment enclosures shall be grounded in accordance with the NEC.

L. PV design and installation shall be installed in accordance with manufacturer's instructions and meet all NEC requirements, specifically including rapid shutdown requirements.

3.3 MICROGRID INTEGRATION

A. Provide all necessary wiring, devices and accessories to integrate PV monitoring system with the microgrid controller.

B. Coordinate all required programming to allow for microgrid controller to sequence open and close electronic operation of PV distribution panels to both normal and emergency distribution.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring and components; provide warnings signs complying with Division 26 Section 260553 “Identification for Electrical Systems”.

B. Nameplates: Label all photovoltaic equipment as required by the NEC (article 690). Nameplates and labeling shall comply with requirements for identification specified in Division 26 Section “Identification for Electrical Systems”.

C. All exterior signage must be weather resistant and otherwise suitable for the environment.

3.5 TRAINING

A. Provide the services of a factory-trained representative of the manufacturer for the training of the Owner’s personnel in the operation of the PV system, inverters, combiner boxes and monitoring system.

B. Provide training services for up to six persons for a minimum of one eight-hour day or duration of time as recommended by the manufacturer.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections, per manufacturer's recommendations and required testing procedures.

B. PV module will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 CLEANING

A. Periodically clean exposed surfaces of sun control devices that are not protected by temporary covering to remove fingerprints and soil during construction. Do not let soil, dust, debris, etc. accumulate.

B. Just prior to final project acceptance, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Protect sun control assemblies from damage during construction. Use temporary protective coverings where required and approved by the sun control assembly manufacturer. Remove protective covering at time of project final acceptance.

END OF SECTION

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for emergency standby power supply with the features as specified and indicated.

B. Related Sections include the following:
1. Section 260573.13 "Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19 "Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
3. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.
4. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
5. Section 263650 "Generator Docking Stations" for temporary generator and load bank connection cabinets.

1.2 DEFINITIONS

A. 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.

1.3 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
1. Thermal damage curve for generator.
2. Available fault current produced from each generator.
3. Time-current characteristic curves for generator protective device.
4. Certified summary of prototype-unit test report.
5. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

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. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Compliance Statement
1. Submit a document which states whether the proposed product(s) either comply or deviate from the Specification requirements. This includes all Part 1, Part 2, and Part 3 specification items. Specification requirements not noted as deviations will be assumed as complying.
2. Provide the statement in an itemized, columnar format as follows:
   a. Column 1 - Reference to the specification item, organized in the same sequential order as in the Specification.
   b. Column 2 - Explanation for noted deviations.

D. Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.
1. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. 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.

H. Training Video: Copy of video recorded training.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than 275 miles (321 km) from Installer's place of business to Project site.
   2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 275 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Qualifications: Experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
   1. Testing Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. 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.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

K. Comply with UL 2200.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 PROJECT 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 Owner no fewer than fourteen days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: -20 to 100F .
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 5500ft

1.6 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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.
1. Warranty Period: Two years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Date of Acceptance, 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.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar; Engine Div.
2. Onan/Cummins Power Generation; Industrial Business Group.
3. MTU Onsite Energy Corporation.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Continuous electrical output power rating for standby operation of not less than KW which is shown in the Drawings, at 80 percent lagging power factor, 480/277 -volt, three phase, 4-wire, 60 hertz. In addition, provide power required for generator accessories including battery charger and radiator.
   2. Provide generator with a minimum motor starting capability of that which shown on the DrawingsA and capable of sustaining a minimum of 90 percent of rated no-load voltage with the specified kVA load at near zero power factor applied to the generator.
   3. System fault current contribution from each generator shall not exceed 35,000 amps under any condition.
   4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
      a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
   2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
   3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
   4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
   5. 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.
   6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
   7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
1. Suitable for operation on 480-volt, single phase, 60 hertz power.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set 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. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections

6. Radiator discharge shall be vertically oriented through weather enclosure scoop.

I. Muffler/Silencer: Hospital Grade critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 70 dBA or less.
   3. Silencer shall be internal to enclosure provided with factory provided rain cap.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 12V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" 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 adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. 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 C to plus 60 deg C 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.
f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Sub-Base Mounted Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of minimum 4 hours' operation at 100 percent of rated power output of engine-generator system without being refilled. Minimum 1100 gallons. Maximum tank dimensions shall be as shown on drawings.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Tank level indicator.
5. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
6. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
7. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
8. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.
9. Provide with vandal resistant fill cap for backup local fill in the event of central storage failure.
10. Provide tank level indicator, and tank venting system.
11. Sub-base tank shall be piped by Division 23 to central fuel storage system comprised of (2) 25,000 gallon above grade storage tanks and central pumping and fuel polishing system. The fuel storage system provides 96 hours of runtime for facility at 100% load plus 33% required by NFPA 110.

C. Fuel Oil Tank Alarm Panel: Weatherproof enclosure with the following features:
1. Low level alarm.

2. High level alarm.
3. Critical high level alarm.
4. Fuel tank leak alarm.
5. Alarm horn.
6. Silence button.

D. Fuel Oil
1. Fill storage tanks with fuel oil prior to Acceptance Testing and replenish spent fuel after Owner Acceptance.

2.5 CONTROL AND MONITORING

A. Section 262313 "Paralleling Low-voltage Switchgear" for multiple-generator and PV paralleling microgrid monitoring and control and single-generator paralleling monitoring and control requirements.

B. 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 generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
1. Engine start circuits from emergency and fire pump transfer switches shall be monitored for broken, shorted , or disconnected wires as required by NFPA 70 articles 695 and 700. Loss of start circuit wiring shall start the generator. Provide all control wiring and hardware required to provide engine start circuit integrity monitoring as required by the referenced code articles.

C. Configuration: 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 generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Provide remote annuciator panels as indicated on the Drawings and in coordination with Owner. Provide a minimum of (3) full featured annuciator panels for monitoring of all generator status functions.

E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
2. Current and Potential Transformers: Instrument accuracy class.

F. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter.
2. AC ammeter.

3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

H. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

I. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

J. Remote Alarm Annunciator: Comply with NFPA 99. An LED 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.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be provided as break glass type to prevent inadvertent operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Insulated-case, true RMS sensing electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Main circuit breaker UL-listed as service-entrance equipment.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 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 or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

2.8 LOAD BANK

A. Description: As specifed on the Drawings.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels or hinged doors shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments, control, day tank and battery system shall be mounted within enclosure.
   1. Provide enclosure which maintains a minimum interior ambient temperature of 40 degrees F. per NFPA 110.
   2. Level 2 sound attenuation, 70 decibels at 23ft..

B. Description: Prefabricated or preengineered walk-in enclosure with the following features:
   1. Provide enclosure which maintains a minimum interior ambient temperature of 40 degrees F per NFPA 110.
   2. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
   3. Engine radiator exhaust shall be vertically oriented with engine exhaust introduced at outlet just below top of enclosure for blending and dispersion.
   4. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
   5. Space Heater: Thermostatically controlled and sized to prevent condensation.
   6. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.

7. Hinged Doors: With padlocking provisions.
8. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
9. 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-set components and NFPA 110.
10. Muffler Location: Within enclosure.
11. Access Stairs and Platforms: Provide where indicated on Drawings or if required by governing codes to provide access to overcurrent protective devices.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

D. Interior Lights with Switch: Factory-wired, vaporproof-type 4ft linear LED fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

F. Load Center: Provide a 480Y/277V, 3 Phase, 4 Wire, 100A MCB (main circuit breaker) type panelboard within the enclosure for power service to generator accessories including but not limited to: battery charger, jacket water heaters, lights, receptacles, enclsoure heater, and motorized dampers. Generator accessories shall be factory wired to the panelboard. Provide step-down transformer to 208Y/120V, 3-Phase, 4-wire, 125A MCB panelboard for respective accesory loads. All internal wiring shall be type THHN/THWN-2 in EMT in accordance with all governing codes. If load center is located near the air intake louver and will be subject to moisture from rain or snow, provide a NEMA 3R enclosure.

2.10 LOAD BANK CONNECTION BOX

A. As specified on the Drawings. Provide as specified in generator docking station spec and on Drawings.

2.11 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside;

and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.12 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer. Outdoor enclosure finish color shall be selected by Architect in neutral grey or tan shade.

2.13 SOURCE QUALITY CONTROL

A. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
   9. Report factory test results within 10 days of completion of test.

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 of 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 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolation devices as specified having a minimum deflection as required to meet acoustical/vibration design and manufacturers requirements on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 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. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23 Section "Facility Fuel-Oil Piping."

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect power wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. Provide engine start wiring from generator controller to paralleling switchgear. Engine start wiring shall be type and size as recommended by manufacturer. Where manufacturer does not have a specific recommendation, provide #12 AWG THHN/THWN-2 conductors.
   1. Route engine start wiring in separate raceways and entirely indepedent from all wiring
   2. Coordinate engine start signal wiring installation with transfer switch manufacturer and installer. For emergency and fire pump transfer switches, ensure proper connection and operation of the engine start circuit integrity monitoring required by NFPA 70 articles 695 and 700.

H. Provide power and communications wiring for remote generator annunciator (derangement) panel. Provide wiring type and size as recommended by manufacturer.
   1. Where generator annunciator panel location is not specifically indicated on Drawings, coordinate exact location with Owner prior to installation.

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test sequence of operation step by step for each mode.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest and reinspect as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

B. Record the training and provide a video copy to the Owner per Division 01.

END OF SECTION

SECTION 263213 - ENGINE GENERATORS - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for emergency standby power supply with the features as specified and indicated.

B. Related Sections include the following:
1. Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY-WWTP, Section 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY-WWTP, and Section 260573.19, OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY-WWTP for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913, ELECTRICAL POWER MONITORING AND CONTROL-WWTP for interfacing communication and metering requirements.
3. Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.
4. Section 263600, TRANSFER SWITCHES-WWTP for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
5. Section 263650, GENERATOR DOCKING STATIONS for temporary generator and load bank connection cabinets.

1.2 DEFINITIONS

A. 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.

1.3 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
1. Thermal damage curve for generator.
2. Available fault current produced from each generator.
3. Time-current characteristic curves for generator protective device.
4. Certified summary of prototype-unit test report.
5. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

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. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Compliance Statement
1. Submit a document which states whether the proposed product(s) either comply or deviate from the Specification requirements. This includes all Part 1, Part 2, and Part 3 specification items. Specification requirements not noted as deviations will be assumed as complying.
2. Provide the statement in an itemized, columnar format as follows:
   a. Column 1 - Reference to the specification item, organized in the same sequential order as in the Specification.
   b. Column 2 - Explanation for noted deviations.

D. Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.
1. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. 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.

H. Training Video: Copy of video recorded training.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than 275 miles (321 km) from Installer's place of business to Project site.
   2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 275 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Qualifications: Experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
   1. Testing Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. 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.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with UL 2200.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

K. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 PROJECT 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 Owner no fewer than fourteen days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner’s written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature:
      a. Hospital Site: 40 to 120F.
      b. Hon-Dah Site: 0 to 100F.
   2. Relative Humidity: 0 to 95 percent.
   3. Altitude:
      a. Hospital Site: 5,630 ft
      b. Hon-Dah Site: 7,160ft.

1.6 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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.
   1. Warranty Period: Two years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Date of Acceptance, 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.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar; Engine Div.
   2. Onan/Cummins Power Generation; Industrial Business Group.
   3. MTU Onsite Energy Corporation.
   4. Rehlko.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Continuous electrical output power rating for standby operation of not less than KW which is shown in the Drawings, at 80 percent lagging power factor, 480/277 -volt, three phase, 4-wire, 60 hertz. In addition, provide power required for generator accessories including battery charger and coolant jacket heater.
   2. Provide generator with a minimum motor starting capability of that which shown on the Drawings. and capable of sustaining a minimum of 90 percent of rated no-load voltage with the specified kVA load at near zero power factor applied to the generator.
   3. System fault current contribution from each generator shall not exceed 35,000 amps under any condition.
   4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
      a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
   2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
   3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
   4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
   5. 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.
   6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
   7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: 10 seconds.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499. Provide a 208 Volt ac, 3-phase rated block heater pre-wired to a manufacturer installed load panel.

F. Governor: Adjustable isochronous, with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set 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. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections
6. Radiator discharge shall be vertically oriented through weather enclosure scoop.

H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 25 feet (7.6 m) from exhaust discharge after installation is complete shall be 75 dBA or less.
   3. Silencer shall be internal to enclosure provided with factory provided rain cap.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 24V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: 60 seconds.
   4. Battery: Lead-acid adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. 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 C to plus 60 deg C 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.
f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

K. Distribution Panel/Load Center:
1. Prewired AC power distribution of all factory installed features including two GFCI protected internal 120 Volt ac service receptacles, two AC LED lights, and a commercial grade light switch. The three-phase load center shall be powered by a building source and protected by a main circuit breaker, rated for 100 amps with capacity and circuit positions for future expansion. Load panel supply voltage shall be 208 Volt, 3-phase. AC power distribution shall be installed in accordance with the NEC and all wiring shall be within EMT or flexible metal conduit. Lighting fixtures shall be located within UL-listed fixtures designed for wet locations.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Sub-Base Mounted Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
2. Tank Capacity: As recommended by the engine manufacturer for an uninterrupted period of 24 hours' operation at 100 percent of rated power output of the engine generator system without being refilled.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Tank level indicator.
5. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
6. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
7. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
8. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

9. Provide with vandal resistant fill cap for backup local fill in the event of central storage failure.
10. Provide tank level indicator, and tank venting system.

C. Fuel Oil Tank Alarm Panel: Weatherproof enclosure with the following features:
1. Low level alarm.
2. High level alarm.
3. Critical high level alarm.
4. Fuel tank leak alarm.
5. Alarm horn.
6. Silence button.

D. Fuel Oil
1. Fill storage tanks with fuel oil prior to Acceptance Testing and replenish spent fuel after Owner Acceptance.

2.5 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 generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Provide a minimum run time control set for 15 minutes adjustable to 30 minutes with an override only by operation of a remote Emergency Stop switch.

C. Comply with UL 508A.

D. Configuration: 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 generator set. Mounting method shall isolate the control panel from generator-set vibration.

E. Configuration: 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 engine generator vibration. Panel shall be powered from the engine generator battery.

F. Control and Monitoring Panel:
1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup. Controller to provide fault/alarm historian.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.
   a. Engine lubricating oil pressure gage.
   b. Engine coolant temperature gauge.
   c. DC voltmeter (alternator battery charging).
   d. Running time meter.
   e. AC voltmeter, for each phase.

f. AC ammeter, for each phase.
g. AC frequency meter.
h. Generator voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:
   a. Cranking control equipment.
   b. Run-Off-Auto switch.
   c. Control switch not in automatic position alarm.
   d. Overcrank alarm.
   e. Overcrank shutdown device.
   f. Low-water temperature alarm.
   g. High engine temperature pre-alarm.
   h. High engine temperature.
   i. High engine temperature shutdown device.
   j. Overspeed alarm.
   k. Overspeed shutdown device.
   l. Low fuel main tank.
      1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation.
   m. Coolant low level alarm.
   n. Coolant low level shutdown device.
   o. Coolant high temperature pre-alarm.
   p. Coolant high temperature alarm.
   q. Coolant low temperature alarm.
   r. Coolant high temperature shutdown device.
   s. Battery high voltage alarm.
   t. Low cranking voltage alarm.
   u. Battery charger malfunction alarm.
   v. Battery low voltage alarm.
   w. Lamp test.
   x. Contacts for local and remote common alarm.
   y. Low starting air pressure alarm.
   z. Low starting hydraulic pressure alarm.
   aa. Remote manual stop shutdown device.
   bb. Air shutdown damper alarm when used.
   cc. Air shutdown damper shutdown device when used.
   dd. Generator overcurrent protective device not-closed alarm.
   ee. Hours of operation.
   ff. Engine generator metering, including voltage, current, hertz, kilowatt, kilowatt hours, kilovolt ampere, and power factor.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
   1. One Normally Open “Generator Run” contact is required for the Remote Terminal Unit PLC.
   2. One Normally Open “Generator Fail” contact is required for the Remote Terminal Unit PLC.

3. One Normally Open “Battery Low” contact is required for the Remote Terminal Unit PLC.
4. One Normally Open “Fuel Low” contact is required for the Remote Terminal Unit PLC.

H. Common Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of the initiating condition will reactivate the alarm until the silencing switch is reset.
1. Engine high temperature shutdown.
2. Lube oil, low pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency stop shutdown.
5. Engine high temperature pre-alarm.
6. Lube-oil, low pressure pre-alarm.
7. Low coolant level.
8. Fuel low alarm.
9. Control switch not in auto position.
10. Battery-charger malfunction alarm.
11. Battery low-voltage alarm.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Insulated-case, true RMS sensing electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Main circuit breaker UL-listed as service-entrance equipment.

B. Generator Protector: Microprocessor based unit shall continuously monitor the current level in each phase of the generator output, integrate generator heating effect over time, and predict when thermal damage of the alternator will occur. When signaled by the generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm shall be integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single phase or three phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.7 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 or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
   2. Maintain voltage within 20 percent on one step, full load.
   3. Provide anti-hunt provision to stabilize voltage.
   4. Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels or hinged doors shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments, control, day tank and battery system shall be mounted within enclosure.
   1. Provide enclosure which maintains a minimum interior ambient temperature of 40 degrees F. per NFPA 110.
   2. Level 2 sound attenuation, 75 decibels at 25ft.

B. Description: Prefabricated or preengineered walk-in enclosure with the following features:
   1. Provide enclosure which maintains a minimum interior ambient temperature of 40 degrees F per NFPA 110.
   2. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
   3. Engine radiator exhaust shall be vertically oriented with engine exhaust introduced at outlet just below top of enclosure for blending and dispersion.
   4. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
   5. Space Heater: Thermostatically controlled and sized to prevent condensation.
   6. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
   7. Hinged Doors: With padlocking provisions.

8. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
9. 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-set components and NFPA 110.
10. Muffler Location: Within enclosure.
11. Access Stairs and Platforms: Provide where indicated on Drawings or if required by governing codes to provide access to overcurrent protective devices.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

D. Interior Lights with Switch: Factory-wired, vaporproof-type 4ft linear LED fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

F. Load Center: Provide a 208Y/120V, 3 Phase, 4 Wire, 100A MCB (main circuit breaker) type panelboard within the enclosure for power service to generator accessories including but not limited to: battery charger, jacket water heaters, lights, receptacles, enclsoure heater, and motorized dampers. Generator accessories shall be factory wired to the panelboard. All internal wiring shall be type THHN/THWN-2 in EMT in accordance with all governing codes. If load center is located near the air intake louver and will be subject to moisture from rain or snow, provide a NEMA 3R enclosure.

2.9 VIBRATION ISOLATION DEVICES

A. ¼-inch thick, elastomeric isolator pad attached to baseplate underside.

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer. Outdoor enclosure finish color shall be selected by Architect in neutral grey or tan shade.

2.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion air filters.

2.12 SOURCE QUALITY CONTROL

A. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

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 of 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 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generators on cast-in-place concrete equipment bases complying with the details shown on the Drawings. Coordinate the size and location of concrete bases and anchor bolts for packaged engine generators. Cast anchor bolt inserts into bases per templates provided by the manufacturer. Install packaged engine generator with elastomeric isolator pads on the concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

B. Connect wiring according to Section 260519, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES-WWTP. Provide a minimum of one 90-degree bend in flexible conduits routed to the engine generator from a stationary element.

C. Balance single phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.4 IDENTIFICATION

A. Identify system components according to Section 230553, IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT-WWTP and Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: The Contractor shall engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations including all connections.

B. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   3. Load Bank Tests: Perform load bank testing on the generator per the following:
      a. 25% Loading for 30 minutes.
      b. 50% Loading for 30 minutes.
      c. 100% Loading for 60 minutes.
      d. Complete a Load Bank Test form with measured values every 15 minutes for the following (at a minimum):
         1) Engine Temperature (°F).
         2) Oil Pressure (PSI).
         3) Amps; A, B, & C Phases.
         4) Voltage.
         5) Frequency.
         6) % Load
         7) kW.
         8) Exhaust Temperature (°F).
   4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
      c. Verify acceptance of charge for each element of the battery after discharge.
      d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
8. Exhaust Emissions Test: Comply with applicable government test criteria.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
11. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test sequence of operation step by step for each mode.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest and reinspect as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Contractor shall provide a full tank of fuel after all testing and before the system is turned over to the owner.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

B. Record the training and provide a video copy to the Owner.

END OF SECTION

SECTION 263233 - ROTARY UNINTERRUPTIBLE POWER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. A DC Flywheel Energy Storage System (Rotary Uninterruptible Power Supply / RUPS) to be integrated with Uninterruptible Power Supply (UPS) systems. The DC Flywheel is a mechanical battery that stores energy in the form of a rotating mass. The DC Flywheel shall be configured as a two terminal Energy Storage System and shall be used as a functional replacement or supplement for a bank of chemical batteries for UPS systems. Like a chemical battery bank, it shall receive recharge and float power from the two terminal UPS DC bus and shall return power to the same DC bus whenever the bus voltage drops below a programmable factory set threshold level.

B. Related Requirements:
   1. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of RUPS.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for RUPS.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For RUPS.
   1. Include plans, elevations, sections, mounting, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Show access, workspace, and clearance requirements; and details of control panels.
   4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For RUPS equipment, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Factory Test Reports: Comply with specified requirements.

C. Product Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

D. Sample Warranties: For manufacturer's special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RUPS units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Inspections: The DC Flywheel Manufacturer shall have a documented quality assurance program that includes inspection of incoming parts, modular assemblies and final products. In addition, every rotor shall be inspected, and overspeed tested.

B. Factory Testing: The DC Flywheel shall be inspected and tested in the manufacturer's facility to demonstrate full compliance with the requirements of this specification.

1.6 WARRANTY

A. Special RUPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
   1. Special Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 RUPS REQUIREMENTS

A. System Description: The DC Flywheel shall deliver power and energy to the DC bus of a UPS system when input power sags or is interrupted. The DC Flywheel shall store energy kinetically in a high-speed, aerospace grade steel rotor rotating in a vacuum. A vacuum pump external to the evacuated flywheel housing assembly shall be required. The DC Flywheel and rotating group shall be fully levitated and centered by an active magnetic bearing system that minimizes idling losses and eliminates mechanical bearing maintenance and replacement. The motor/generator shall consist of a permanent magnet design that is integrated with the flywheel rotor and minimizes idling losses, maximizing efficiency.

B. Longevity: The DC Flywheel must be able to recover (return to normal operation) from a failure of the active magnetic bearing controller while at maximum operating speed until the flywheel RPM is at zero. Such a condition shall not require replacement of the flywheel, back-up bearings or rotating group. The DC Flywheel shall be designed for a life in excess of 20 years in a UPS application.

C. Modes of Operation:
   1. Ready to Start Mode: When the DC Flywheel is initially powered on, it shall enter the Ready to Startup Mode and commence to draw vacuum on the DC flywheel until the minimum vacuum level is met. Once the minimum vacuum level has been met, the system shall magnetically levitate its rotating group and notify the user that the system is ready to transition to Starting-up Mode. A manual user command will make the system transition from Ready to Start mode to Starting-up mode.

2. Starting-up Mode: In Starting up Mode, the DC Flywheel shall initialize a pre-charge process to energize the DC capacitors. When the pre-charge process is complete, the DC Flywheel shall automatically enter the Charging Mode.
3. Charging Mode: To charge the DC Flywheel, power shall be drawn from the UPS system DC bus to accelerate the rotor provided the voltage on the DC bus is within acceptable limits (equal to or above the charging voltage threshold). The charge rate shall be limited so that it does not exceed a UPS manufacturer's specified input rectifier current or charging current rating. In this Mode, the DC Flywheel's AE shall progressively increase from 0% to 100%. The DC Flywheel will be in Charging Mode as long as: 1) the DC Flywheel's AE is between 0% and 100%; and 2) the UPS system DC bus voltage is greater than or equal to the DC Flywheel Charging Voltage Threshold. While in Charging Mode, the DC Flywheel shall be capable of providing power to the UPS DC bus provided the AE is greater than 0%.
4. Ready Mode: The DC Flywheel shall be in Ready Mode when it reaches its maximum operating ("fully charged") speed. While in Ready Mode, the DC Flywheel shall continue to receive a very small amount of power from the UPS system DC bus to maintain an AE > 99.5%. While in Ready Mode, the DC Flywheel shall be capable of supporting the UPS DC bus.
5. Discharging Mode: When a voltage sag or failure of the utility AC power source results in a reduction of voltage on the UPS system DC bus, the DC Flywheel shall enter the Discharging mode and supply power to the critical load by maintaining a pre-set voltage level on the DC bus. The DC Flywheel shall be in the Discharging mode until the DC bus voltage rises (when the AC power returns) or until the DC flywheel reaches its minimum operating speed.
6. Flywheel Shutdown Mode: In Shutdown Mode the DC Flywheel cannot provide energy to the UPS DC bus. A Shutdown process is initiated after a system discharge when the flywheel speed reaches the minimum operating speed and the UPS system DC bus voltage is less than the DC Flywheel Charging Voltage Threshold. A user shall also be able to command the DC Flywheel to transition to Shutdown Mode. While in Shutdown Mode, the user may command a change to Startup or Charge mode provided all required operating parameters are satisfied. System Faults will also initiate a Shutdown.
7. System Parameters Elevated Mode: In this mode, an error has been detected waiting to be cleared. The flywheel shall continue to operate normally unless the error is further elevated beyond acceptable limits. Errors elevated beyond acceptable limits shall result in a transition to Flywheel Shutdown Mode.
8. Emergency Power Off: The DC Flywheel enters this mode after the local Emergency Shutdown button has been depressed or the Remote Emergency contact has been activated. User intervention is required for the system to be removed from this mode.

D. Construction and Mounting: The DC Flywheel shall be housed in a freestanding cabinet with a NEMA 1 construction rating or IEC equivalent. No space is required between the back or sides of the cabinet and any walls. The DC Flywheel shall accommodate bottom or top access for on site wiring. The DC Flywheel shall be able to be rolled into place and go through a standard 30-inch-wide door. The DC Flywheel shall be cleaned, primed and painted with the manufacturer's standard color. The DC Flywheel shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug connections. Like assemblies and like components shall be interchangeable.
   1. Dimensions and Weight: The DC Flywheel, as a single standard unit, shall have dimensions not more than 30.5 in. width, 30.0 in. depth, and 73.7 in. height. The DC Flywheel, as a single standard unit without options, shall weigh no more than 2048 lbs.
   2. Transport: The DC Flywheel shall be designed to be handled with a forklift, pallet jack, or lifting with load rated straps.
   3. Floor Mounting: Provisions shall be made for anchoring to the floor (concrete or raised).
   4. Maintenance Access: Front clearance is required per the National Electric Code. No side or rear access shall be required for any service. Access to all components shall be from the front and top.

E. Cooling: The DC Flywheel stator and power electronics shall be air cooled with no requirements for liquid cooling. The DC Flywheel package shall be designed for natural and forced air-cooling. Air inlets shall be provided from the bottom front of the DC Flywheel enclosure. Air exhaust shall be from the top of the unit. For air ventilation, a 12 in. minimum clearance overhead is required.

F. Grounding: The DC Flywheel shall have an equipment ground terminal such as to be able to be effectively grounded to the frame of the interconnected UPS system.

G. Environmental Conditions: The DC Flywheel shall be capable of being stored for a period of up to 6 months and capable of operation within the following environmental conditions without damage or performance degradation:
   1. Startup Ambient Temperature: 32 to 104 deg F.
   2. Operating Ambient Temperature: 14 to 104 deg F.
   3. Non-Operating Ambient Temperature: -4 to 158 deg F
   4. Relative Humidity: Zero to 90 percent, noncondensing.
   5. Operating Altitude: Sea level to 5000 feet.
   6. Non-Operating Altitude: Sea level to 39370 feet

H. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

I. UL Compliance: Listed and labeled by an NRTL to comply with UL 1778 and/or UL 9540 as applicable.

J. NFPA Compliance: UPS components shall be listed and labeled by an NRTL as suitable for installation in computer rooms according to NFPA 75.

2.2 RUPS SYSTEM COMPONENTS

A. UPS Interconnection: The DC Flywheel shall enable physical interconnection to a UPS system. The interconnection shall include a disconnect-switch and system controls configured for operation with specific UPS systems.

B. Power Conversion Module: The Power Conversion Module shall be a 3-phase IGBT bridge converter capable of sourcing or sinking power to and from the UPS DC bus. While providing energy to the DC Bus of the UPS, the Power Conversion Module shall convert "variable frequency - variable voltage" AC power from the motor-generator and deliver regulated DC voltage to the UPS DC bus. Conversely, during rotor acceleration to store energy, the Power Conversion Module shall convert DC power from the UPS DC Bus into "variable frequency - variable voltage" AC power to the motor-generator.

C. Control Panel: The DC Flywheel shall use a touchscreen control panel PC as the primary means for an operator to interface with the system. The control panel shall indicate operating parameters listed in this section. Additionally, the control panel shall be menu driven and provide access to warning and fault information.

1. Mode Indicators:
    a. Ready to Start (No system faults; the system can be started)
    b. Starting-up (System is in start-up mode, DC Bus is pre-charging)
    c. Charging (Flywheel is accelerating to its fully charged state)
    d. Ready / Full Charge (Flywheel is fully charged, ready for discharge)
    e. Discharging (Flywheel is discharging, supplying power to the DC bus.
    f. System Parameters Elevated (System has entered a condition waiting to be cleared. If the condition persists or is further elevated, the system will enter the Flywheel Shutdown mode.)
    g. Flywheel Shutdown (System entered a condition resulting in a shutdown. This may be user or system initiated.)
    h. Emergency Power Off (The local emergency shutdown button has been depressed or the Remote emergency contact has been activated.)
    i. Display Parameters:
    j. DC Bus Voltage, VDC
    k. DC Bus Current, Amps
    l. DC Bus Power, kW
    m. Flywheel Speed, % Operating Speed
    n. Inverter Temperature Status.
    o. Pre-charge Contactor Status
    p. DC Isolation Contactor Status
    q. Magnetic Bearing Status
    r. Vacuum Level Status
    s. Enclosure Temperature Status
    t. Flywheel System Hours
    u. Number of Discharge Events
2. Warnings and Alarms (accessed via a Warning/Alarm Events screen):
    a. Vacuum Level
    b. Enclosure Temperature
    c. IGBT Temp Phase A
    d. IGBT Temp Phase B
    e. IGBT Temp Phase C

f. Precharge Contactor
g. DC Bus Isolation Contactor
h. Magnetic Bearing Failure
i. System Alarm
j. Enclosure Temperature Fault
k. Vacuum Level Fault
l. Remote EPO
m. Emergency Power Off
n. Precharge Timeout
o. User Stop Initiated
p. High DC Voltage
q. Low DC Voltage

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the RUPS.

B. Inspect equipment for signs of damage.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

E. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

3.3 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Separately Derived Systems: If part of a listed power supply for a data-processing room, comply with manufacturer's written instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

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. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections to be performed during DC Flywheel startup:
   1. Verify all printed circuit boards are configured properly
   2. Check all control wiring and power wiring connections for tightness
   3. Check all Vacuum Pump Connections
   4. Check fuses for continuity
   5. Check and verify UPS DC bus voltage
   6. Check and verify AC Input power

C. Startup and Commissioning:
   1. Perform Pre-Startup System Inspection
   2. Verify UPS settings and adjustments
   3. Verify on Control Panel that system settings and configurations of the UPS and DC Flywheel are compatible.
   4. Once UPS is online and providing DC Bus Voltage, close the DC Breaker
   5. Verify that the unit reaches maximum state of charge without failure

D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the RUPS. Training courses shall include DC Flywheel theory, safety, system considerations, and operational procedures.

END OF SECTION

SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
      a. Surge suppression.
      b. Rectifier-charger.
      c. Inverter.
      d. Controls and indications.
      e. Static bypass transfer switch.
      f. External maintenance bypass/isolation switch.
      g. Output distribution section.
      h. Output isolation transformers.
      i. Remote status and alarm panels.
      j. Remote monitoring provisions.
      k. Battery and battery disconnect device.
      l. Battery monitoring.

B. Related Requirements:
   1. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
   2. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GTO: Gate turn-off thyristor.

C. IGBT: Isolated gate bipolar transistor.

D. LCD: Liquid-crystal display.

E. LED: Light-emitting diode.

F. NiCd: Nickel cadmium.

G. PC: Personal computer.

H. SPD: Surge protection device.

I. THD: Total harmonic distortion.

J. UPS: Uninterruptible power supply.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of UPS.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For UPS.
1. Include plans, elevations, sections, and mounting details.
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. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For UPS equipment, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Factory Test Reports: Comply with specified requirements.

C. Product Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

D. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For UPS units to include in emergency, 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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Cabinet Ventilation Filters: One complete set(s).

1.7 QUALITY ASSURANCE

A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.

1.8 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Lithium Ion Batteries: Equal to or greater than Four years from date of Substantial Completion.

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
   1. Special Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:
   1. Double Conversion, IGBT:
      a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. High-efficiency carrier stored trench IGBT, in both rectifier-charger and inverter circuits, provides a minimum of 96 percent efficiency for the UPS system at full load and a minimum of 94 percent efficiency at 50 percent load.
      b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to provide constant, regulated inverter power output to the load.
      c. Power Failure: If normal power fails, the rectifier-charger and inverter use energy from the battery to supply constant, regulated power output to the load without switching or disturbance.
   2. When power is restored at the normal supply terminals of the system, controls shall automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger shall supply power to the load through the inverter and simultaneously recharge the battery.
   3. If the battery becomes discharged and normal supply is available, the rectifier-charger shall charge the battery. The rectifier-charger shall automatically shift to float-charge mode on reaching full charge.
   4. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch shall switch the load to the normal ac supply circuit without disturbance or interruption.
   5. The output power converters shall produce up to 300 percent of rated full-load current for short-circuit clearing. The inverter shall sustain steady-state overload conditions of up to 150 percent of rated full-load current for 60 seconds in normal operation.
   6. The inverter shall be capable of sustaining 150 percent of system capacity for 60 seconds while powered from the battery.
   7. Should overloads persist past the time limitations, the automatic static transfer switch shall switch the load to the bypass output of the UPS. When the fault has cleared, the static bypass transfer switch shall return the load to the UPS system.
   8. If the battery is disconnected, the UPS shall supply power to the load from the normal supply with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:
   1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
   2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions described below without interrupting supply to the load during switching:
   1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
   2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
   3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance:
   1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
   2. Ambient Temperature for Battery: 41 to 95 deg F.
   3. Relative Humidity: Zero to 95 percent, noncondensing.
   4. Altitude: Sea level to 4000 feet.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL Compliance: Listed and labeled by an NRTL to comply with UL 1778.

C. NFPA Compliance: UPS components shall be listed and labeled by an NRTL as suitable for installation in computer rooms according to NFPA 75.

D. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:
   1. Inverter is switched to battery source.
   2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
   3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.

4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is 100 percent unbalanced continuously.

E. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is five minutes.

F. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10 percent and minus 15 percent from nominal voltage.

G. Overall UPS Efficiency: Equal to or greater than 95 percent at 100 percent load, 95 percent at 75 percent load, and 93 percent at 25 percent load.

H. Maximum Acoustical Noise: 65dBA, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 39 inches (1 meter) from nearest surface of component enclosure.

I. Maximum Energizing Inrush Current: Soft start linear input current rise to 100 percent over a 1- to 30-second period, factory set at 5 seconds.

J. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

K. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

L. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

M. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. Description: Rectifier-charger circuits shall limit THD to 10 percent, maximum, at 25% linear load; 5 percent, maximum, at 100% nonlinear load at rated full-load UPS current, and 3 percent, maximum, at 100% linear load, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.

N. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.

O. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 150 percent for 60 seconds in normal operation, and 150 percent for 60 seconds in battery operating mode.

P. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:
1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

Q. Input Power Factor: A minimum of 0.90 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

R. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging shall not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:
1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

S. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. APC by Schneider Electric.
2. Eaton.
3. Liebert; a brand of Emerson Electric Co..
4. Toshiba International Corporation.

C. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

D. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

E. Configuration: Multicabinet modular style units.

F. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

G. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

H. 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.

I. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

J. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

K. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.
   1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B.

2.5 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life. The battery charger shall be matched to the battery type supplied.

2.6 INVERTER

A. Description: Pulse-width modulated, IGBT with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.7 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: Plain-language messages on a digital LCD.
   1. Quantitative indications shall include the following:
      a. Input voltage, each phase, line to line.
      b. Input current, each phase, line to line.
      c. Bypass input voltage, each phase, line to line.
      d. Bypass input frequency.
      e. System output voltage, each phase, line to line.
      f. System output current, each phase.
      g. System output frequency.
      h. DC bus voltage.
      i. Battery current and direction (charge/discharge).
      j. Elapsed time discharging battery.
      k. Battery state of charge.
      l. Battery temperature, each battery string

m. Load real power (kW), total and percentage.
n. Load apparent power (kVA), total and percentage.
o. Load percentage of capacity.
p. Real time efficiency curve.
q. Crest Factor

2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.
3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Battery system alarm.
   h. Control power failure.
   i. Fan failure.
   j. UPS overload.
   k. Battery-charging control faulty.
   l. Input overvoltage or undervoltage.
   m. Input circuit breaker tripped.
   n. Input wrong-phase rotation.
   o. Input single-phase condition.
   p. Inverter fuse blown.
   q. Inverter output overvoltage or undervoltage.
   r. UPS overload shutdown.
   s. Inverter current sensor fault.
4. Controls shall include the following:
   a. Inverter on-off.
   b. UPS start and stop.
   c. Battery test.
   d. Alarm silence/reset.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer with a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load UPS current, minimum.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
2. Switch shall electrically isolate other UPS components to permit safe servicing.
3. Switch shall electrically isolate the rectifier-charger, inverter, and static bypass transfer switch from the load, but shall allow primary power to the UPS for testing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full-load UPS current.

D. Key interlock with key that is released only when the rectifier-charger and inverter are bypassed by the static bypass transfer switch. Key shall be required to unlock maintenance bypass/isolation switch before switching from open (normal) position to closed position. Lock shall be designed specifically for mechanical and electrical component interlocking.

2.10 BASIC BATTERY MONITORING

A. Description: Continuous, real-time capture of battery performance data.

B. Annunciation of Alarms: At UPS control panel and remotely.

2.11 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:
1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Report test results. Include the following data:
1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify installation conditions are representative of the conditions used in the coordination studies for the electrical system. Provide fuse protection according to Section 262813 "Fuses" if required for coordination with UPS overcurrent protective device requirements.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Division 3
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base 6 inches from the outer edge of the base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.3 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Separately Derived Systems: If part of a listed power supply for a data-processing room, comply with manufacturer's written instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

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 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Inspect interiors of enclosures, including the following:
      a. Inspect anchorage, alignment, grounding, and required clearances.
      b. Component type and labeling verification.
      c. Ratings of installed components.
   2. Test electrical and mechanical interlock systems for correct operation and sequencing.
   3. Test static transfer from inverter to bypass and back. Use normal load, if possible.
   4. Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
   5. Verify synchronizing indicators for static switch and bypass switches.
   6. Test insulated-case and molded-case breakers.
      a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 of NETA ATS.
      b. Perform insulation-resistance tests on all control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation.
      c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
      d. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.
      e. Verify operation of charging mechanism.
      f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.
   7. Test automatic transfer switches.
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, according to Section 7.22.3.1 of NETA ATS.
      b. Perform insulation-resistance tests on all control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
      c. Perform a contact/pole-resistance test.
      d. Verify settings and operation of control devices.

e. Calibrate and set all relays and timers according to Section 7.9 of NETA ATS.
f. Verify phase rotation, phasing, and synchronized operation as required by the application.
g. Perform automatic transfer tests.
    1) Simulate loss of normal power.
    2) Return to normal power.
    3) Simulate loss of emergency power.
    4) Simulate all forms of single-phase conditions.
h. Verify correct operation and timing of the following functions:
    1) Normal source voltage-sensing and frequency-sensing relays.
    2) Time delay on transfer.
    3) Alternative source voltage-sensing and frequency-sensing relays.
    4) Automatic transfer operation.
    5) Interlocks and limit switch function.
    6) Time delay and retransfer on normal power restoration.

8. Test direct current system's batteries.
    a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
    b. Verify all charger functions and alarms.
    c. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
    d. Perform a load test according to manufacturer's published data or IEEE 450.
    e. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
    f. Test values.
        1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        2) Charger float and equalize voltage levels shall be according to battery manufacturer's published data.
        3) The results of charger functions and alarms shall be according to manufacturer's published data.
        4) Cell voltages shall be within 0.05 V of each other or according to manufacturer's published data.
        5) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        6) Cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical cells that are in a fully charged state.
    g. Results of load tests shall be according to manufacturer's published data or IEEE 450.
9. Test communication of status and alarms to remote monitoring equipment.
10. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
    a. Test remote status and alarm panel functions.

b. Test battery-monitoring system functions.

C. Seismic-restraint tests and inspections shall include the following:
1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices according to requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. The UPS system will be considered defective if it does not pass tests and inspections.

E. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

F. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION

SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
      a. Surge suppression.
      b. Rectifier-charger.
      c. Inverter.
      d. Controls and indications.
      e. Static bypass transfer switch.
      f. External maintenance bypass/isolation switch.
      g. Output distribution section.
      h. Output isolation transformers.
      i. Remote status and alarm panels.
      j. Remote monitoring provisions.
      k. Battery and battery disconnect device.
      l. Battery monitoring.

B. Related Requirements:
   1. Section 260913, ELECTRICAL POWER MONITORING AND CONTROL-WWTP for interfacing communication and metering requirements.
   2. Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GTO: Gate turn-off thyristor.

C. IGBT: Isolated gate bipolar transistor.

D. LCD: Liquid-crystal display.

E. LED: Light-emitting diode.

F. NiCd: Nickel cadmium.

G. PC: Personal computer.

H. SPD: Surge protection device.

I. THD: Total harmonic distortion.

J. UPS: Uninterruptible power supply.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of UPS.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For UPS.
1. Include plans, elevations, sections, and mounting details.
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. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For UPS equipment, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Factory Test Reports: Comply with specified requirements.

C. Product Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

D. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For UPS units to include in emergency, 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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Cabinet Ventilation Filters: One complete set(s).

1.7 QUALITY ASSURANCE

A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.

1.8 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Lithium Ion Batteries: Equal to or greater than Four years from date of Substantial Completion.

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
   1. Special Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:
   1. Double Conversion, IGBT:
      a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. High-efficiency carrier stored trench IGBT, in both rectifier-charger and inverter circuits, provides a minimum of 96 percent efficiency for the UPS system at full load and a minimum of 94 percent efficiency at 50 percent load.
      b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to provide constant, regulated inverter power output to the load.
      c. Power Failure: If normal power fails, the rectifier-charger and inverter use energy from the battery to supply constant, regulated power output to the load without switching or disturbance.
   2. When power is restored at the normal supply terminals of the system, controls shall automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger shall supply power to the load through the inverter and simultaneously recharge the battery.
   3. If the battery becomes discharged and normal supply is available, the rectifier-charger shall charge the battery. The rectifier-charger shall automatically shift to float-charge mode on reaching full charge.
   4. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch shall switch the load to the normal ac supply circuit without disturbance or interruption.
   5. The output power converters shall produce up to 300 percent of rated full-load current for short-circuit clearing. The inverter shall sustain steady-state overload conditions of up to 150 percent of rated full-load current for 60 seconds in normal operation.
   6. The inverter shall be capable of sustaining 150 percent of system capacity for 60 seconds while powered from the battery.
   7. Should overloads persist past the time limitations, the automatic static transfer switch shall switch the load to the bypass output of the UPS. When the fault has cleared, the static bypass transfer switch shall return the load to the UPS system.
   8. If the battery is disconnected, the UPS shall supply power to the load from the normal supply with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:
   1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
   2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions described below without interrupting supply to the load during switching:
   1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
   2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
   3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance:
   1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
   2. Ambient Temperature for Battery: 41 to 95 deg F.
   3. Relative Humidity: Zero to 95 percent, noncondensing.
   4. Altitude: Sea level to 4000 feet.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL Compliance: Listed and labeled by an NRTL to comply with UL 1778.

C. NFPA Compliance: UPS components shall be listed and labeled by an NRTL as suitable for installation in computer rooms according to NFPA 75.

D. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:
   1. Inverter is switched to battery source.
   2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
   3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
   4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.

5. Load is 100 percent unbalanced continuously.

E. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is five minutes.

F. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10 percent and minus 15 percent from nominal voltage.

G. Overall UPS Efficiency: Equal to or greater than 95 percent at 100 percent load, 95 percent at 75 percent load, and 93 percent at 25 percent load.

H. Maximum Acoustical Noise: 65dBA, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 39 inches (1 meter) from nearest surface of component enclosure.

I. Maximum Energizing Inrush Current: Soft start linear input current rise to 100 percent over a 1- to 30-second period, factory set at 5 seconds.

J. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

K. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

L. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

M. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. Description: Rectifier-charger circuits shall limit THD to 10 percent, maximum, at 25% linear load; 5 percent, maximum, at 100% nonlinear load at rated full-load UPS current, and 3 percent, maximum, at 100% linear load, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.

N. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.

O. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 150 percent for 60 seconds in normal operation, and 150 percent for 60 seconds in battery operating mode.

P. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:
1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

Q. Input Power Factor: A minimum of 0.90 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

R. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging shall not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:
   1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
   2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
   3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
   4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

S. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. APC by Schneider Electric.
   2. Eaton.
   3. Liebert; a brand of Emerson Electric Co..
   4. Toshiba International Corporation.

C. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

D. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

E. Configuration: Multicabinet modular style units.

F. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

G. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

H. 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.

I. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

J. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

K. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B.

2.5 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life. The battery charger shall be matched to the battery type supplied.

2.6 INVERTER

A. Description: Pulse-width modulated, IGBT with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.7 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: Plain-language messages on a digital LCD.
   1. Quantitative indications shall include the following:
      a. Input voltage, each phase, line to line.
      b. Input current, each phase, line to line.
      c. Bypass input voltage, each phase, line to line.
      d. Bypass input frequency.
      e. System output voltage, each phase, line to line.
      f. System output current, each phase.
      g. System output frequency.
      h. DC bus voltage.
      i. Battery current and direction (charge/discharge).
      j. Elapsed time discharging battery.
      k. Battery state of charge.
      l. Battery temperature, each battery string
      m. Load real power (kW), total and percentage.
      n. Load apparent power (kVA), total and percentage.
      o. Load percentage of capacity.
      p. Real time efficiency curve.
      q. Crest Factor

2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.
3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Battery system alarm.
   h. Control power failure.
   i. Fan failure.
   j. UPS overload.
   k. Battery-charging control faulty.
   l. Input overvoltage or undervoltage.
   m. Input circuit breaker tripped.
   n. Input wrong-phase rotation.
   o. Input single-phase condition.
   p. Inverter fuse blown.
   q. Inverter output overvoltage or undervoltage.
   r. UPS overload shutdown.
   s. Inverter current sensor fault.
4. Controls shall include the following:
   a. Inverter on-off.
   b. UPS start and stop.
   c. Battery test.
   d. Alarm silence/reset.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer with a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load UPS current, minimum.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
   1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
   2. Switch shall electrically isolate other UPS components to permit safe servicing.
   3. Switch shall electrically isolate the rectifier-charger, inverter, and static bypass transfer switch from the load, but shall allow primary power to the UPS for testing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full-load UPS current.

D. Key interlock with key that is released only when the rectifier-charger and inverter are bypassed by the static bypass transfer switch. Key shall be required to unlock maintenance bypass/isolation switch before switching from open (normal) position to closed position. Lock shall be designed specifically for mechanical and electrical component interlocking.

2.10 BASIC BATTERY MONITORING

A. Description: Continuous, real-time capture of battery performance data.

B. Annunciation of Alarms: At UPS control panel and remotely.

2.11 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:
1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Report test results. Include the following data:
1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify installation conditions are representative of the conditions used in the coordination studies for the electrical system. Provide fuse protection according to Section 262813, FUSES-WWTP if required for coordination with UPS overcurrent protective device requirements.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Division 03
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base 6 inches from the outer edge of the base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.3 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

B. Separately Derived Systems: If part of a listed power supply for a data-processing room, comply with manufacturer's written instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

3.5 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Inspect interiors of enclosures, including the following:
      a. Inspect anchorage, alignment, grounding, and required clearances.
      b. Component type and labeling verification.
      c. Ratings of installed components.
   2. Test electrical and mechanical interlock systems for correct operation and sequencing.
   3. Test static transfer from inverter to bypass and back. Use normal load, if possible.
   4. Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
   5. Verify synchronizing indicators for static switch and bypass switches.
   6. Test insulated-case and molded-case breakers.
      a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 of NETA ATS.
      b. Perform insulation-resistance tests on all control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation.
      c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
      d. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.
      e. Verify operation of charging mechanism.
      f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.
   7. Test automatic transfer switches.
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, according to Section 7.22.3.1 of NETA ATS.
      b. Perform insulation-resistance tests on all control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
      c. Perform a contact/pole-resistance test.
      d. Verify settings and operation of control devices.
      e. Calibrate and set all relays and timers according to Section 7.9 of NETA ATS.
      f. Verify phase rotation, phasing, and synchronized operation as required by the application.

g. Perform automatic transfer tests.
   1) Simulate loss of normal power.
   2) Return to normal power.
   3) Simulate loss of emergency power.
   4) Simulate all forms of single-phase conditions.
h. Verify correct operation and timing of the following functions:
   1) Normal source voltage-sensing and frequency-sensing relays.
   2) Time delay on transfer.
   3) Alternative source voltage-sensing and frequency-sensing relays.
   4) Automatic transfer operation.
   5) Interlocks and limit switch function.
   6) Time delay and retransfer on normal power restoration.

8. Test direct current system's batteries.
   a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
   b. Verify all charger functions and alarms.
   c. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
   d. Perform a load test according to manufacturer's published data or IEEE 450.
   e. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
   f. Test values.
      1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Charger float and equalize voltage levels shall be according to battery manufacturer's published data.
      3) The results of charger functions and alarms shall be according to manufacturer's published data.
      4) Cell voltages shall be within 0.05 V of each other or according to manufacturer's published data.
      5) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      6) Cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical cells that are in a fully charged state.
   g. Results of load tests shall be according to manufacturer's published data or IEEE 450.
9. Test communication of status and alarms to remote monitoring equipment.
10. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
    a. Test remote status and alarm panel functions.
    b. Test battery-monitoring system functions.

C. Seismic-restraint tests and inspections shall include the following:
   1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
   2. Test mounting and anchorage devices according to requirements in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.

D. The UPS system will be considered defective if it does not pass tests and inspections.

E. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

F. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:
1. Section 260573.13"Overcurrent Protective Device Short-Circuit Study", Section 260573.16 "Overcurrent Protective Device Coordination Study", and Section 260573.19"Overcurrent Protective Device Arc-Flash study" for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
3. Section 262313 "Paralleling Low-voltage Switchgear" for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.
4. Section 263213 "Engine Generators" for source limitations and interfacing systems.

1.2 ACTION SUBMITTALS

A. Coordination of Submittals: Include preliminary power system studies with submittal or submit to Architect prior to submittal. Refer to Section 260573.13 and 260573.16 for additional requirements. Transfer switches submitted prior to preliminary power system studies will be returned without review.

B. 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.

C. Shop Drawings:
1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. 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.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative.

B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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 QUALITY ASSURANCE

A. Testing Qualifications:
   1. Member company of NETA.
      a. Testing Field Supervisor: Certified by NETA to supervise on-site testing.

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: Match Generator warranty.

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 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. 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.

G. 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 3 cycles.

H. 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.

I. 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.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

L. Battery Charger: For generator starting batteries.
1. Float type, rated 10 A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

M. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

N. 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 rear and front access.

O. 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, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. ASCO Power Technologies.
4. Russelectric, Inc.

B. Source Limitations: The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double throw; mechanically held in both directions.

2. 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.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Compression type.
6. Ground Lugs and Bus-Configured Terminators: Compression type.
7. Connectors shall be marked for conductor size and type according to UL 1008.

E. 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.

F. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

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. 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.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

J. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
    a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.

b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
g. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
j. Load shed relay.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. 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.
4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciation and Control System:
1. Remote annunciation and control shall be by the multiple-generator and PV paralleling microgrid monitoring control system. See Section "262313 Paralleling Low-voltage Switchgear" and Section "260913 Electrical Power Monitoring and Control" for annunciation, control and graphics requirements.
2. Include the following functions for indicated transfer switches:
a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Indication of switch position.

c. Indication of switch in test mode.
d. Indication of failure of digital communication link.
e. Key-switch or user-code access to control functions of panel.
f. `Control of switch-test initiation.
g. Control of switch operation in either direction.
h. Control of time-delay bypass for transfer to normal source.
i. General alarm.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

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 and each systems branch indicated on Drawings. 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.
m. Receptacle withstand capability.
n. Insulating base and supports damage.

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 Division 3.
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
1. Connect signal-before-transfer contacts to elevator controllers where applicable.

B. 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."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

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."

F. Connect twisted pair cable according to manufacturer's installation instructions.

G. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

H. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

I. 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.
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 PV and run them concurrently.

C. Test sequence of operation step by step for each mode.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. 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

SECTION 263600 - TRANSFER SWITCHES - WWTP

PART 1 - GENERAL

1.1 SUMMARY

A. Related Requirements:
1. Section 260573.13, OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY-WWTP, Section 260573.16, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY-WWTP, and Section 260573.19, OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY-WWTP for power study performance requirements for equipment ratings and component adjusting.
2. Section 260913, ELECTRICAL POWER MONITORING AND CONTROL-WWTP for interfacing communication and metering requirements.
3. Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR for remote management of circuit breakers and for interfacing communication, monitoring, and metering requirements.
4. Section 263213, ENGINE GENERATORS-WWTP for source limitations and interfacing systems.

1.2 ACTION SUBMITTALS

A. Coordination of Submittals: Include preliminary power system studies with submittal or submit to Architect prior to submittal. Refer to Section 260573.13-WWTP and 260573.16-WWTP for additional requirements. Transfer switches submitted prior to preliminary power system studies will be returned without review.

B. 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.

C. Shop Drawings:
1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. 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.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative.

B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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 QUALITY ASSURANCE

A. Testing Qualifications:
   1. Member company of NETA.
      a. Testing Field Supervisor: Certified by NETA to supervise on-site testing.

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: Match Generator warranty.

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 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. 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.

G. 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 3 cycles.

H. 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.

I. 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.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. 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-WWTP.
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 rear and front access.

N. 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, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. ASCO Power Technologies.
4. Russelectric, Inc.

B. Source Limitations: The transfer switches shall be by the same supplier as engine generators and paralleling switchgear.

C. Comply with Level 1 equipment according to NFPA 110.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double throw; mechanically held in both directions.
2. 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.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Compression type.

6. Ground Lugs and Bus-Configured Terminators: Compression type.
7. Connectors shall be marked for conductor size and type according to UL 1008.

E. 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.

F. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

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. 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.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

J. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
    a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
    b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
    c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
    d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.

e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
g. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
j. Load shed relay.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. 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.
4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciation and Control System:
1. Remote annunciation and control shall be by the multiple-generator and PV paralleling microgrid monitoring control system. See Section 262313, PARALLELING LOW-VOLTAGE SWITCHGEAR and Section 260913, ELECTRICAL POWER MONITORING AND CONTROL-WWTP for annunciation, control and graphics requirements.
2. Include the following functions for indicated transfer switches:
a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Indication of switch position.
c. Indication of switch in test mode.
d. Indication of failure of digital communication link.
e. Key-switch or user-code access to control functions of panel.
f. `Control of switch-test initiation.
g. Control of switch operation in either direction.
h. Control of time-delay bypass for transfer to normal source.
i. General alarm.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

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 and each systems branch indicated on Drawings. 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.
      m. Receptacle withstand capability.
      n. Insulating base and supports damage.

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 Division 3.
   2. Comply with requirements for seismic control devices specified in Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.
   3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
   4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
   1. Connect signal-before-transfer contacts to elevator controllers where applicable.

B. 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-WWTP.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.

E. Connect wiring according to Section 260519, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES-WWTP.

F. Connect twisted pair cable according to manufacturer's installation instructions.

G. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

H. Brace and support equipment according to Section 260548.16, SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS-WWTP.

I. 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.

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 PV and run them concurrently.

C. Test sequence of operation step by step for each mode.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. 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

SECTION 263650 - GENERATOR DOCKING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes generator docking stations (also referred to as quick-connect panels) rated 600V and less.

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 plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Include material lists for each switch specified.
   3. Single-Line Diagram: Show connections between permanent generator, load bank, temporary generator, automatic transfer switch. Show interlocking provisions as specified.
   4. Riser Diagram: Show interconnection wiring between docking station, remote transfer switches, power sources, power distribution equipment, remote start contacts, remote alarm and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operations and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

C. Comply with NFPA 110.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

A. The equipment installed under this contract shall be left in proper working order.

B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.1 GENERATOR DOCKING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trystar
2. ASCO
3. Eaton
4. ESL Power Systems

2.2 GENERAL REQUIREMENTS

A. Unit shall be three-way, capable of temporary generator or temporary load bank connection.

B. Docking station shall include 16 Series Camlok Panel Mounts for use as connection to Portable Generator and/or Temporary Load Bank as indicated on Drawings.

C. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

D. Enclosures:
1. NEMA 3R enclosure.
   a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA integrity shall be maintained with access plate open for cable entry.
   b. Front and side through a front access panel shall be accessible for maintenance.
   c. Top, side, and bottom through a front access panel shall be accessible for permanent cabling.
2. Finishes:
   a. Paint after fabrication. Powder coated manufacturer's standard grey.

E. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated or Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Ground Bus: 50% of phase size.
4. Neutral Bus: Neutral bus rated 100 percent of phase bus.

F. Temporary generator connectors shall be Camlok style mounted on gland plate.
1. Camlok shall be color coded according to system voltage
   a. A phase: Black (208/120V) or Brown (480/277V)
   b. B phase: Red (208/120V) or Orange (480/277V)
   c. C phase: Blue (208/120V) or Yellow (480/277V)
   d. N Neutral: White
   e. G Ground: Green

G. Temporary load bank connectors shall be Camlok style mounted on gland plate.
1. Camlok shall be color coded according to system voltage

a. A phase: Black (208/120V) or Brown (480/277V)
b. B phase: Red (208/120V) or Orange (480/277V)
c. C phase: Blue (208/120V) or Yellow (480/277V)
d. G Ground: Green

H. Temporary connectors shall include protective flip lids to prevent accidental contact.

I. Permanent connectors shall be broad range set-screw type, located behind an aluminum barrier.

J. Short Circuit & Withstand Rating
1. 65kAIC minimum, unless otherwise indicated on drawings.

K. Voltage:
1. As indicated on Drawings

L. Current Rating:
1. As indicated on Drawings.

M. Phase Rotation Monitor Device:
1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal.

N. Circuit Breakers:
1. UL 489 Listed
2. Circuit breakers shall be removable for service and maintenance
3. Circuit breakers rated 1200A or greater shall contain a maintenance mode switch which complies with NFPA 70 Article 240 arc energy reduction requirements. The maintenance mode switch shall temporarily modifiy the trip settings of the circuit breaker to reduce the available arc energy downstream of the circuit breaker.
4. Circuit breakers for load bank connectors shall have a shunt trip coil, and shall be wired to trip the circuit breaker when a start signal is received from the transfer switch.

O. Additional accessories shall be included in submittal drawings as follows:
1. Two-wire auto-start
2. Battery charger receptacle, NEMA 5-20R, GFCI
3. Block heater receptacle
4. Extra-depth for bottom conduit entry.
5. Kirk key door interlock
6. Surge protection device
7. Utility light.
8. Alarm contacts to indicate that the permanent emergency source is disconnected from the emergency system. Contacts shall change state when the generator feed circuit breaker is in the open position.
9. SCADA input connection

2.3 ALARM PANEL

A. Description: Annunciator/alarm panel to indicate that the permanent emergency source is disconnected from the emergency system

B. Features:
1. Enclosure: Steel, flush or surface mountable
2. Indicating Light: Red LED
3. Buzzer

4. Silence Button
5. Operating Voltage: 120VAC

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.

3.2 INSTALLATION

A. Surface, Flush or Base Mounted: Determined by Application
   1. Concrete bases: 4 inches high above finished grade, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of the enclosure. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems." Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

B. Power Wiring: Make connections to power distribution system as indicated on Drawings. Install wiring as required by Section 260519: "Low Voltage Power Conductors and Cables."

C. Control Wiring: Install wiring as required by Section 260519: "Low Voltage Power Conductors and Cables."
   1. Start Circuit: Provide 2-wire start circuit wiring to the emergency system transfer switch(es) for installations where the generator docking station is connected to the emergency power system. Terminate 2-wire start circuit wiring at a terminal block inside generator docking station and label "Generator Start Circuit."
   2. Alarm Panel: Provide wiring from the docking station to the alarm panel. Where the alarm panel requires an external power source, provide a dedicated 120V circuit from a spare circuit breaker in the nearest panelboard.

3.3 FIELD QUALITY CONTROL

A. 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 test and inspection results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes lightning protection system for ordinary structures.

B. Section includes lightning protection system for the following:
   1. All buildings shown on the Plans as required. rdinary structures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
   2. Include raceway locations needed for the installation of conductors.
   3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
   4. Include roof attachment details, coordinated with roof installation.
   5. Calculations required by NFPA 780 for bonding of metal bodies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Lightning protection cabling attachments to roofing systems and accessories.
   2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
   3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
      b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:
   1. UL Master Label Certificate.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ERICO International Corporation.
   2. Hicks Lightning Protection.
   3. Thompson Lightning Protection, Inc.
   4. Insert manufacturer's name.

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I or Class II buildings as required by building height.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I or Class II buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:
   1. Copper unless otherwise indicated.
   2. 5/8-inch diameter by 15 inches long.
   3. Pointed tip.
   4. Threaded base support.

B. Air Terminal Bracing:
   1. Copper.
   2. 1/4-inch diameter rod.

C. Class 1 Main Conductors:
   1. Stranded Copper: 57,400 circular mils in diameter.

D. Class II Main Conductors:
   1. Stranded Copper: 115,000 circular mils in diameter.

E. Secondary Conductors:
   1. Stranded Copper: 26,240 circular mils in diameter.

F. Ground Loop Conductor: Stranded copper.

G. Ground Rods:
   1. Material: Solid copper.
   2. Diameter: 3/4 inch.
   3. Rods shall be not less than 120 inches long.
   4. Sectional type, with integral threads.

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A or concealed systems in NFPA 780.
   1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
   2. Install conduit where necessary to comply with conductor concealment requirements.
   3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: Exothermic weld.

C. 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.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION

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.

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.
   2. Eaton Corporation.
   3. Schneider Electric Industries SAS.
   4. 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 115 percent of the nominal system voltage.

2.3 SERVICE ENTRANCE 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 400 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. SCCR: Equal or exceed 150 kA.

E. Inominal Rating: 20 kA.

2.4 PANEL SUPPRESSORS

A. SPDs: Comply with UL 1449, Type 2.

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.

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 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.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS - WWTP

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-WWTP for factory-installed SPDs.
   2. Section 262416, PANELBOARDS-WWTP 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.

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.
   2. Eaton Corporation.
   3. Schneider Electric Industries SAS.
   4. 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 115 percent of the nominal system voltage.

2.3 SERVICE ENTRANCE 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 400 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. SCCR: Equal or exceed 150 kA.

E. Inominal Rating: 20 kA.

2.4 PANEL SUPPRESSORS

A. SPDs: Comply with UL 1449, Type 2.

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.

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-WWTP.

3.2 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.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LED: Light-emitting diode.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. L70: Point in time where light fixture lumen output is 70% of initial light output.

H. McAdams Ellipses: Color consistency of LED's from chip to chip.

1.2 SUBMITTALS

A. Substitutions are permitted but must be of equal aesthetic and performance subject to Engineer approval via supplier provided submittal and calculation evaluation . Calculations shall be completed to IES industry standards in Lighting Analysts AGI-32 software.

B. Product Data: For each type of lighting fixture, arranged in order of fixture designation as listed on the fixture schedule. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Ballast, including BF.
   3. Energy-efficiency data.
   4. Lamp data: rated life, lumen output, CCT, CRI and wattage.
   5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
   6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

C. Photometric Data Submittals
   1. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for the following lighting fixture types. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   2. Include the following in the photometric report:

a. List the measured candela values of the photometric distribution in at least three planes, except in the case of an axially symmetrical lighting fixture. Candela curves, lux (footcandle) and lumen tables, and iso-lux (iso-footcandle) contours are not acceptable.
b. List the type of lamps, ballasts, and lighting control devices, such as lenses and louvers, used with the tested lighting fixture.

D. Shop Drawings: For nonstandard or custom lighting fixtures as indicated on the fixture schule. Include plans, elevations, sections, details, and attachments to other work.
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. Wiring Diagrams: For power, signal, and control wiring.

E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

F. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. 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, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. 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.

D. Comply with NFPA 70.

E. Provide fixtures U.L. listed and labeled for the application.

F. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.4 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.5 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Special Warranty for LED Lighting Fixtures: Manufacturer's standard form in which manufacturer of lightingfixture agrees to repair or replace components, including driver/power supplies and thermal management, that fail in materials or workmanship within five years date of substatial completion.

1.6 EXTRA MATERIALS

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: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Emergency battery pack: One for every 20 emergency lighting unit.
4. LED Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 ALLOWANCES

A. Extra Fixtures
1. Provide an additional 25 exit signs, of each type scheduled above what is indicated on the drawings. Include for each of the extra units, installation of 75 feet of conduit and wire, and connection to the emergency system.
2. Install devices at locations to be determined by the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product by manufacturers indicated on Drawings and specified.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. LED Fixtures: Minimum rated lifetime of L70 at 50,000 hours based on IES LM-79 testing; passive thermal management only unless otherwise indicared.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
      b. Distribution: as indicated
      c. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.

H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LED MODULES/BOARDS

A. Minimum rated lifetime of L70 at 50,000 hours based on IES LM-80 testing; 4-step McAdams Ellipse maximum color consistency unless otherwise indicated; 80 CRI minimum unless otherwise indicated.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: As shown in Drawings. Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.Provide as specified on the Drawings.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   6. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
   7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.2 CLEANING

A. Clean interior surfaces of lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints, smudges, and other marks from lenses, louvers, and reflecting surfaces. Leave free of visible marks.

3.3 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.
   2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
   3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING - WWTP

PART 1 - GENERAL

1.1 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LED: Light-emitting diode.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. L70: Point in time where light fixture lumen output is 70% of initial light output.

H. McAdams Ellipses: Color consistency of LED's from chip to chip.

1.2 SUBMITTALS

A. Substitutions are permitted but must be of equal aesthetic and performance subject to Engineer approval via supplier provided submittal and calculation evaluation . Calculations shall be completed to IES industry standards in Lighting Analysts AGI-32 software.

B. Product Data: For each type of lighting fixture, arranged in order of fixture designation as listed on the fixture schedule. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Ballast, including BF.
   3. Energy-efficiency data.
   4. Lamp data: rated life, lumen output, CCT, CRI and wattage.
   5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
   6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

C. Photometric Data Submittals
   1. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for the following lighting fixture types. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   2. Include the following in the photometric report:

a. List the measured candela values of the photometric distribution in at least three planes, except in the case of an axially symmetrical lighting fixture. Candela curves, lux (footcandle) and lumen tables, and iso-lux (iso-footcandle) contours are not acceptable.
b. List the type of lamps, ballasts, and lighting control devices, such as lenses and louvers, used with the tested lighting fixture.

D. Shop Drawings: For nonstandard or custom lighting fixtures as indicated on the fixture schule. Include plans, elevations, sections, details, and attachments to other work.
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. Wiring Diagrams: For power, signal, and control wiring.

E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

F. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. 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, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. 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.

D. Comply with NFPA 70.

E. Provide fixtures U.L. listed and labeled for the application.

F. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.4 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.5 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Special Warranty for LED Lighting Fixtures: Manufacturer's standard form in which manufacturer of lightingfixture agrees to repair or replace components, including driver/power supplies and thermal management, that fail in materials or workmanship within five years date of substatial completion.

1.6 EXTRA MATERIALS

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: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Emergency battery pack: One for every 20 emergency lighting unit.
4. LED Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 ALLOWANCES

A. Extra Fixtures
1. Provide an additional 25 exit signs, of each type scheduled above what is indicated on the drawings. Include for each of the extra units, installation of 75 feet of conduit and wire, and connection to the emergency system.
2. Install devices at locations to be determined by the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product by manufacturers indicated on Drawings and specified.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. LED Fixtures: Minimum rated lifetime of L70 at 50,000 hours based on IES LM-79 testing; passive thermal management only unless otherwise indicared.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
      b. Distribution: as indicated
      c. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.

H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LED MODULES/BOARDS

A. Minimum rated lifetime of L70 at 50,000 hours based on IES LM-80 testing; 4-step McAdams Ellipse maximum color consistency unless otherwise indicated; 80 CRI minimum unless otherwise indicated.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: As shown in Drawings. Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.Provide as specified on the Drawings.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   6. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
   7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553, IDENTIFICATION FOR ELECTRICAL SYSTEMS-WWTP.

3.2 CLEANING

A. Clean interior surfaces of lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints, smudges, and other marks from lenses, louvers, and reflecting surfaces. Leave free of visible marks.

3.3 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.
   2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
   3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

1.2 Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
   1. Lamps, including life, output (lumens, CCT, and CRI) and energy-efficiency data.
   2. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.
      a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficiency Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independant testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   3. Wiring diagrams for power, control, and signal wiring.
   4. Photoelectric relays.
   5. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings:
   1. For nonstandard or custom luminaires.
      a. Include plans, elevations, sections, and mounting and attachment details.
      b. Include details of luminaire assemblies. Include dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      c. Include diagrams for power, signal, and control wiring.
   2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.3 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.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective cover prior to shipping.

1.6 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of the luminaire installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, 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. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Internal driver.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. L70 lamp life of 50,000 hours.

K. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

L. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

M. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

N. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

O. 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.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in structural drawings.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03.

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

2.4 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: As specified on the Drawings. .
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: As specified on the Drawings , continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless -steel bolts.
2. Cross Section: As specified on the Drawings, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
a. Color: As shown on Drawings and confirmed by architect from manufacturers full range.

2.5 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet
   3. Trees: 5 feet from mature drip edge of tree.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03.

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top as detailed in the Plans above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top as detailed in Plans above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03.

B. Remote Mounting of Drivers/Power Supplies: Do not exceed the manufacturer's recommended maximum distance between the fixture and the driver/power supply.

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 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.
   2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
   3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING - WWTP

PART 1 - GENERAL

1.1 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

1.2 Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
   1. Lamps, including life, output (lumens, CCT, and CRI) and energy-efficiency data.
   2. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.
      a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficiency Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independant testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   3. Wiring diagrams for power, control, and signal wiring.
   4. Photoelectric relays.
   5. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings:
   1. For nonstandard or custom luminaires.
      a. Include plans, elevations, sections, and mounting and attachment details.
      b. Include details of luminaire assemblies. Include dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      c. Include diagrams for power, signal, and control wiring.
   2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.3 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.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective cover prior to shipping.

1.6 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of the luminaire installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, 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. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Internal driver.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. L70 lamp life of 50,000 hours.

K. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

L. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

M. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

N. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

O. 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.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in structural drawings.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03.

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

2.4 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.
1. Shape: As specified on the Drawings. .

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: As specified on the Drawings , continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless -steel bolts.
2. Cross Section: As specified on the Drawings, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
a. Color: As shown on Drawings and confirmed by architect from manufacturers full range.

2.5 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet
   3. Trees: 5 feet from mature drip edge of tree.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03.

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top as detailed in the Plans above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top as detailed in Plans above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03.

B. Remote Mounting of Drivers/Power Supplies: Do not exceed the manufacturer's recommended maximum distance between the fixture and the driver/power supply.

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-WWTP. In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS-WWTP.
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.
   2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
   3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 270413 - COMMON SUBMITTAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes supplementary administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals specific to the work of this Division.

B. Related Requirements:
   1. Division 01 requirements for warranty, trainings, and general requirements.

C. Manufacturers
   1. Unless otherwise noted, all telecommunications systems have manufacturers listed. The contractor is permitted to propose a substitution for an equivalent product.

D. System Integration Scope
   1. Contractor shall engage a master systems integrator for division 27 and 28 scopes of work. Contractor to include 1 FTE Support on Site for a two-week duration to assist with any training and operations support, starting from occupancy date. This scope of services is separate from and does not include the training and commissioning requirements identified in these specifications.
   2. Contractor to include scope and pricing for a professional quality video recording of the various training sessions referenced throughout and handover to IHS prior to project completion.

E. Warranty
   1. For all products and services included in Division 27 and 28 specifications, Contractor to include 1-year warranty and provide pricing for the same warranty services during years 2-5, broken out by year with pricing valid 1 year from project completion. IHS to advise on years 2-5 warranty procurement prior to the end of the 1-year period after project completion.

1.2 DEFINITIONS

A. Contractor: Refers to an entity in direct Contract with the Owner to furnish and/or perform any portion of the Work of the Contract, including but not limited to a Construction Manager.
   1. Contractor shall review and approve Product Submittals prior to forwarding them to the Architect.

B. Product Submittals: In general, Product Submittals show characteristics of the proposed construction in one of the following forms:
   1. Shop Drawings.
   2. Product Data.
   3. Samples.

C. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

D. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

E. Submittal Review Sheet: Specific form required to accompany each submittal. Obtain Submittal Review Sheet from the SmithGroup Project Manager.

1.3 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Requirements specified for submittals are intended to provide efficient handling, while permitting review responsibilities to be carried out.

B. Avoidable Resubmittals: The first two reviews of each specified submittal will be processed without cost to the Contractor. After the second review, the Owner may charge the Contractor for the cost of such additional processing, unless the processing results from approved Change Orders causing revisions to previously approved submittals.

C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
   4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   1. Initial Review: Allow 10 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required.
   2. When a large volume of submittal materials is scheduled, additional review time may be required. Similarly, a particular submittal may require review completion in less than the agreed normal time. Due to variations in submittal volume and processing needs, agreed review time is not intended to apply to extreme conditions.
   3. Resubmittal Review: Allow 10 business days for review of each resubmittal.
   4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow **15** business days for initial review of each submittal.

E. Maintain at the Project Site ready access to the latest reviewed Shop Drawings and Product Data, and one set of samples.

1.4 DELEGATED-DESIGN SERVICES

A. Definitions:
   1. Delegated Design: A portion or component of the Work identified by the Contract Documents to be designed by the Contractor, or an entity assigned by the Contractor, to satisfy performance and design criteria specified in the Contract Documents for that portion or component.
   2. Registered Design Professional: Design professional, assigned by the Contractor, who is responsible for providing the delegated design work, and for certifying that the work is in compliance with the specified performance requirements and design criteria. Design professional shall be legally qualified to practice in jurisdiction where Project is located and shall be experienced in providing delegated design services of the kind indicated. Delegated design services are defined as those performed for installation of the system, assembly or product that are similar in material, design, and extent to those indicated for this Project.

B. 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 Architect.

C. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file copies of certificate, 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.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Combine with Submittal Review Sheet before submitting to Architect.

1. Submittal Compliance Form: Allowed in lieu of some product data and sample submittals. See individual specification sections for specific allowable use. By submitting the form, the Contractor certifies that all products specified in the Section are being submitted exactly as indicated, including all options and features indicated, with no substitutions or comparable products. Where a Basis-of-Design manufacturer/product is indicated, along with a list of other manufacturers, the Contractor certifies that only the Basis-of-Design manufacturer/product will be provided and not any other listed manufacturers/products. Where a single manufacturer/product is indicated, even if specified as "available manufacturer" or manufacturer "included but not limited to the following", Contractor certifies that only the indicated single manufacturer/product will be provided.
    a. Obtain a copy of the Submittal Compliance Form from the Architect, fill in the information required and include as a line item on the Submittal Cover Sheet for each applicable Submittal.
    b. Upon receipt, the Architect will complete the form in the space below "Architect Action" and indicate the Action on the Submittal Cover Sheet.

B. Project Closeout and Maintenance Material Submittals: See requirements in Division 01.

C. Be responsible for quantities, weights, and dimensions to be confirmed and correlated at the site; for information that pertains solely to the fabrication processes and to the means, methods, techniques, sequences, and procedures of construction; and for coordination of the work of every trade, supplier, and subcontractor.

D. Be responsible for each submittal to be in conformance with information given and the design intent expressed in the Contract Documents.

E. Provide with each submittal specific written notice of any variation from the requirements of the Contract Documents by causing a specific notation to be made on the Submittal Review Sheet and Submittal Transmittal.

3.2 ARCHITECT'S AND GENERAL CONTRACTOR'S ACTION

A. General: Architect will not review submittals that do not include the Submittal Review Sheet.

B. Action Submittals: Architect's staff and consultants will review the submittal, and mark the Submittal Review Sheet with an action code. The code meanings are described below.

C. Additional codes may be provided within comments or as an electronic submittal review stamp and shall be used in help indicating return of partial submittals.

D. The Final Review Code on the Submittal Review Sheet prevails and governs the action of the overall submittal.

E. Review Code meanings are as follows:
1. Action Codes Permitting Use:
    a. When an action code permitting use is assigned to a submittal, it does not authorize work that does not comply with the requirements of the Contract Documents. Acceptance of the Work will depend on compliance.

b. Code AP - Approved: The Work covered by the submittal item may proceed, provided it complies with Contract Document requirements.
c. Code AN - Approved as Noted: The Work covered by the submittal item may proceed, provided it complies with the Architect's notations and Contract Document requirements.
d. Code AN-R - Approved as Noted - Resubmit: Do not deliver or install the related work until the resubmittal has received Code AP or AN. However, fabrication and other off-site work covered by the submittal item may proceed, at the Contractor's risk, provided it complies with the Architect's notations and Contract Document requirements.

2. Action Code Prohibiting Use:
   a. Action Code REJ - Not Approved: The Work covered by the submittal item, including purchasing, fabrication, delivery, and other activity, shall not proceed. Revise the submittal item or prepare a new item in accordance with the Architect's notations. Resubmit the corrected or new item without delay; do not permit submittal items marked "Not Approved" to be used. Work incorporating such items will be rejected.
3. Action Code for Items Not Required:
   a. Action Code X - Not Requested by Contract Documents: The submittal item is not called for by the Contract Documents and is being returned unreviewed by the Architect except to the extent necessary to determine its status.

F. Informational Submittals: For Architect's information only. Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
1. Action Code for Information Only:
   a. Action Code INF - Information Only - Received: The submittal item is not called for a return with a reviewed action code by the Contract Documents and is being returned un-reviewed by the Architect except to the extent necessary to determine its status.

G. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

H. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.

I. Architect will return without review submittals received from sources other than the Contractor.

J. Submittals not required by the Contract Documents may be returned by the Architect without action.
1. Do not submit Material Safety Data Sheets. They will be returned without review.

3.3 SUBMITTAL TRANSMITTAL REQUIREMENTS

A. Submittal Transmittal shall be a PDF file in electronic format. It is recommended, to expedite the submittal review, the electronic form be emailed for review to the Architect as early as possible.
1. Submittal Numbering: See below.
2. Contact Information: Full Name, Phone Number and Email Address.

B. Submittal Definition
   1. Each submittal consists of items from only ONE Specifications section.
   2. Complete Submittal: If ALL the items required by the Specifications section are listed on one Submittal Form (including continuation sheet), it is a complete submittal.
   3. Partial Submittals: If it is necessary to divide the required items of a given Specifications section into two or more submittals to meet schedule or handling requirements, the separate submittals are partial submittals. All partial submittals have the same submittal number, and are differentiated by sequential P-numbers (see below).
   4. All items in each submittal, whether complete or partial, will be processed together: Individual items will not be 'broken out' for special handling. Arrange submittals accordingly.

C. Submittal Numbering
   1. Number submittals as described below to assist tracking.
   2. Number each submittal in the format nnnnnn-nn.
      a. The 6-digit number is the number of the section that requires the submittal. For example, 044200.
      b. The 2-digit number is based on the numerical sequence of submittals from that section. In other words, for each section, the first submittal is 01, the second is 02, and so on. The 2-digit number does not change for partial or re-submittals, so that the submittal can be tracked.
      c. P-Number for Partial Submittals: Number each partial submittal in the pee space, beginning with P1, and increasing by one for each partial submittal of that submittal. If the submittal is a complete submittal, leave the P space blank.
      d. R-Number for Re-submittals: Number each re-submittal in the arr space, beginning with R1, and increasing by one for each re-submittal of that submittal. Do not include an R-Number for the initial submittal.
      e. Examples:
         1) Initial Complete Submittal: 044200-01. First Re-Submittal: 044200-01-R1.
         2) Initial Partial Submittal: 044200-01-P1. Second Partial Submittal: 0044200-01-P2. First Re-submittal of Second Partial Submittal: 044200-R1-P2.

3.4 SUBMITTAL REVIEW SHEET REQUIREMENTS

A. Provide Submittal Review Sheet in PDF format. Submit as the page after the Submittal Transmittal.

B. When attached, the Submittal Review Sheet shall not obscure information contained in the submittal.

C. Do not edit any of the information contained within the Submittal Review Sheet except as follows:
   1. Submittal Number: See Submittal Numbering in Submittal Transmittal Requirements paragraph.

D. The Contractor shall submit the PDF file in a manner that will allow editing of the Submittal Review Sheet fields by SmithGroup and its consultants.

END OF SECTION

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.
   4. Grounding rods.
   5. Grounding labeling.

1.2 RELATED DOUMENTS

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

B. This section is inclusive of all Division 27 sections.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TBB: Telecommunications bonding backbone.

D. SBB: Secondary bonding busbar.

E. PBB: Primary bonding busbar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans showing equipment locations, elevations, conductor routing, riser diagram, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: As-Built Drawings showing final locations of grounding and bonding infrastructure, including the following:
   1. Ground rods.
   2. Ground and roof rings.
   3. BCT, PBB, SBBs, and routing of associated bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each SBB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of ITS Installer 2 who shall be present at all times when Work of this Section is performed at Project site.
   2. Field Inspector: Currently registered by BICSI as a Registered Communications Distribution Designer (RCDD) to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with ANSI/TIA-607-D, Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises.

2.2 CONDUCTORS

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. Harger Lightning and Grounding
   2. Panduit Corp
   3. Tyco Electronics Corp

B. Comply with UL 486A-486B.

C. Insulated Conductors:
   1. Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
   2. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
   3. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:
   1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:
   1. Solid Conductors: Comply with ASTM B 3.
   2. Stranded Conductors: Comply with ASTM B 8.
   3. Tinned Conductors: Comply with ASTM B 33.
   4. Bonding Conductor sizing: Refer to Part-3 Execution within for sizing requirements.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

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. B-Line Systems.
   2. Burndy Corp.
   3. Chatsworth Products.
   4. Harger Lightning and Grounding.
   5. Panduit Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
   1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inchcenters for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

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 Systems
   2. Burndy Corp
   3. Chatsworth Products
   4. Harger Lightning and Grounding
   5. Panduit Corp

B. PBB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inchesin cross section, 24" in length. The busbar shall be NRTL listed for use as PBB and shall comply with Generic Telecommunications Bonding and Grounding for Customer Premise.
   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide a 4-inchclearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
   3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. SBB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, 20" in length. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with Generic Telecommunications Bonding and Grounding for Customer Premise.
   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide at least a 2-inchclearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
   3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with Generic Telecommunications Bonding and Grounding for Customer Premise. Predrilling shall be with holes for use with lugs specified in this Section.
   1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
   2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
   3. Rack-Mounted Vertical Busbar: 36 inchesong, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Ground Rods: Where required, Copper-clad steel, sectional; 3/4 inch by 10 feet, or as indicated on the contract Drawings.

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. Harger Lightning and Grounding
   2. Tyco Electronics Corp

C. Refer to Section 260526 Grounding and Bonding for Electrical Systems, for information and requirements of the grounding electrode system for the alternating-current (ac) power system.

2.6 LABELING

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. Brother International Corp
   2. HellermannTyton
   3. Panduit Corp

B. Comply with TIA/EIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with the latest revision of the following:
1. ANSI/TIA-607-D: Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises.
2. ANSI/IEEE Std C2: 2007 National Electrical Safety Code (NESC).
3. ANSI/IEEE Std 1100-2005: Recommended Practice for Powering and Grounding Electronic Equipment.
4. ANSI/NFPA-70: 2011 National Electrical Code (NEC).
5. ANSI/TIA-606-D: Administration Standard for Telecommunications Infrastructure.
6. NECA/BICSI 607-2011: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
7. Applicable local Codes, Regulations, or Ordinances.

C. Where conflict may exist, NEC and applicable local Codes or Ordinances take precedence over low-voltage cabling Standards. Contractor is responsible make Architect aware of any conflicts between project documents and referenced codes or standards, prior to work. Contractor is responsible to remedy field installed code violations at Contractor's expense.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. 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.

D. Conductor Support:
1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:
1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inchintervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
   a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a SBB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the PBB and the ac service equipment ground shall not be smaller than No. 1/0 (BCT length up to 52 feet), and not smaller than No. 3/0 (if BCT length is longer than 52 feet). Where specifically indicated on contract Drawings, BCT size indication on the Drawings shall dictate.

3.5 GROUNDING BUSBARS

A. Within telecommunications rooms, install busbars horizontally, on insulated spacers 2 inches minimum from wall. Locate 12 inchesabove finished floor, unless otherwise indicated on contract Drawings.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the PBB with insulated bonding conductor.

E. Interconnections: Interconnect all SBBs with the PBB with the telecommunications bonding backbone (TBB) conductor. If more than one PBB is installed, interconnect PBBs using a grounding equalizer (GE) conductor. The telecommunications bonding backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG, unless otherwise indicated. Where specifically indicated on contract Drawings, TBB size indication(s) on the Drawings shall dictate.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the SBB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.

I. Shielded Cable: Where screened twisted-pair cables and/or coaxial cables are installed in communications rooms, bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568.2-D when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the SBB.

L. Equipment Room Signal Reference Grid: For raised-floor applications, provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
   1. Install the conductors in grid pattern on 4-footcenters, allowing bonding of one pedestal from each access floor tile.
   2. Bond the SBB of the equipment room to the reference grid at two or more locations.
   3. Bond all conduits and piping entering the equipment room to the SBB at the perimeter of the room.

M. Towers and Antennas:
   1. Ground Ring: Buried at least 30 inchesbelow grade and at least 24 inchesfrom the base of the tower or mounting.
   2. Bond each tower base and metallic frame of a dish to the ground ring, buried at least 18 inchesbelow grade.
   3. Bond the ground ring and antenna grounds to the equipment room PBB or SBB, buried at least 30 inchesbelow grade.

4. Bond metallic fences within 6 feetof towers and antennas to the ground ring, buried at least 18 inchesbelow grade.
5. Special Requirements for Roof-Mounted Towers applications:
   a. Roof Ring: Meet requirements for the ground ring except the conductors shall comply with requirements in Section 264113 "Lightning Protection for Structures."
   b. Bond tower base footings steel, the SBB in the equipment room, and antenna support guys to the roof ring.
   c. Coordinate and connect roof ring to the perimeter conductors of the lightning protection system.
6. Waveguides and Coaxial Cable:
   a. Bond cable shields at the point of entry into the building to the SBB and to the cable entrance plate, using No. 2 AWG bonding conductors.
   b. Bond coaxial cable surge arrester to the ground or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

N. Ground system equipment and components as required, according to manufacturer's written instructions.

3.7 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

B. Comply with IEEE C2 grounding requirements.

C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inchesabove to 6 inchesbelow concrete. Seal floor opening with waterproof, non-shrink grout.

D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

E. Coordinate grounding of underground distribution system components with the following Sections:
   1. Section 260526: Grounding and Bonding for Electrical Systems.
   2. Section 260543: Underground Ducts and Raceways for Electrical Systems.
   3. Where there are specification conflicts, specific requirements of the above two sections and information on the contract documents shall dictate.

3.8 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
2. Label SBB(s) with "fs-SBB," where "fs" is the telecommunications space identifier for the space containing the SBB.
3. Label the BCT and each telecommunications bonding backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 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 physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI Telecommunications Distribution Methods Manual (TDMM). Conduct tests with the facility in operation.
    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Refer to the following Sections:
1. Section 014000: Quality Requirements, for retesting and reinspecting requirements.
2. Section 017300: Execution, for requirements for correcting the Work.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Tele-power poles.
9. Hooks and hangers.Enclosures for wireless access devices.
10. Boxes, enclosures, and cabinets.
11. Handholes and boxes for underground cabling.
12. Innerduct for outside plant pathways.
13. Boxes, enclosures, and cabinets.
14. Handholes and boxes for exterior underground cabling

1.2 RELATED DOUMENTS

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

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping."

D. Section 260543 "Underground Ducts and Raceways for Electrical Systems."

E. Section 260533 "Raceways and Boxes for Electrical Systems."

F. Section 280528 "Pathways for Electronic Safety and Security."

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electrical metallic tubing.

C. ENT: Electrical non-metallic tubing.

D. GRC: Galvanized rigid conduit.

E. IMC: Intermediate metal conduit.

F. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

A. Product data for the following:
1. Surface pathways.
2. Wireways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.

5. Underground handholes and boxes.
6. For each type of product to be used on Project.

B. Shop Drawings: As applicable for custom enclosures and cabinets, and custom underground handholes or boxes. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway 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 pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

B. Qualification Data: For professional engineer, if required per Section 014000.

C. Seismic Qualification Certificates: For pathways racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

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. AFC Cable Systems
2. Allied Tube & Conduit
3. Alpha Wire Company
4. Anamet Electrical
5. Electri-Flex Company
6. O-Z/Gedney
7. Picoma Industries
8. Republic Conduit
9. Robroy Industries
10. Southwire Company

11. Thomas & Betts Corp
12. Western Tube and Conduit Corp
13. Wheatland Tube Company

C. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-E.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. ARC: Comply with ANSI C80.5 and UL 6A.

F. IMC: Comply with ANSI C80.6 and UL 1242.

G. PVC-Coated Steel Conduit: PVC-coated GRC.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. FMC: Comply with UL 1; Zinc-coated steel.

J. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

K. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:
a. Material: Steel.
b. Type: Compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

L. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS{NONMETALLIC CONDUITS AND FITTINGS}

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

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. AFC Cable Systems
2. Allied Tube & Conduit
3. Anamet Electrical
4. Arnco Corp
5. CANTEX

6. CertainTeed Corp
7. Condux International
8. Electri-Flex Company
9. Kraloy
10. Lamson & Sessions: Carlon
11. Niedax-Kleinhuis USA
12. RACO
13. Thomas & Betts Corp

C. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-E.

D. ENT: Comply with NEMA TC 13 and UL 1653.

E. LFNC: Comply with UL 1660.

F. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

G. Rigid HDPE: Comply with UL 651A.

H. Continuous HDPE: Comply with UL 651A.

I. RTRC: Comply with UL 2515A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

L. Solvents and Adhesives: As recommended by conduit manufacturer.

M. Solvents and Adhesives for LEED projects, as applicable:
1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

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. Alpha Wire Company
2. Arnco Corp
3. Dura-Line
4. Endot Industries.
5. IPEX USA
6. Lamson & Sessions: Carlon

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with TIA-569-E.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS{METAL WIREWAYS AND AUXILIARY GUTTERS}

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

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. B-Line Systems
   2. Hoffman
   3. Mono-Systems
   4. Square D

C. General Requirements: Sheet metal, complying with UL 870 and NEMA 250, Type 1 (indoor) and Type 4 (outdoor), unless otherwise indicate on Drawings. 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.
   2. Comply with TIA-569-E.

D. 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.

E. Wireway Covers: Screw-cover type unless otherwise indicated.

F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

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. Allied Moulded Products
   2. Hoffman
   3. Lamson & Sessions: Carlon
   4. Niedax-Kleinhuis USA

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-E.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

F. Solvents and Adhesives for LEED projects, as applicable:

1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.6 SURFACE METALLIC PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

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. Mono-Systems
2. Niedax-Kleinhuis USA
3. Panduit Corp
4. Wiremold / Legrand

C. Finish: Manufacturer's standard enamel finish in color selected by Architect.

D. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with TIA-569-E.

2.7 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

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. Lamson & Sessions: Carlon
2. Mono-Systems
3. Panduit Corp
4. Quazite: Hubbell Power Systems
5. Wiremold / Legrand

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with TIA-569-E.

2.8 HOOKS AND HANGERS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

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. MonoSystems
2. Panduit Corp
3. Wiremold / Legrand

C. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with TIA-569-E.

E. Galvanized steel.

F. J shape.

2.9 ENCLOSURES FOR WIRELESS ACCESS DEVICES

A. Furnish and install recessed enclosures to house wireless access points (WAP's), where data outlets are indicated on drawings.

B. Contractor shall confirm specific AP manufacturer and model number with owner IT prior to procuring enclosure equipment. For bidding purposes and current basis of design reference specification section 272100 and T-series drawings.

C. Recessed wireless AP Enclosures shall be provided for all hard-lid and non-accessible ceiling locations.

D. AP device fastens to enclosure. Trim plate fastens to enclosure back-box with torsion springs.

E. For recessed locations in inaccessible ceilings, coordinate ceiling penetration and installation requirements with GC prior to work. Confirm final AP locations with owner IT prior to rough-in.

F. Provide all associated equipment, supports and fasteners for complete installation of enclosures.

G. Modular data jacks shall terminate to Category data cabling within AP enclosure.

H. Enclosure manufacturer:
   1. Oberon 1043-FL, or equivalent.

I. Product sample submittal:
   1. Provide sample enclosure and coordinate with owner IT for mock-up assembly of project standard AP device installed within the sample enclosure.
   2. Proper fitment within enclosure must be demonstrated and accepted by owner IT prior to procuring balance of enclosures for project.

2.10 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

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. Adalet
   2. Cooper Crouse-Hinds
   3. EGS/Appleton Electric
   4. Erickson Electrical Equipment Company
   5. Hoffman
   6. Lamson & Sessions: Carlon
   7. Milbank Manufacturing Co
   8. Molex
   9. Mono-Systems

10. O-Z/Gedney
11. Quazite: Hubbell Power Systems
12. RACO
13. Robroy Industries
14. Spring City Electrical Manufacturing Company
15. Stahlin Non-Metallic Enclosures
16. Thomas & Betts Corp
17. Wiremold / Legrand

C. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-E.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep, unless otherwise indicated on Drawings.
5. Gangable boxes are allowed.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 (indoor) and Type 4 (outdoor), unless otherwise indicated on Drawings. Provided with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:
a. Material: Plastic.
b. Finished inside with radio-frequency-resistant paint, if indicated on Drawings.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:
1. NEMA 250, Type 1 (indoor) and Type 4 (outdoor), unless otherwise indicated, 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.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.11 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Device covers shall have appropriate load rating for application(s) in which they are installed.
   3. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   4. Comply with TIA-569-E.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two.
   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. Armorcast Products Company
      b. Carson Industries
      c. NewBasis
      d. Oldcastle Precast: Christy Concrete Products
      e. Quazite: Hubbell Power Systems
      f. Synertech Moulded Products
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "COMMUNICATIONS".
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes **24** Inches Wide by 48 Inches Longand Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of Fiberglass or Polymer-Concrete.
   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. Armorcast Products Company
      b. Carson Industries
      c. NewBasis
      d. Nordic Fiberglass
      e. Oldcastle Precast: Christy Concrete Products
      f. Quazite: Hubbell Power Systems
      g. Synertech Moulded Products
   2. Standard: Comply with SCTE 77.

3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "COMMUNICATIONS".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 24 Inches Wide by 48 Inches Longand Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Source quality control for underground enclosures
1. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
a. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
b. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

2.12 INNERDUCT FOR OUTSIDE PLANT PATHWAYS

A. Innerduct is to be provided and installed within all outside plant (OSP) communications conduit pathways, as described here within.

B. Description:
1. Innerduct must be a flexible fabric type system, designed specifically for the network communications construction industry.
2. The fabric innerduct is designed to maximize the capacity of conduits in the OSP network infrastructure while preserving space for future network cabling deployment.
3. In occupied conduits, the fabric innerduct design will allow for more effective and efficient pathway creation when overriding existing cabling or more traditional rigid innerduct.
4. The innerduct fabric construction will allow the innerduct to conform to the shape of cables placed within, to reduce unused space which is often the case with rigid innerduct type products.

C. Installation Criteria:
1. Provide and install (1) 3-cell 3" fabric innerduct within min 50% of the installed 4" OSP communications conduit pathways, as grouped in a common route.
a. Example: If (5) 4" OSP communications conduit pathways are indicated on drawings in a common route, provide and install (1) 3-cell 3" fabric innerduct within (3) of the (5) OSP communications conduit pathways.
2. Install innerduct per manufacturer written recommendations.

D. Manufacturers: Subject to compliance with requirements, available manufacturer offering products that may be incorporated into the Work:
1. MaxCell Edge fabric innerduct.
2. No substitutions.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway 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. Pathway locations include those such as:
      a. Loading docks.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   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. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
   8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
   9. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
   10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables; 1 inchfor optical-fiber cables; and 1 inchfor Category data cables. Refer to the Drawings for project specific conduit sizing requirements.

D. Pathway Fittings: Compatible with pathways 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 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. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-E for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NECA 105 and NECA 111 for cable tray systems, as applicable.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
   1. ANSI/BICSI N1-2019

F. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

G. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

H. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

I. Arrange stub-ups so curved portions of bends are not visible above finished slab.

J. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

K. Conceal EMT conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

L. Support conduit within 12 inchesof enclosures to which attached.

M. Pathways Embedded in Slabs:
   1. Run conduit larger than 1-inchtrade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-footintervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
   3. Arrange pathways to keep a minimum of 1 inchof concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. When running ENT in slab, change from ENT to RNC Type EPC-40-PVC before rising above floor.

N. Stub-ups to above accessible, recessed ceilings:
   1. Use EMT for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

P. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install locknuts hand tight plus one additional quarter-turn. Install insulated bushings on conduits terminated with locknuts.

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 of 2-inchtrade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inchesof slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways are designated as spare alongside pathways in use.

U. Surface Pathways:
   1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inchesand with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
   1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
   2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway-sealing fittings according to NFPA 70.

X. Install devices to seal pathway 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 pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. 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 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 temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg Ftemperature change.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. 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.

AA. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feeton center.
5. Provide a hook at each change in direction.

BB. 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 center of box unless otherwise indicated.

CC. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE. 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.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. 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 in Section 312000 "Earth Moving" for pipe of less than 6 inches in nominal diameter.
   2. Install backfill as specified in Section 312000 "Earth Moving."
   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 in Section 312000 "Earth Moving."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
      a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inchesfrom edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
   5. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

B. Innerduct within Underground Conduit:
   1. Innerduct is to be provided and installed within all outside plant (OSP) communications conduit pathways.
   2. Installation Criteria:
      a. Provide and install fabric innerduct as described earlier under Part-2 Products article 'Innerduct for Outside Plant Pathways".
   3. Install innerduct per manufacturer written recommendations.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, as based on documented frost line for project site. Confirm frost line criteria with Architect.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors, per manufacturer instructions. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed. Cutting not required if conduits enter enclosure through open bottom or manufacturer-supplied openings through the sides.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS SYSTEMS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or 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

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wire basket cable tray
   2. Ladder rack cable tray (runway)
   3. Cable tray accessories
   4. Warning signs

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.

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray to be used on Project.
   1. Indicate type, dimensions, and finishes for each type of cable tray to be used.
   2. For each type of cable tray accessory to be used on Project.

B. Shop Drawings:
   1. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to sides of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
   2. Show installation details of cable trays, including attachments to other construction elements. Include typical installation details for cable tray and accessories such as clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. As-Built Data: As-built Drawings of cable tray layout, showing cable tray route to scale.

C. Field quality-control reports.

D. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.
3. Component Amplification Factor: Determined per Delegated Design.
4. Component Response Modification Factor: Determined per Delegated Design.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Product source limitations:
1. Obtain wire basket cable tray and associated components from single manufacturer.
2. Obtain ladder rack cable tray and associated components from single manufacturer.

C. Refer to reflected ceiling plan Drawings for requirements of wire basket cable tray sizes and general routing. Provided and installed by Division 26 electrical contractor.

D. Provide wire basket and ladder rack cable trays with support spans of 96 inches maximum.

E. Refer to enlarged plan Drawings for requirements of ladder rack cable tray (runway) within telecommunications rooms. Within telecom rooms provide vertically mounted ladder rack on wall where required to support vertical backbone cabling, whether vertical ladder rack is shown on the Drawings or not. Provided and installed by Division 27 telecommunications cable contractor.

F. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE BASKET CABLE TRAY

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. Legrand Cablofil
   2. Chatsworth Products
   3. B-Line Systems
   4. Hubbell

B. Description:
   1. Configuration: Galvanized steel wire basket (mesh), complying with NEMA VE 1.
   2. Width: 12 inches, unless otherwise indicated on Drawings.
   3. Usable Load Depth: 4 Inches, unless otherwise indicated on drawnings.
   4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
   5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lbconcentrated load, when tested according to NEMA VE 1.
   6. Class Designation: Comply with NEMA VE 1, minimum Class 8A.
   7. Splicing Assemblies: Bolted type using serrated flange locknuts.
   8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Steel:
      a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
      b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
      c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      d. Finish:
         1) Indoor: Electro Zinc Plating, ASTM B633, applied after fabrication

2.4 LADDER RACK CABLE TRAY (RUNWAY, WITHIN TELECOM ROOMS)

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. Legrand Cablofil
   2. Chatsworth Products
   3. B-Line Systems
   4. Hubbell

B. Description:
   1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
   2. Width: 12 inches, unless otherwise indicated on Drawings.
   3. Height: 1.5 inches, unless otherwise indicated on Drawings.
   4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
   5. Rung Spacing: 12 inches, unless otherwise indicated on Drawings.
   6. Radius-Fitting Rung Spacing: 9 inchesat center of tray's width.
   7. Minimum Cable-Bearing Surface for Rungs: 7/8-inchwidth with radius edges.
   8. No portion of the rungs shall protrude below the bottom plane of side rails.
   9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lbconcentrated load, when tested according to NEMA VE 1.
   10. Class Designation: Comply with NEMA VE 1, minimum Class 8A.
   11. Splicing Assemblies: Bolted type using serrated flange locknuts.
   12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Steel:
      a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade.
      b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
      c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      d. Finish: Black powder coated, applied after fabrication.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Same materials and finishes as for cable tray. Provide tees, crosses, risers, elbows, waterfalls, and other fittings as required for a complete cable tray system.

B. Barrier Strips: Same materials and finishes as for cable tray. Provide barrier strips where indicated on Drawings.

C. Provide cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."

B. Lettering: 1-1/2 inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and modifications, and all cable tray connections are accessible for inspection and adjustment.

D. Clearances for cable trays installed within accessible ceilings: Install cable trays to provide 6" to 12" of clearance from bottom of tray to top of finished ceiling. Maintain minimum 12" clearance above cable tray and minimum 12" clearance on at least one side of cable tray.

E. Remove burrs and sharp edges from cable trays.

F. Fasten cable tray supports to building structure.

G. Install seismic restraints from cable tray to structure. Fasteners and supports shall carry cable tray, the cables, and a concentrated load of 200 lb, Comply with seismic-restraint details according to the approved seismic restraint Delegated Design.

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

L. Support trapeze hangers for wire basket cable trays with 1/4 inch diameter rods.

M. Where wire basket cable trays connect to equipment, make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

N. Where ladder rack cable trays are installed within telecommunication rooms, secure ladder rack along walls and provide accessories to secure ladder rack above floor standing equipment racks, as recommended by manufacturer.

O. Where cable trays cross building expansion joints, install expansion connectors in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

P. Make changes in direction and elevation using manufacturer's recommended fittings.

Q. Make cable tray connections using manufacturer's recommended fittings.

R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

S. Install cable trays with enough workspace to permit access for installing cables.

T. Where different low voltage systems cabling is run within cable tray, install barriers to separate the different system types and different insulation levels (such as 600, 5000 V, etc).

U. If indicated on plans, install and clamp covers on cable trays installed outdoors with heavy-duty clamps. Install cover clamps according to NEMA VE 2.

V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified.

B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

C. Comply with TIA-607-D and NECA/BICSI-607.

D. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

E. When bonding cable trays, completely remove finish coating at all splice contact points or ground connector attachment, or as recommended by manufacturer. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

F. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Cable tray shall be used for installation and routing of telecommunications cabling only. Power circuits and other low voltage system cabling such as audiovisual or security cabling shall not be installed in cable tray, unless otherwise indicated on the drawings or pre-approved by owner.

C. Fasten cables on horizontal runs with Velcro cable ties according to NEMA VE 2. Tighten Velcro ties only enough to secure the cable, without indenting the cable jacket.

D. Fasten cables on vertical runs with Velcro cable ties every 18 inches vertically. Tighten Velcro ties only enough to secure the cable, without indenting the cable jacket.

E. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 60 inches.

F. Tie MI cables down every 36 incheswhere required to provide a 2-hour fire rating and every 72 incheselsewhere.

G. In existing construction, remove any inactive or abandoned cables from cable trays.

3.4 CONNECTIONS

A. Remove paint finish from all connection points, as recommended by manufacturer, before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. After installing cable trays and associated cabling, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. If applicable, verify that different low voltage systems cabling is separated by barriers, is data and security cabling.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

3.7 PROTECTION

A. Protect installed cable trays and cables.
   1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
   2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
   3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Round sleeves
2. Rectangular sleeves
3. Sleeve seal systems
4. Fire-rated self-seal pathways
5. Grout
6. Pourable sealants
7. Foam sealants

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.

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Sustainable Design Submittals, as applicable to Project:
1. Product Data for Credit IEQ 4.1: Documentation of printed statement indicating that solvent cements and adhesive primers have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. General, for exterior walls above and below grade:
1. When placing sleeve during new wall construction, provide steel or cast iron wall sleeves.
2. Where sleeves are required for penetrations of existing walls, provide non-flanged pipe sleeves made of standard Schedule 40 conduit cut flush at both sides of the wall.

B. Wall Sleeves, Steel:
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

b. CCI Piping Systems
c. Flexicraft Industries
d. EnPro Industries: GPT

2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

C. Wall Sleeves, Cast Iron:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American Ductile Iron Pipe
b. Flexicraft Industries
c. McWane Ductile
2. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

D. Molded Sleeves, PVC:
1. Molded sleeves (PVC) may be used during construction as an extension of the concrete form to form holes through concrete structure and shall be removed after the concrete is set.
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. Thomas & Betts: ABB
b. Arlington Industries
c. Reliance Worldwide Corp
3. Description: With nailing flange for attaching to wooden forms.

E. Sheet Metal Sleeves, Galvanized Steel, Round:
1. For interior non-fire rated gypsum board wall assemblies, provide Schedule 40 conduit sleeves.
2. Galvanized steel sheet metal sleeves shall be round, unless otherwise indicated on Drawings.
3. 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. Benefast
b. Specified Technologies
4. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round closed tube.

2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
1. For interior non-fire rated gypsum board wall assemblies, provide Schedule 40 conduit sleeves, where specifically indicated on Drawings.
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. Abesco Fire
b. Legrand Wiremold
c. Specified Technologies

3. Description:
    a. Material: Galvanized sheet steel.
    b. Minimum Metal Thickness:
        1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness must be 0.052 inch.
        2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches, thickness must be 0.138 inch.

2.3 SLEEVE SEAL SYSTEMS

A. Sleeve seal systems:
1. For conduit penetrations in slabs-on-grade and in below-grade exterior walls, use sleeve seal systems.
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. Advance Products & Systems
    b. BWM Company
    c. CALPICO
    d. Flexicraft Industries
    e. Metraflex Company
    f. Pipeline Seal and Insulator
    g. Proco Products

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.
1. Provide sleeve-seal fittings as required for the application.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Where hydrocarbons are present in soil, use Nitrile (Buna N) rubber gasket material.
3. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 FIRE-RATED, SELF-SEAL PATHWAYS

A. Fire-rated, self-seal pathways:
1. Provide fire-rated, self-sealing pathway device system(s), where indicated on Drawings.
2. May be installed in horizontal wall partitions or floor slabs as vertical cable pathway.
3. Installed devices must meet fire-rating of application for which it is installed.
4. Install devices per manufacturer written instructions.
5. 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. STI Firestop: EZ Path
    b. Hilti
6. Description:
    a. Self-sealing firestop system, available in modular, gangable design.

b. Offer both fire-rated and non-fire-rated devices.
c. Allow for ease of cable modification (adds, changes) following initial installation.

2.5 GROUT

A. Grout for sealing of conduit or cable penetrations.

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. W.R. Meadows

C. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

D. Sustainability Criteria for LEED projects, as applicable:
1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.6 POURABLE SEALANTS

A. Pourable sealants may only be used as an alternate to sealing of conduit or cable penetrations where permitted by applicable codes and local AHJ.

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. Carlisle SynTec
2. GAF
3. Johns Manville

C. Description: Single-component, 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.

D. Sustainability Criteria for LEED projects, as applicable:
1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.7 FOAM SEALANTS

A. Foam sealants may only be used as an alternate to sealing of conduit or cable penetrations where permitted by applicable codes and local AHJ.

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. Dow Chemical Company.
2. Innovative Chemical Products

C. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

D. Sustainability Criteria for LEED projects, as applicable:
   1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1 and TIA-569-E for installation requirements except where requirements on Drawings or in this section are stricter.

B. 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 space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
      b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   2. Use round pipe sleeves unless penetration arrangement requires rectangular sleeved opening, or is otherwise indicated on the Drawings.
   3. Size pipe sleeves to provide 1/4-inchannular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
   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.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inchannular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:
   1. For new construction, install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inchannular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.

2. For existing walls requiring core drill, install steel pipe sleeves. Size sleeves to allow for 1-inchannular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Install sleeve-seal fittings in new walls and slabs as they are constructed.

D. 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.

E. Secure nailing flanges to concrete forms.

F. Using grout, seal the space around outside of sleeve-seal fittings.

G. Install devices per manufacturer written instructions.

3.4 INSTALLATION OF FIRE-RATED SELF-SEAL PATHWAYS

A. Install fire-rated, self-sealing pathway devices where indicated on Drawings.

B. Comply with NECA 1 and TIA-569-E for installation requirements.

C. Installed devices must meet fire-rating of application for which it is installed.

D. Install devices per manufacturer written instructions.

3.5 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

END OF SECTION

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Labels.
   1. Bands and tubes.
   2. Underground-line warning tape.
   3. Signs.
   4. Cable ties.
   5. Miscellaneous identification products.

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.

B. This section is inclusive of all Division 27 sections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Identification Schedule:
   1. Work Area Outlets: Scaled drawings indicating location and proposed designation.
   2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
   3. Racks: Scaled drawings indicating location and proposed designation.
   4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.
   5. Refer to Shop Drawing submittal requirements within associated Division 27 sections.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA/EIA 606-D.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:
   1. Provide for all equipment housings such as racks, cabinets, enclosures, etc.
   2. Black letters on a white field.

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 Worldwide
      b. HellermannTyton
      c. Kroy
      d. Panduit

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, 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 Worldwide
      b. HellermannTyton
      c. Kroy
      d. Panduit

C. Self-Adhesive Wraparound Labels: Preprinted, polyester flexible labels with acrylic pressure-sensitive 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. Brady Worldwide
      b. HellermannTyton
      c. Kroy
      d. Panduit
   2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   3. Marker for Labels:
      a. Permanent, waterproof black ink marker recommended by tag manufacturer.
      b. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
   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 Worldwide
      b. HellermannTyton
      c. Kroy

d. Panduit
2. Minimum Nominal Size:
a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 incheslong, with diameters sized to suit diameters of raceway or cable they identify, 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 Worldwide
b. HellermannTyton
c. Kroy
d. Panduit

2.5 UNDERGROUND-LINE WARNING TAPE

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. Brady Worldwide
2. Ideal Industries, Inc.
3. LEM Products, Inc.
4. Marking Services, Inc.
5. Reef Industries, Inc.

B. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

C. Color and Printing:
1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
2. Inscriptions for Orange-Colored Tapes, IE:
a. COMMUNICATIONS CABLE
b. OPTICAL-FIBER CABLE
c. TELEPHONE CABLE
d. CATV CABLE
e. Other, as needed

D. Tag, Nonconducting Polyolefin, Type I:
1. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Thickness: 4 mils.

4. Weight: 18.5 lb/1000 sq. ft.
5. Tensile According to ASTM D882: 30 lbfand 2500 psi.

E. Tag, Nonconducting Multilayer Laminate, Type II:
1. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Thickness: 12 mils.
4. Weight: 36.1 lb/1000 sq. ft.
5. Tensile According to ASTM D882: 400 lbfand 11,500 psi.

F. Tag, Detectable, Type ID:
1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 5 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 28 lb/1000 sq. ft.
6. Tensile According to ASTM D882: 70 lbfand 4600 psi.

G. Tag, Detectable, Reinforced, Type IID:
1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 8 mils
4. Foil Core Thickness: 0.35 mil
5. Weight: 34 lb/1000 sq. ft.
6. Tensile According to ASTM D882: 300 lbfand 12,500 psi.

2.6 SIGNS

A. Baked-Enamel Signs:
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. Carlton Industries
   b. Champion America
   c. Marking Services Inc
   d. Emedco
2. Preprinted signs, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inchgrommets in corners for mounting.
4. Nominal Size: 7 by 10 inches

2.7 CABLE TIES

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. Brady Worldwide
   2. HellermannTyton
   3. Ideal Industries Inc
   4. Panduit

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg FAccording to ASTM D638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg FAccording to ASTM D638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

D. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch
   2. Tensile Strength at 73 deg FAccording to ASTM D638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F
   4. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and installation location.

B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications 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 communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:
   1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
   2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
   3. Provide label 6 inchesfrom cable end.

I. Snap-Around Labels:
   1. Secure tight to surface at a location with high visibility and accessibility.
   2. Provide label 6 inchesfrom cable end.

J. Self-Adhesive Wraparound Labels:
   1. Secure tight to surface at a location with high visibility and accessibility.
   2. Provide label 6 inchesfrom cable end.

K. Self-Adhesive Labels:
   1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 incheshigh.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Underground-Line Warning Tape:
   1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inchesbelow finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inchesoverall.
   2. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, except as listed below:
   1. In Spaces Handling Environmental Air: Plenum rated.
   2. Outdoors: UV-stabilized nylon.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
   1. Identification to be inclusive of all components to be compliant with TIA 606-D.
   2. Identification to be compliant with Administration Class 3.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
   1. System legends shall be as follows:
   2. Telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
   1. Wiring closet designation.
   2. Colon.
   3. Faceplate number.

E. Equipment Room Labeling:
   1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
   2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels. Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
   3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
      a. Room number being served.
      b. Colon.
      c. Faceplate number.
   4. Confirm all above listed labeling requirements with owner IT, prior to work.

F. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
   1. Room number.
   2. Colon.
   3. Faceplate number.
   4. Confirm all above listed labeling requirements with owner IT, prior to work.

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.

K. Equipment Identification Labels:
   1. Label equipment with: Self-adhesive labels.
   2. Communications equipment to be labeled:
      a. Communications racks, cabinets, and enclosures.
      b. Uninterruptible power supplies.
      c. Power distribution components.
      d. Telecom and computer room air conditioners.

END OF SECTION

SECTION 270800 – COMMUNICATION SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the contractor is partially responsible to execute, is defined in SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) contracted by IHS will manage the commissioning process.

B. Related Sections:
   1. The requirements of this Section apply to all Sections of Division 27
   2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
   3. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

1.2 DEFINITIONS

A. Refer to SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS, for definitions.

1.3 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 27 is part of the construction process. Documentation and testing of these systems, as well as training of O&M personnel in accordance with the requirements of Division 01 and 27 Sections, is required in cooperation with the IHS and CxA.

B. The COMMUNICATION Systems Commissioning will include the systems listed in SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

1.4 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The CxA will provide a list of Submittals earmarked for CxA review. This list will be reviewed and approved by IHS prior to sharing with the contractor. Refer to SECTION 01 33 00 – SUBMITTAL PROCEDURES for further details.

B. The commissioning process requires Cx Submittal review simultaneous to A/E Submittal review. Specific submittal requirements related to the Commissioning Process are specified in SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 START-UP AND CONSTRUCTION INSPECTIONS

A. General. Commissioning of the Building Communication Systems will require inspection of individual elements of the Communication System construction throughout the construction period. The Contractor shall coordinate with the CxA in accordance with SECTION 01 91 13 – GENERAL COMMISSIONING

REQUIREMENTS and the Commissioning Plan to schedule inspections as required to support the commissioning process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. General. Pre-functional Checklists are developed and completed for all major equipment and systems being commissioned. The checklist captures equipment nameplate and characteristics data, confirming the as-built status of the equipment or system. These checklists also ensure that the systems are complete and operational, so that the functional performance testing can be scheduled. The checklists are drafted by the CxA and completed (filled out) by the installing Contractor.

B. Review. Upon notification of checklist completion, the CxA and IHS will review the Pre-Functional Checklists for accuracy. If the CxA or IHS determine that the information provided on a checklist is not accurate, the marked-up checklist will be returned to the Contractor for correction and resubmission. An item be added to the Commissioning Issue Log (CIL) to track the deficiency.

If the CxA or IHS determine that a significant number of completed checklists for similar equipment are not accurate, all the checklists for the equipment type will be returned to the Contractor for correction and resubmission.

Refer to SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

3.3 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, equipment failure, intelligibility, data reporting, signal strength verification vs. predicted mapping, etc. shall also be tested.

B. Development of Test Procedures. Before test procedures are written, the CxA 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 CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA shall review contracted or factory testing which the CxA is not responsible to oversee and shall determine what further testing may be required to comply with the Contract Documents. Redundancy of testing shall be minimized.

C. Test Methods:

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance), by monitoring the performance and analyzing the results using the control system's trend log capabilities, by stand-alone data loggers, or in some cases by CxA reviewing/evaluating test documentation for tests that are performed by

installing contractors or providers and observing the installed systems to validate the systems. The CxA will determine which method is most appropriate.

2. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
3. Sampling. Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy will be developed by the CxA and approved by the Owner's Representative. For details on Sampling, refer to the Commissioning Plan. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units are tested at the Contractor's expense.

D. Coordination and Scheduling. The Contractor shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the Owner's Representative. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractor shall execute the tests.

E. Problem Solving. The CxA will recommend solutions to problems found; however, the burden of responsibility to solve, correct, and retest problems lie with the Contractor and their subcontractors.

3.4 O&M PERSONNEL TRAINING REQUIREMENTS

A. Training Plans: Contractor shall develop an instructional program that includes individual training modules for each system, subsystem, and equipment as specified in SECTION 01 79 00 – DEMONSTRATION AND TRAINING.

B. The minimum training requirements for Communication Systems are specified in technical sections.

C. The CxA shall review and provide comment on the training plans developed by the contractor for alignment with the requirements of the OPR and BOD.

-- END OF SECTION --

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Backboards.
2. 19-inch equipment racks.
3. 19-inch equipment cabinets.
4. Cable managers.
5. Power distribution units.
6. Enclosures and boxes.
7. Identification Products.

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.

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping."

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TDMM: BICSI Telecommunications Distribution Methods Manual

G. SBB: Secondary Bonding Busbar.

H. PBB: Primary Boonding Busbar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: Reviewed and stamped by RCDD.
1. As part of communications system shop drawings, include telecom room enlarge plans, elevations, sections, typical details, and attachments to other work.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
4. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Sustainable Design Submittals, if applicable to Project.

D. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. Certifications for RCDD, installation supervisor, and field inspector.
   2. Certification from cabling manufacturer.

B. Field quality-control reports.

C. Seismic Qualification Data: Certificates, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Closeout Documentation: In general, Closeout Documentation includes the following post construction items:
   1. As-Built Drawings: Provide all items listed under Shop Drawings submittal. Show all information in the As-Built Drawings in its final installed condition, as was constructed.
   2. Operation and Maintenance Manuals (O&Ms).
   3. Warranty Information.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently certified by BICSI as an RCDD to supervise on-site inspection.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

A. Coordinate telecom equipment room layouts, power requirements, and equipment rack elevations with owner IT prior to work.

B. Coordinate power circuit requirements within telecom equipment rooms with EC and other trades, as applicable to scope of work.

C. Coordinate related communication services within telecom equipment rooms with access providers, service providers, and owner IT.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing for installed audiovisual equipment to include equipment racks, and wall and ceiling mounted equipment.

B. Seismic Performance: Audiovisual equipment to withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit or equipment will remain in place without separation of any parts when subjected to the seismic forces specified and the unit or equipment will be fully operational after the seismic event."
   2. Component Importance Factor: 1.5.
   3. Component Amplification Factor: Determined per Delegated Design.
   4. Component Response Modification Factor: Determined per Delegated Design.

2.2 GENERAL REQUIREMENTS FOR EQUIPMENT ROOM FITTINGS

A. Equipment room racks, cabinets, fittings, and accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. UL listed.

C. RoHS compliant.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
   1. If painted, leave fire rating stamp visible.
   2. Coordinate painting requirements with owner IT.

2.4 OVERHEAD LADDER RACK (CABLE RUNWAY)

A. Refer to enlarged plan Drawings for requirements of overhead ladder rack cable tray (cable runway) within telecommunications rooms. For vertical cable management on walls, provide vertically mounted ladder rack on wall where required, whether vertical ladder rack is shown on the Drawings or not.

B. Refer to section 270536 Cable Trays for Communication Systems, for requirements of Overhead Ladder Rack to be installed within telecommunication rooms.

2.5 EQUIPMENT RACKS{19-INCH EQUIPMENT RACKS} 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. Great Lakes Data Racks & Cabinets - or Equal

B. General Requirements:
   1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   2. Material: Extruded steel.
   3. Finish: Manufacturer's standard, baked-polyester powder coat.
   4. Color: White.

C. MDF
   1. Rack type 1 - Cabinet (QTY 7)
      a. GL840ES-3042-W-MS - 42 x 30
   2. Rack Type 2 - 4-Post (QTY 2)
      a. CMRX-45U24-W-1224 - 24 x 24

D. IDF
   1. Rack Type 2 - 4-Post (QTY 6)
   2. CMRX-45U24-W-1224 - 24 x 24
   3. IDF w/Tenant
      a. Provide CH-06 for Access Control for tenant racks inside IDFs.

E. Pharmacy Rack / OEH-2405
   1. GL24WDXP-B-SH-00
   2. Provide CH-06 for Access Control

F. Tenant IDFs
   1. Rack Type 3 - Wall Mounted Cabinet (QTY 2)
      a. GL36WDXP-B-SE-AF
      b. 7219-20AR Power Strip
      c. 7217WS FAN

G. Service Entrance Room
   1. Rack Type 4 - Wall Mounted Cabinet
      a. GL48WDXP-B-SE-AF
      b. 7217WS FAN

2.6 CABLE MANAGERS

A. General Requirements:
   1. Provide horizontal and vertical cable managers within telecom equipment rooms.
   2. Drawings indicate general arrangement of cable management equipment.
   3. Metal, baked-polyester powder coat finish, black.

B. Manufacturer: Subject to compliance with requirements, match supplied equipment rack manufacturer, unless otherwise indicated.

C. Horizontal Cable Managers
   1. Provide horizontal cable managers in equipment racks.

2. Cable manager with integral wire retaining fingers, 19" rack mount, 2U (3.5") high, 5" deep.
3. Provide one horizontal cable manager for each supplied 48-port Category cable patch panel, and each supplied fiber optic patch panel, or quantity of cable managers as indicated on Drawings.
4. Coordinate telecom room equipment rack elevations and cable manager placement with owner IT.

D. Vertical Cable Managers
1. Provide vertical cable managers on the sides of each supplied equipment rack or cabinet.
2. Double-sided vertical cable manager, with front and back covers.
3. Height: Match that of supplied floor-mounted equipment racks or cabinets.
4. Width: 6 inches wide, unless otherwise indicated on Drawings.

2.7 POWER DISTRIBUTION UNITS

A. Provide PDU's per the above. IHS vendor to provide PDU's in IHS MDF and IDF Racks.

B. Description: Power Distribution Units (PDUs) provide reliable rack-mount power distribution via a single input with multiple output receptacles. PDUs will be horizontal rack mount units, unless otherwise indicated on the Drawings.

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. Great Lakes Data Racks & Cabinets, APC - or Equal

D. General Requirements:
1. Listed and labeled as defined in NFPA 70, and marked for intended location and application.
2. Comply with UL 1363 and UL/IEC 62368.
3. Provide power distribution and surge protection, UL 1449 Type 3.
4. Network management and active monitoring.
5. Alarm thresholds and power delays.
6. Remote individual outlet control.
7. Power cycling and reboot control.
8. Single input, multiple outputs.
9. Horizontal Application:
   a. Rack mount, with detachable flanges.
   b. Rear-facing receptacles.
   c. Height: 1 RU.
   d. Input 5-20P; with (8) 5-20R outputs.

E. Provide one horizontal PDU for each supplied equipment rack or cabinet.

F. Confirm PDU power input and output connection types with owner IT prior to ordering equipment.

G. Coordinate telecom room equipment rack and cabinet elevations and PDU placement with owner IT.

2.8 ENCLOSURES AND BOXES

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. Arlington Industries
   2. Hoffman
   3. Hubbell
   4. Raco
   5. Wiremold

B. General Requirements for Enclosures and boxes: Listed and labeled for intended location and use.

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, Type FD, ferrous alloy, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

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 with gasketed cover.

H. Standard Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep. Provide raised cover where required for recessed installation in finished surfaces.

I. Box extensions and raised covers used to accommodate new building finishes shall be of same material as recessed box.

J. Enclosures:
   1. Hinged door in front cover with flush latch and concealed hinge.
   2. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel. UL 50 and NEMA 250 Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
      a. Interior panels or barriers to separate wiring of different systems and voltage. Steel, panel sides finished with manufacturer's standard enamel.
   3. Nonmetallic Enclosures: Plastic. Nonmetallic enclosures shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      a. Interior panels or barriers to separate wiring of different systems and voltage. Steel or aluminum; steel panel sides finished with manufacturer's standard enamel.
   4. Accessory feet where required for freestanding equipment.
   5. Key latch to match panelboards.

2.9 IDENTIFICATION PRODUCTS

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. Brady Worldwide
2. HellermannTyton
3. Kroy
4. Panduit

B. Comply with TIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment room pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, and other conditions affecting installation.

B. Examine roughing-in for equipment room communications conduit pathways to verify actual locations of conduit and back boxes before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with TIA/EIA 606-D, "Administration Standard for Commercial Telecommunications Infrastructure."

B. In meetings with Architect and Owner, present, review and coordinate Project planning documents.

C. Verify and obtain all necessary licenses and construction permits required to complete the Project scope.

3.3 INSTALLATION

A. Drawings indicate general arrangement and layout of equipment and fittings within telecom equipment rooms.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Backboards:
1. Install from 24 inchesto 10 feet above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible. Confirm painting requirement and color with owner IT.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-E.

E. Coordinate layout and installation of communications equipment in racks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications and other equipment within telecom rooms requiring electrical power to operate.

G. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

H. Comply with NECA 1.

I. Install racks, equipment room fittings, and supports in compliance with the seismic-restraint details according to the approved seismic restraint Delegated Design.

3.4 INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement and routing of primary cabling pathways.

B. Comply with the following Sections:
1. 260533 "Raceways and Boxes for Electrical Systems"
2. 270528 "Pathways for Communications Systems"
3. 270536 "Cable Trays for Communications Systems"
4. 270544 "Sleeves and Seals for Communications Pathways and Cabling"

3.5 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

3.6 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

C. Comply with TIA-607-D and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inchclearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Comply with requirements in Section 270553 "Identification for Communications Systems" and requirements of TIA/EIA 606-D.

3.8 FIELD QUALITY CONTROL

A. Perform equipment room field inspections:
   1. Prior to permanently affixing racks, overhead cable runway, and related equipment room fittings, field walk each telecom with owner IT, to review and confirm the equipment layouts as planned.
   2. Following installation of racks and other primary equipment room fittings, arrange with owner IT to field survey each telecom room for progress review and owner approval of layout(s). Make necessary adjustments as requested by owner.
   3. After installing telecom equipment room racks and fittings, survey for compliance specifications and referenced standards documents.
   4. Visually inspect all associated equipment for damage and correct any deficiencies.
   5. Check bolted connections between equipment components. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   6. Visually inspect each rack, cable tray and metallic equipment for grounding and bonding connections, check for improperly sized or installed bonding jumpers.
   7. Coordinate telecom room equipment rack and cabinet elevations with owner IT prior to terminating communications horizontal or backbone cabling within equipment room racks or cabinets.

B. Prepare test and inspection reports.

END OF SECTION

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category copper cabling.
2. Copper cabling connecting hardware.
3. Optical fiber cabling.
4. Optical fiber connecting hardware.
5. Coaxial cabling.
6. Coaxial connecting hardware.
7. Identification products.
8. Cable management system.

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.

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping."

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. CATV: Community antenna television.

C. CEA: Consumer Electronics Association.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Jack: Also termed outlet, or fixed female connector.

G. LAN: Local area network.

H. MATV: Master antenna television.

I. MMFO: Multimode Fiber Optic.

J. Outlet: Cable connecting device at work area plate.

K. Plug: Also termed connector, or male connector.

L. RCDD: Registered Communications Distribution Designer.

M. RF: Radio frequency.

N. SMFO: Single Mode Fiber Optic.

O. TDMM: BICSI Telecommunications Distribution Methods Manual.

P. UTP: Unscreened (unshielded) twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: Reviewed and stamped by RCDD.
   1. Telecom structured cabling plan drawings, showing backbone cabling locations, routing, quantities, and types.
   2. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   3. Cabling administration drawings and printouts.
   4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      a. Telecommunications room plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Typical telecommunications details.

C. Cable testing plan for each cable type provided.

D. Sustainable Design Submittals, if applicable to Project.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. Certifications for RCDD, installation supervisor, and field inspector.
   2. Certification from cabling manufacturer.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Closeout Documentation: In general, Closeout Documentation includes the following post construction items:
   1. As-Built Drawings: Provide all items listed under Shop Drawings submittal. Show all information in the As-Built Drawings in its final installed condition, as was constructed.
   2. Operation and Maintenance Manuals (O&Ms).
   3. Cabling Certification and Test Results.
   4. Warranty Information.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently certified by BICSI as an RCDD to supervise on-site inspection.

4. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.
   2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each coaxial cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with owner IT and third-party service providers.

B. Coordinate telecom equipment room layouts and equipment rack elevations with owner IT prior to work.

PART 2 - PRODUCTS

2.1 CABLING PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling systems shall comply with TIA-568.0-E and TIA-568.1-E

B. Electrical Components, Devices, and Accessories: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70.

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: 25 or less.
   2. Smoke-Developed Index: 50 or less.

D. For all installation applications of Project, provide cabling rated for the environment in which it is installed.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-E.

F. Grounding: Comply with TIA-607-D.

2.2 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.

B. Cabling system consists of backbone cables, intermediate and main cross-connects, terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

C. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

D. Communications backbone cabling may include copper, optical fiber, and/or coaxial cabling.

2.3 CATEGORY TWISTED PAIR CABLE

A. Provide twisted pair copper backbone cabling as indicated on the Drawings and Specifications.

B. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.
   1. Berk-Tek Leviton

C. Description: Multi-pair, 100-ohm UTP cabling, comply with TIA-568-C.2.

D. Provide: 25-pair Category 5e backbone cabling.

E. Jacket Color: Grey, confirm with owner IT.

2.4 TWISTED PAIR CABLE CONNECTING HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

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:

C. Belden
   1. Berk-Tek
   2. CommScope

D. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with and match the performance criteria of the provided copper backbone cabling.
   2. Comply with TIA-568.2-D, IDC type, with connections designed for punch-down caps or tools.

E. Connecting Blocks:
   1. Cross-connect punch down blocks, wall mount.
   2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare.
   3. 110-style IDC termination block.

F. Patch Panel:
   1. Provide patch panel in telecom rack for termination of copper backbone tie cable from wall mount copper cross-connect. Provide one patch panel within each telecom room.

2. Modular panel housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
3. Features:
   a. Labeling areas adjacent to conductors.
   b. Replaceable connectors.
   c. 24 ports, unless otherwise indicated on Drawings.
   d. Part # 41DBR-1F5
4. Construction: 16-gauge steel and mountable on 19-inchequipment racks
5. Provide 100-pair copper tie cable, matching the supplied Category copper backbone cable.
   a. Terminate the first 24 pairs in patch panel: pair 25 left unterminated.

G. Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a 100-ohm, unshielded twisted pair cable. Terminate one pair per jack, for POTS pone line use.
2. Designed to snap-in to a patch panel.
3. Standard: Comply with TIA-568-C.2.

H. Entrance Protection Blocks:
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. Avaya
   b. Circa Telecom
   c. Marconi
   d. Power & Tel
   e. TII Technologies
2. Provide lightning protection block for outside plant copper cabling entering the facility.
3. Comply with and match the performance requirements of the incoming service copper cabling and the provided copper backbone cabling.
4. Size entrance protection block to support the number of cables terminated, plus 25 percent spare.
5. Ground and bond equipment per manufacturer instructions.
6. 110-style IDC protection block.

2.5 OPTICAL FIBER CABLE

A. Optical fiber backbone cabling is part of the optical fiber cabling subsystem within the telecommunications cabling system structure.

B. Fiber optic cabling subsystem consists of backbone cables, terminations, patch panels, and patch cords or jumpers used for fiber backbone cross-connection. Optical fiber interconnecting units may be referred to as light interface units (LIUs).

C. Provide optical fiber backbone cabling as indicated on the Drawings and Specifications.

D. Product source limitations:
1. Obtain fiber optic cabling, connectors, and connecting hardware from a single manufacturer.

E. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner. Berk-Tek Leviton
   1. Berk-Tek{BERK-TEK}
   2. Leviton{SUPERIOR ESSEX}

F. Standards requirements:
   1. Comply with TIA-568.3-E performance specifications.
   2. Comply with TIA-598-D fiber optic cable color coding.

G. Provide: MMFO cabling, 48-strand OM4 50/125-micrometer, tight buffer, 850-nm laser-optimized, armored, Aqua. SMFO cabling, 48-strand OS2 9/125-micrometer, tight buffer, armored, yellow. SMFO cabling, 24-strand OS2 9/125-micrometer, loose tube, armored, yellow.
   1. OM4 Part # PDPK12B048FB3010/F5-I/O-C2C4C5(AQU)
   2. OS2 Part # PDP12B048-AB0707-I/O-C4 (YEL)
   3. OS2 24 Part # PDPK024AB0707-I/O-C4C5(YEL)

H. Where drawings indicate; Provide SMFO cabling, 12 Strand OS2 9/125-micrometer, tight buffer, armored, yellow.
   1. OS2 Part # OS2, 12 Fiber: PDPK012AB0707-I/O-C4C5(YEL)

I. Jacket: Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

J. Splicing: Provide fusion splicing of optical fibers. Mechanical splicing not acceptable.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.
   1. Berk-Tek Leviton

B. Standards requirements:
   1. Comply with and match the performance criteria of the provided optical fiber backbone cabling.
   2. Comply with TIA-568-C.3 performance specifications.
   3. Comply with TIA-598-D fiber optic cable and connector color coding.

C. Source Limitations: Obtain optical fiber connecting hardware from same manufacturer as optical fiber cable, from single source.

D. Fiber Patch Panels or LIUs:
   1. Modular panels housing multiple-numbered, duplex cable connectors.
   2. Rack mount in telecom equipment racks.
   3. Provide fiber patch panel in each telecom room, sized to accommodate one duplex connector for each pair of installed fiber strands assigned to field, plus 25 percent spare.
   4. Provide all required fiber cassettes, adapter panels, and associated components.
   5. Provide fusion splicing of optical fibers. Mechanical splicing not acceptable.
      a. Part # 5R1UH-W03 White

E. Fiber Cable Connecting Hardware:

1. Quick-connect, duplex, Type LC connectors, with UPC polish type. Insertion loss not more than 0.75 dB.
2. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-C.3.

F. Fiber Patch Cords:
1. Factory-made, dual fiber cables with duplex connector at each end, matching the supplied fiber connector Type.
2. Comply with and match the performance criteria of the provided optical fiber backbone cabling.
3. Provide two patch cords for each installed fiber optic strand pair: One patch cord for each end.
4. Provide patch cords in the following lengths:
   a. Provide 25% for each of the following lengths: 3', 5', 7', 10'.
   b. Part # OM4 VPC-M4D1LCLCxxxx - xxxx = Length
   c. Part # OS2 LC-LC VPC-S2D1LCLCxxxx - xxxx = Length
5. Review telecom shop drawings with owner prior to procuring patch cords.

2.7 CABLING IDENTIFICATION PRODUCTS

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. Brady Worldwide
2. HellermannTyton
3. Kroy
4. Panduit

B. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 270553 "Identification for Communications Systems."

2.8 SOURCE QUALITY CONTROL

A. Factory test twisted pair cables according to TIA-568-C.2.

B. Factory test optical fiber cables according to TIA-568-C.3.

C. Factory test coaxial cables according to TIA-568-C.4.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.9 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database and graphic capabilities.

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. iTRACS Corporation

2. Telsoft Solutions

C. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.
1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:
1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

F. Closeout Submittal Requirements:
1. Software and Firmware operational documentation.
2. Software operating and upgrade manuals.
3. Program Software Backup: On compact disk or USB, complete with project data files.
4. Software application device address list data files.
5. Printout of device address list and graphic screens.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for communications device cabling conduit systems to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with TIA/EIA 606-D, "Administration Standard for Commercial Telecommunications Infrastructure."

B. In meetings with Architect and Owner, present, review and coordinate Project planning documents.

C. Verify and obtain all necessary licenses and construction permits required to complete the Project scope.

3.3 INSTALLATION

A. Comply with all state and local ordinances, codes, and regulations.

B. Coordinate all communications conduit rough-in requirements with EC and GC prior to work.

3.4 ENTRANCE FACILITIES

A. Contact communications service provider to coordinate and arrange for installation of demarcation points and associated equipment. Coordinate specific requirements with owner IT.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems."

3.5 WIRING METHODS

A. Routing:
1. Cabling may be installed in accessible ceilings unenclosed, unless otherwise indicated on the Drawings.
2. Install cable and conduit, concealed in accessible ceilings, walls, and floors where possible.
3. Cabling may be installed unenclosed within consoles, cabinets, desks, and counters.
4. In unfinished spaces, install cabling in conduit pathways; concealed in walls for new construction.
5. Where installed within conduit, conduit size shall be minimum 1 inch, maximum conduit fill 40%.
6. Refer to the Drawings for typical device conduit requirements.
7. Telecom copper transmission wiring shall not share conduit with other building wiring systems.
8. Install plenum cable in environmental air spaces, including plenum ceilings.
9. For all installation applications, provide cabling rated for the environment in which it is installed.
    a. Provide riser rated cabling as required.
    b. Provide plenum rated cabling as required.
    c. Provide indoor/outdoor rated cabling as required.
    d. Provide outside plant (OSP) or direct burial cabling as required.
    e. Non-rated OSP cabling must be terminated within 50 feet from its point of entry into the building, unless installed within continuous metallic conduit pathway.

B. Wiring within Enclosures:
1. Bundle, lace, and train cables within enclosures.
2. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
3. Provide and use lacing bars and distribution spools.
4. Install conductors parallel with or at right angles to sides and back of enclosure.

3.6 INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement and routing of primary cabling pathways.

B. Comply with the following Sections:
1. 260533 "Raceways and Boxes for Electrical Systems"
2. 270528 "Pathways for Communications Systems"
3. 270536 "Cable Trays for Communications Systems"
4. 270544 "Sleeves and Seals for Communications Pathways and Cabling"

C. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.7 INSTALLATION OF CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
   1. Comply with TIA/EIA-568-C.1.
   2. Comply with BICSI ITSIMM Ch 5 "Cable Installation" and Ch 6 "Cable Termination Practices."
   3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
   4. Cables may not be spliced.
   5. Secure and support cables not more than 6 inchesfrom cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices." Install lacing bars and distribution spools.
   8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
   11. In communications equipment rooms, install and manage a 10 foot service loop for all cables.

C. Open Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. J-hook installation: Suspend twisted pair cable not in a wireway or pathway a minimum of 8 inchesabove ceilings by cable supports not more than 60 inches apart, and at each change in direction. Hook spacing shall allow no more than 6 inches of slack. Size J-hooks to allow a minimum of 25 percent future capacity without exceeding design capacity limits. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 6 feetlong not less than 12 inchesin diameter below each feed point.

E. Twisted Pair Cable Installation:
   1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
   2. Do not untwist twisted pair cables more than 1/2 inchfrom the point of termination to maintain cable geometry.

F. Optical Fiber Cable Installation:
   1. Comply with TIA-568-C.0, TIA-568-C.1, TIA-568-C.3 and TIA-526-14-B.
   2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

G. Coaxial Cable Installation:
   1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.4.
   2. Outdoor Coaxial Cable Installation:
      a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-D for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.8 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

3.9 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

C. Comply with TIA-607-D and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inchclearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-D.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications equipment rooms, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
   1. Label each cable within 4 inchesof each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number and identify each cable extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.
   4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Visually inspect cable jacket materials for NRTL certification markings.
   2. Inspect twisted pair cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test telecom copper circuit link after termination.
   5. Test coaxial cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test coaxial cable distribution subsystem for compliance with TIA-568-C.4. Test cables after termination.
   6. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   7. Backbone Twisted Pair Calbe Tests:
      a. Test for each circuit according to TIA/EIA-568-C.1 and TIA/EIA-568-C.2.
   8. Optical Fiber Cable Tests:
      a. Link end-to-end performant test include but may not be limited to:
         1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-B, Method B, One Reference Jumper.
         2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.
         3) Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests.
   9. Coaxial Cable Tests:
      a. Test coaxial cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI TDMM, or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Where not-compliant with specified criteria, correct terminations and/or remove and replace cabling if required, to remedy deficient installation.

E. Collect results, assemble, and submit test and inspection reports.

3.12 DEMONSTRATION AND TRAINING

A. Provide four hours of training. Train owner's IT maintenance personnel in backbone cable-plant management operations, including changing signal pathways for different backbone circuits, rerouting signals in failed cables, and keeping records of backbone cabling assignments when making revisions to the installed backbone cabling system.

END OF SECTION

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category data cabling.
2. Data cabling connecting hardware.
3. Optical fiber cabling.
4. Optical fiber connecting hardware.
5. Identification products.
6. Cable management system.

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.

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping."

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. CATV: Community antenna television.

C. CEA: Consumer Electronics Association.

D. EMI: Electromagnetic interference.

E. FTP: Shielded twisted pair.

F. F/FTP: Overall foil screened cable with foil screened twisted pair.

G. F/UTP: Overall foil screened cable with unscreened twisted pair.

H. IDC: Insulation displacement connector.

I. Jack: Also termed outlet, or fixed female connector.

J. LAN: Local area network.

K. MATV: Master antenna television.

L. MMFO: Multimode Fiber Optic.

M. Outlet: Cable connecting device at work area plate.

N. Plug: Also termed connector, or male connector.

O. RCDD: Registered Communications Distribution Designer.

P. RF: Radio frequency.

Q. Screen: Metallic layer, either a foil or braid, placed around a pair or group of conductors.

R. Shield: Metallic layer, either a foil or braid, placed around a pair or group of conductors.

S. S/FTP: Overall braid screened cable with foil screened twisted pair.

T. S/UTP: Overall braid screened cable with unscreened twisted pairs.

U. SMFO: Single Mode Fiber Optic.

V. TDMM: BICSI Telecommunications Distribution Methods Manual.

W. UTP: Unscreened (unshielded) twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: Reviewed and stamped by RCDD.
   1. Telecom structured cabling plan drawings, showing data outlet locations, quantities, and types. Identify and label all data outlet locations on plans.
   2. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   3. Cabling administration drawings and printouts.
   4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Telecommunications conductor drop locations.
      f. Typical telecommunications details.

C. Cable testing plan for each cable type provided.

D. Sustainable Design Submittals, if applicable to Project.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. Certifications for RCDD, installation supervisor, and field inspector.
   2. Certification from cabling manufacturer.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Closeout Documentation: In general, Closeout Documentation includes the following post construction items:
   1. As-Built Drawings: Provide all items listed under Shop Drawings submittal. Show all information in the As-Built Drawings in its final installed condition, as was constructed.
   2. Operation and Maintenance Manuals (O&Ms).
   3. Cabling Certification and Test Results.
   4. Warranty Information.
   5. Structured Cabling Solution Manufacturer Warranty Information.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently certified by BICSI as an RCDD to supervise on-site inspection.
   4. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
   5. Manufacturer Certification: Installer must be certified by the horizonal structured cabling solution manufacturer to design and install the system and provide the specified manufacturer warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.
   2. Test each coaxial cable for open and short circuits.
   3. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with owner IT.

B. Coordinate telecom equipment room layouts and equipment rack elevations with owner IT prior to work.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling systems shall comply with TIA-568.0-D and TIA-568.1-E

B. Electrical Components, Devices, and Accessories: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70.

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: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. For all installation applications of Project, provide plenum rated cable.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-E.

F. Grounding: Comply with TIA-607-D.

2.2 HORIZONTAL TWISTED PAIR CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols. Cable splices are not allowed in the permanent link.

B. The maximum allowable permanent link twisted pair cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect within equipment room.

C. Based on field conditions, cable pathway routing, and shop drawings, notify Architect if any twisted pair data circuit length will exceed the 295 foot maximum allowable length.

D. Provide an end-to-end Category 6A horizontal structured cabling solution for the Project, as indicated on the Drawings and Specifications.

E. The installed horizonal structured cabling solution shall be certified and warrantied by the cable Manufacturer for a minimum of 25 years. Provide Manufacturer warranty information with Close Out Submittals, as identified under Part 1.

F. Product source limitations:
1. Obtain all Category data cabling, connectors, and connecting hardware from a single manufacturer.

G. Cable and outlet colors:
1. Prior to procuring equipment, confirm all cable, outlet, and connector colors with owner IT.

2.3 CATEGORY TWISTED PAIR CABLE

A. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.
1. Leviton

B. Conductors: 100-ohm, 23 AWG solid copper.

C. Standard: Comply with TIA-568.2-D for Category cables.

D. Provide Category **6A** cabling.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Jacket Color: Blue.
1. Part # 11101842 - Blue

2.4 TWISTED PAIR CABLE CONNECTING HARDWARE{CATEGORY TWISTED PAIR CABLE}

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.
   1. Leviton

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with and match the performance criteria of the provided Category data cabling.
   2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.

D. Source Limitations: Obtain twisted pair cable connecting hardware from same manufacturer as twisted pair cable, from single source.

E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
   1. Features:
      a. Universal T568A and T568B wiring labels.
      b. Labeling areas adjacent to conductors.
      c. Replaceable connectors.
      d. 48 ports, unless otherwise indicated on Drawings.
      e. Part # E2X1A-S48
   2. Construction: 16-gauge steel and mountable on 19-inchequipment racks.
   3. Number of outlet jacks: One for each four-pair Category cable indicated on Drawings.

F. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Standard: Comply with TIA-568.2-D.
      a. Part # 6ASJK-RW6

G. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Designed to snap-in to a patch panel or cover plate.
   3. Standard: Comply with TIA-568.2-D.

H. Faceplates:
   1. Provide faceplates in port configuration as required per data layout on the Drawings.
   2. Two-, four-, or six-port, vertical single gang cover plates designed to mount to single gang wall boxes, as required.
   3. Eight-, Ten-, or Twelve-port, vertical double gang cover plates designed to mount to double gang wall boxes, as required.

4. Provide plastic or metal cover plates, as coordinated with Architect prior to procuring equipment.
   a. Plastic Cover Plate: High-impact plastic. Coordinate finish and color with Architect.
   b. Metal Cover Plate: Stainless steel, or as coordinated with Architect.
5. For use with snap-in jacks accommodating any combination of twisted pair, coaxial, and optical fiber work area cords.
6. Labels: Machine printed, in the field, using adhesive-tape label. Or snap-in, clear-label covers and machine-printed paper inserts.

I. Patch Cords:
1. Factory-made, four-pair cables, terminated with an eight-position modular plug at each end.
2. Comply with and match the performance criteria of the provided Category data cabling solution.
3. Provide two patch cords for each installed data circuit: One within telecom room at rack, and one for work area outlet.
4. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
5. Provide patch cords in the following lengths:
   a. For work area outlets provide 50% 10' and 50% 15' in length.
   b. For telecom room patch cords provide 25% for each of the following lengths: 3', 5', 7' 10'.
   c. Part # 6AS10-XXL XX = Length
6. Review telecom shop drawings with owner prior to procuring patch cords. Provide patch cords in color as directed by owner.

J. Exterior Wireless AP Enclosures
1. Protective cover for wireless equipment
2. Extends RF coverage outdoors
   a. ACCELTEX 46" x 11" ATS-BOLMNT-11-STDBR
   b. ACCELTEX | ATS-14126-S-L-CG-POE-HC

2.5 HORIZONTAL OPTICAL FIBER CABLING DESCRIPTION

A. Hybrid optical fiber horizontal cabling system shall provide interconnections between equipment room distributor locations and the site CST devices consisting of (4) POE connections. Refer to project plan sheets TY 1.1.1 and TY 1.2.1 for quantities and locations.

B. Fiber optic cabling subsystem consists of horizontal cables, terminations, patch panels, and patch cords or jumpers used for horizontal-to-horizontal cross-connection. Optical fiber interconnecting units may be referred to as light interface units (LIUs).

C. Provide optical fiber horizontal cabling as indicated on the Drawings and Specifications.

D. Product source limitations:

E. Obtain fiber optic cabling, connectors, and connecting hardware from a single manufacturer.

F. Cable and outlet colors:

1. Optical fiber cable and connector colors shall be per industry standards.

2.6 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.:
   1. Leviton

B. Standards requirements:
   1. Comply with TIA-569.3-E performance specifications.
   2. Comply with TIA-598-D fiber optic cable color coding.

C. Provide: MMFO cabling, 2-strand OM3 50/125-micrometer, tight buffer, 850-nm laser-optimized, Aqua. Length at regular intervals not to exceed 40 inches. Splicing: Provide fusion splicing of optical fibers. Mechanical splicing not acceptable.

2.7 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, Basis of Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: Equivalent may be accepted pending approval by owner.:

B. Leviton

C. Standards requirements:
   1. Comply with and match the performance criteria of the provided optical fiber horizontal cabling.
   2. Comply with TIA-569.3-E performance specifications.
   3. Comply with TIA-598-D fiber optic cable and connector color coding.
   4. Leviton
      a. Hybrid Cable, Loose Tube 4 Strand Single Mode Part # ACRC004AB0403-002X12AWG
      b. Hybrid Cable Tight Buffer 2 Strand Single Mode Part # HDRC002AB0707-002X12AWG

D. Source Limitations: Obtain optical fiber connecting hardware from same manufacturer as optical fiber cable, from single source.

E. Fiber Patch Panels or LIUs: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Rack mount in telecom equipment racks.
   2. Provide fiber patch panel in each telecom room, sized to accommodate one duplex connector for each pair of installed fiber strands assigned to field, plus 25 percent spare.
   3. Provide all required fiber cassettes, adapter panels, and associated components.
   4. Provide fusion splicing of optical fibers. Mechanical splicing not acceptable.
   5. Leviton
      a. OneReach Part # 81001531
      b. 250-Watt Power Supply Part # 81001536
      c. Media Module Part # 81001262
      d. M8 Pigtail Part # 2 x 18 AWG Part # 11099456

e. 1 Port Remote Part # 81001513
f. 2 Port Remote Part # 81001535

F. Fiber Cable Connecting Hardware:
1. Quick-connect, duplex, Type LC connectors, with UPC polish type. Insertion loss not more than 0.75 dB. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-569.3-E.

G. Faceplates:
1. Provide faceplates in port configuration as required per telecom cabling layout on the Drawings.
2. Vertical single gang cover plates designed to mount to single gang wall boxes, with fiber optic connectors as required.
3. Provide plastic or metal cover plates, as coordinated with Architect prior to procuring equipment.
4. Plastic Cover Plate: High-impact plastic. Coordinate finish and color with Architect.
5. Metal Cover Plate: Stainless steel, or as coordinated with Architect.
6. For use with snap-in connectors accommodating any combination of twisted pair, coaxial, and optical fiber work area cords.
7. Labels: Machine printed, in the field, using adhesive-tape label. Or snap-in, clear-label covers and machine-printed paper inserts.

H. Fiber Patch Cords:
1. Factory-made, dual fiber cables with duplex connector at each end, matching the supplied fiber connector Type.
2. Comply with and match the performance criteria of the provided optical fiber horizontal cabling.
3. Provide two patch cords for each installed fiber optic strand pair: One patch cord for each end.
4. Provide patch cords in the following lengths:

I. Provide 25% for each of the following lengths: 3', 5', 7', 10'.
1. Review telecom shop drawings with owner prior to procuring patch cords.

2.8 CABLING IDENTIFICATION PRODUCTS

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. Brady Worldwide
2. HellermannTyton
3. Kroy
4. Panduit

B. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 270553 "Identification for Communications Systems."

2.9 SOURCE QUALITY CONTROL

A. Factory test twisted pair cables according to TIA-568.2-D.

B. Factory test optical fiber cables according to TIA-569.3-E.

C. Factory test coaxial cables according to TIA-568.4-E.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.10 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database and graphic capabilities.

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. iTRACS Corporation{ITRACS CORPORATION}
   2. Telsoft Solutions{TELSOFT SOLUTIONS}

C. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.
   1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:
   1. Direct upload tests from circuit testing instrument into the personal computer.
   2. Direct download circuit labeling into labeling printer.

F. Closeout Submittal Requirements:
   1. Software and Firmware operational documentation.
   2. Software operating and upgrade manuals.
   3. Program Software Backup: On compact disk or USB, complete with project data files.
   4. Software application device address list data files.
   5. Printout of device address list and graphic screens.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for communications device cabling conduit systems to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with TIA/EIA 606-D, "Administration Standard for Commercial Telecommunications Infrastructure."

B. In meetings with Architect and Owner, present, review and coordinate Project planning documents.

C. Verify and obtain all necessary licenses and construction permits required to complete the Project scope.

3.3 INSTALLATION

A. Comply with all state and local ordinances, codes, and regulations.

B. Coordinate all communications conduit rough-in requirements with EC and GC prior to work.

3.4 WIRING METHODS

A. Routing:
1. Cabling may be installed in accessible ceilings unenclosed, unless otherwise indicated on the Drawings.
2. Install cable and conduit, concealed in accessible ceilings, walls, and floors where possible.
3. Cabling may be installed unenclosed within consoles, cabinets, desks, and counters.
4. In unfinished spaces, install cabling in conduit pathways; concealed in walls for new construction.
5. Where installed within conduit, conduit size shall be minimum 1 inch, maximum conduit fill 40%.
6. Refer to the Drawings for typical device conduit requirements.
7. Data transmission wiring shall not share conduit with other building wiring systems.
8. Install plenum cable in environmental air spaces, including plenum ceilings.
9. For all installation applications, provide cabling rated for the environment in which it is installed.
    a. Provide riser rated cabling as required.
    b. Provide plenum rated cabling as required.
    c. Provide indoor/outdoor rated cabling as required.
    d. Provide outside plant (OSP) or direct burial cabling as required.
    e. Non-rated OSP cabling must be terminated within 50 feet from its point of entry into the building, unless installed within continuous metallic conduit pathway.

B. Wiring within Enclosures:
1. Bundle, lace, and train cables within enclosures.
2. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
3. Provide and use lacing bars and distribution spools.
4. Install conductors parallel with or at right angles to sides and back of enclosure.

3.5 INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement and routing of primary cabling pathways.

B. Comply with the following Sections:
1. 260533 "Raceways and Boxes for Electrical Systems"
2. 270528 "Pathways for Communications Systems"

3. 270536 "Cable Trays for Communications Systems"
4. 270544 "Sleeves and Seals for Communications Pathways and Cabling"

C. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.6 INSTALLATION OF CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIMM Ch 5 "Cable Installation" and Ch 6 "Cable Termination Practices."
3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
4. Cables may not be spliced.
5. Secure and support cables not more than 6 inchesfrom cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. In communications equipment rooms, install and manage a 10 foot service loop for all cables.

C. Open Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. J-hook installation: Suspend twisted pair cable not in a wireway or pathway a minimum of 8 inchesabove ceilings by cable supports not more than 60 inches apart, and at each change in direction. Hook spacing shall allow no more than 6 inches of slack. Size J-hooks to allow a minimum of 25 percent future capacity without exceeding design capacity limits. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feetlong not less than 12 inchesin diameter below each feed point.

E. Twisted Pair Cable Installation:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568.2-D.
2. Do not untwist twisted pair cables more than 1/2 inchfrom the point of termination to maintain cable geometry.

F. Optical Fiber Cable Installation:
1. Comply with TIA-568-C.0, TIA-568-C.1, TIA-569.3-E and TIA-526-14-D.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

G. Coaxial Cable Installation:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568.4-E.
2. All installed coaxial circuits and associated equipment must comply with FCC requirements for minimum signal strength at work area outlets.
3. Outdoor Coaxial Cable Installation:
   a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-E for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.7 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

3.8 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" chapter.

C. Comply with TIA-607-D and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inchclearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.9 IDENTIFICATION

A. In addition to requirements in this article, comply with identification requirements of TIA/EIA 606-C.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications equipment rooms, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
   1. Label each cable within 4 inchesof each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number and identify each cable extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Visually inspect cable jacket materials for NRTL certification markings.
2. Inspect twisted pair cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test data circuit permanent link after termination.
5. Test coaxial cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test coaxial cable distribution subsystem for compliance with TIA-568.4-E. Test cables after termination.
6. Test instruments shall meet or exceed applicable requirements in TIA-568.2-D. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
7. Twisted pair performance tests include but may not be limited to:
    a. Test for each data circuit permanent link. Perform the following tests according to TIA/EIA-568-C.1 and TIA/EIA-568.2-D:
        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.
8. Coaxial Cable Tests:
    a. Test coaxial cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.
    b. Apply RF signal to each installed circuit and test for signal strength performance at work area outlet. All installed coaxial circuits and associated equipment must comply with FCC requirements for minimum signal strength at work area outlets.
9. Optical Fiber Cable Tests:

a. Link end-to-end performant test include but may not be limited to:
   1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-D, Method B, One Reference Jumper.
   2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.
   3) Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI TDMM, or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Where not-compliant with specified criteria, correct terminations and/or remove and replace cabling if required, to remedy deficient installation.

E. Collect results, assemble, and submit test and inspection reports.

3.11 DEMONSTRATION AND TRAINING

A. Provide four hours of training. Train owner's IT maintenance personnel in horizontal cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments when making revisions to the installed horizontal cabling system.

END OF SECTION

SECTION 272100 - DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 PROJECT DESCRIPTION

A. This specification is directly related to the network electronics for the IHS WHITERIVER project.

B. The successful Bidder will supply equipment, labor, installation materials, testing, and follow-up support for the systems as described in this Specification.

1.2 SYSTEM DESCRIPTION

A. Network Electronic System
   1. The network electronics shall support Voice, data and video.
   2. See T-series drawings for fiber and copper connectivity requirements between telecommunications rooms, AV equipment rooms, and the existing campus telecommunications infrastructure.

B. Technical Power
   1. See electrical drawings for power and UPS design.

1.3 GENERAL CONDITIONS

A. The General Conditions, Requirements, and Special Provisions, of any larger body of specifications, of which this Specification may be a part, are hereby made a part of this Specification. In the event that any clauses or provisions of the larger body of specification conflict with the letter or intent of this Specification, the Contractor shall immediately notify the Consultant for clarification and direction.

1.4 THE SPECIFICATION

A. The "Specification" is defined as the body of documentation provided to the Contractor with the Request for Quotation, as well as all addenda to said documentation. Throughout this document, words such as "herein" refer to the entire Specification, and not just this written document.
   1. The Specification includes, but is not limited to:
      a. This written specification document.
      b. Additions and/or modifications as detailed in written addenda.
      c. Additions and/or modifications as detailed in drawing additions or reissues.

1.5 DEFINITION OF TERMS

A. Reference Division 01 for all definitions of terms. Division 01 will supersede any conflicts.

B. Within this section of the specification, the following definitions shall apply:
   1. The term "Owner" is used to indicate IHS.
   2. The term "Architect" is used to indicate SmithGroup.
   3. The term "Bidder" is used to indicate that entity generating the bid response.
   4. The term "Contractor" is used to indicate the successful Bidder to whom the Owner has awarded the contract.
   5. The term "Furnish" is used to indicate the responsibility to ship or deliver the item to the job site, freight prepaid, for receipt, staging and installation by others.

6. The term "Install" or "Installation" is used to indicate the responsibility of receiving the item at the job site, providing adequate storage, unpacking, or uncrating the item, physically securing the item, or otherwise making ready the item for its intended use by following the instructions and approved methods of the manufacturer and those contained herein.
7. The term "Provide" is used to indicate the responsibility to both "Furnish" and "Install".
8. The term "Provided by Others" shall refer to material and work, which is related to this contract, but has been provided by parties other than the Communications Contractor. An example might be in reference to structured cabling installed during building renovation but requiring connection to the telephony system.
9. The terms "NIC" and "Not In Contract" are equivalent to "Provided by Others".
10. The term "OFCI" (Owner Furnished Contractor Installed) shall refer to equipment that will be furnished by the Owner for installation by the Contractor. The Contractor shall be responsible for installing and integrating this equipment as detailed herein.
11. The term "shall" is mandatory; the term "will" is informative; and the term "should" is advisory.

C. Recommendations
1. Should the Bidder have recommendations that will enhance the performance of the systems, or reduce costs without the loss of performance, such comments shall be made in the Bid Response. All suggestions that are of value to the Owner shall be taken into consideration in the evaluation of the Bid Response. The Bidder shall represent all such proposals as "alternates", with the appropriate cost modifications shown separately and apart from the costs of the system as specified.

D. Exceptions
1. Notwithstanding the detailed information contained in this Specification, the Bidder shall be responsible to see that a complete and functioning system is installed. The Bidder shall notify the Consultant, prior to bidding, of any and all exceptions to these specifications and related drawings. This shall include any errors or omissions in the system design that, in his/her opinion will prevent the system from achieving all intentions of the Specification.

1.6 REQUEST FOR INFORMATION

A. All requests for information shall be e-mailed to the Consultant at RFI's should clearly indicate the specification section and/or drawing number that the request pertains to. Verbal requests for information shall be permitted only during the Pre-Bid meeting. All Bidder questions and responses to Bidder questions shall be under the heading "Addenda to the Bid" and made public to all Bidders. All Requests for Information must be received by the date as listed in the cover letter accompanying this specification. Requests for Information received after this date shall not be honored.

B. Itemized Pricing
1. The bidder shall provide itemized unit pricing for each item of the proposed system design. The Bidder agrees that the Owner may increase, decrease, or delete entirely individual items, scheduled quantities of work to be done, or materials to be furnished after execution of the Contract.

C. Taxes
   1. All appropriate taxes shall be added to the bid form.

D. Post-Bid Interview
   1. Upon receipt of Bid Responses, the Owner, Architect, and Consultant may require Bidders to participate in a Post-Bid Interview. Bidders should be prepared to attend, answer questions, and clarify any discrepancies in Bid Responses.

E. Acceptance
   1. Upon acceptance of the bid, the Bidder assumes responsibility for supplying such materials and taking such actions, whether specifically mentioned herein or not, to satisfy all intentions of the Specification without claim for additional compensation.

1.7 SITE CONDITIONS

A. Equipment Delivery And Storage
   1. Costs of all shipping to the site, and of all unusual storage requirements, shall be borne by the Contractor. It shall be the responsibility of the Contractor to make appropriate arrangements, and to coordinate with the authorized personnel at the site, for the proper acceptance, handling, protections, and storage of equipment so delivered.

B. Refuse
   1. The Contractor shall keep the site and building free of all debris and clutter, to the satisfaction of the Owner or site manager. On a daily basis, the Contractor shall remove refuse and rubbish related to the specified work from the site and shall leave the relevant areas and equipment clean and in an operational state. The Contractor shall be responsible for repairing any damage caused to the premises by the Contractor's installation activities, at no cost to the Owner.

1.8 EVALUATION FACTORS

A. The proposed systems must have a proven capability to accommodate overall size and traffic handling requirements in a stable and trouble-free mode.

B. The selected vendor must demonstrate a strong commitment to IHS in terms of service, technical support, and pricing for add-on equipment in subsequent years.

C. The selected vendor must demonstrate a strong understanding of the project scope as described herein.

1.9 SUBCONTRACT INFORMATION

A. The Bidder shall indicate any portion of the project for which the Bidder intends to engage a Subcontractor. The Bidder shall further identify all responsibilities and all work to be performed by the Subcontractor. All work performed by the Subcontractor shall be under the supervision of the Contractor and shall be the responsibility of the Contractor.

1.10 SCOPE OF WORK

A. The Contractor shall provide a complete, turnkey systems performing all of the services and functions as described herein, together with all other apparatus, cable, materials, labor, tools, transportation, and any other resources necessary to provide a complete system.

B. Specifically, the work shall include, but is not limited to:
   1. Furnishing and/or installing all equipment as specified.
   2. Ensuring that all individual components function as intended by this Specification.
   3. Ensuring that each system functions as intended by this Specification.
   4. Testing, adjusting, and fine-tuning the completed system and components.
   5. Documenting the completed installed systems as defined herein.
   6. Conducting walk-through in systems operation for the Owner's designated representative(s) as defined herein.

C. Work Excluded
   1. Work not included under this contract shall be:
      a. Providing conduit, power receptacles, junction boxes, cable raceways, electrical back-boxes, and floor boxes except where otherwise specified herein.
      b. Providing equipment cabinets.

1.11 COORDINATION

A. In the interest of a coordinated and professional project, the Contractor shall:
   1. Coordinate all work with that of other trades.
   2. Afford other trades reasonable opportunity for installation work and for storage of materials.
   3. Staff the job to keep pace with the project schedule.

1.12 JOB CONDITIONS

A. Space Conditions
   1. The Contractor shall verify dimensions of equipment, equipment arrangements, space availability (including any millwork or cabinetry provided by others) and provide systems that work within the constraints of the space available. The Contractor shall notify the Consultant of any situation where space constraints are a problem, prior to the ordering or purchase of equipment. The Contractor shall bear the expense of providing alternate equipment, which will work within the available space, if space availability problems are discovered after equipment is ordered.
   2. Plotted drawings are available for reference upon request.
   3. The Contractor shall insure during installation that access is provided to equipment and components requiring operation, service, or maintenance within the life of the system.
   4. It shall be the responsibility of the Contractor to identify any condition where the recommended environmental and/or electrical operating parameters for specified equipment/products cannot be assured. Should such condition exist, it shall further be the responsibility of the Contractor to notify the Architect and Consultant of any such condition.

1.13 LAWS AND REGULATIONS

A. All equipment, cabling, materials, and installation methodology shall conform to the requirements of the National Board of Fire Underwriters, the current published edition of the National Electrical Code, and all other applicable laws and regulations. The Contractor shall obtain and pay for any additional permits and inspections required by all legal authorities and agencies having jurisdiction over the Contractor's work.

1.14 QUALITY ASSURANCE

A. All equipment for this installation will be new, less than one year from the date of manufacture, and without blemish or defect.

B. The Contractor shall maintain the same project manager and field supervisor throughout the installation, and where practical, maintain the same installers.

C. The Contractor shall supply and install any incidental equipment needed in order to result in a complete and operable system without claim for additional payment, even if such equipment is not listed in this Specification.

D. All work related to this Specification shall be completed in a professional manner by fully qualified workers.

1.15 SCHEDULE

A. Installation Completion Agreement: The systems must be completed by the date as listed in the cover letter accompanying this specification.

1.16 RELIABILITY

A. General
   1. The system is designed to provide professional quality operation over a period of several years without the need for continual maintenance. Equipment that has a high failure rate is not acceptable for installation as part of this system.

B. Warranty
   1. The Bidder shall make known, in writing, at time of Bid any exceptions that might exist between conditions described herein and Bidder's policy of warranty. After acceptance of bid, all conditions and requirements of warranty described herein shall apply.
      a. The Contractor shall guarantee all equipment, materials, and labor for a period of 2 year from the date of final acceptance and provide additional 3 years of warranty to be reviewed and approved by the Owner.
      b. During the warranty period, within 12 hours of notification, the Contractor shall answer all service calls and requests for information.
      c. During the warranty period, within 24 hours of original notification, the Contractor shall provide emergency service to restore operation of the system, replacing defective materials, repairing faulty workmanship, making temporary repairs, and providing loaner equipment as necessary, all at no charge.
      d. The Contractor shall notify the owner after any service call whether such call is or is not covered under warranty. The Owner may be billed for non-warranty calls. The Contractor shall notify the Owner of any service call or work to be performed for which charges may be incurred before such work commences.
      e. Improper functioning, for warranty purposes, means failure of the system to meet the intentions of the specification because of internal defects. It does not include Owner caused malfunctions such as improper reprogramming or injury to the system beyond normal wear. Nor does the warranty cover paint, exterior finishes, fuses, or associated labor, unless the damage or failure results from defective materials or workmanship covered by the warranty.

f. The Contractor shall take such actions at the time of installation to ensure that all equipment is installed in accordance with the manufacturer recommended environmental and electrical operating conditions and requirements. After installation, the Contractor shall be responsible for the repair or replacement of said equipment that the Contractor installs which fails due to environmental or electrical conditions, even if not covered by the manufacturer's warranty. The Contractor shall not be held responsible for damages due to changes in environmental conditions, which occur after system acceptance.

g. Unless otherwise directed, the Contractor shall activate all manufacturer warranties in the Owner's name. The start date of the warranties shall be the date of final acceptance.

h. If the Contractor has modified certain components, the manufacturer warranty may be void. In this case, the Contractor is responsible for providing warranty coverage equal to that of the manufacturer.

i. Certain subsystems and system components may require installation by authorized representatives in order for the complete manufacturer warranty to apply. If this pertains to any subsystem or component for this project, it is the Contractor's responsibility to make arrangements for the complete manufacturer warranty to apply. These arrangements are to be at no additional cost to the Owner.

j. As part of the Bid Response, the Contractor shall provide the Owner with a proposal to extend the Warranty to cover Year 3 and Year 4 of operation. These offerings are to include all parts and all labor; all conditions and restrictions listed above apply.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: See Below.

B. Other Manufacturer's products must be submitted for Owner and Technology Consultant review for approval.

2.2 PRODUCTS AND EQUIPMENT SCHEDULES

A. Network Switching and Routing

Line #	Manufacturer Part #	Manufacturer	Description	Qty
MDF-2075				
1	C9606R	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 6 Slot Chassis	1
2	CON-SNT-C9606R	CISCO SYSTEMS (CISCOPRO)	SNTC-8X5XNBD Cisco Catalyst 9600Service Duration: 60 Months	1
3	C9600-DNA-A	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 DNA Advantage Term License	1

4	C9600-DNA-A-5Y	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 DNA Advantage 5 Year LicenseService Duration: 60 Months	1
5	CAB-CONSOLE-USB	CISCO SYSTEMS (CISCOPRO)	Console Cable 6ft with USB Type A and mini-B	1
6	C9600-NW-A	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Network Advantage License	2
7	C9606-SLOT-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series Blank for Chassis Module Slot	2
8	C9600-CAMPUS-COLL	CISCO SYSTEMS (CISCOPRO)	Catalyst 9600 Collapsed Campus Core and Distribution	1
9	C9606-FAN	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series C9606 Chassis Fan Tray	1
10	C9600X-SUP-2	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series Supervisor 2 Module	1
11	C9600X-SUP-2/2	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series Redundant Supervisor 2 Module	1
12	C9600X-LC-56YL4C	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 56-Port 10G/25G/50G, 4-Port 100G	1
13	C9600X-LC-56YL4C	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 56-Port 10G/25G/50G, 4-Port 100G	1
14	C9600-PWR-2KWAC	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 2000W AC Power Supply	4
15	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
16	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
17	C9000-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license for Catalyst 9000	1
18	C9K-F2-SSD-480GB	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 480GB SSD Storage	1
19	SFP-10G-SR-S	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module, Enterprise-Class	1
20	C9K-F2-SSD-480GB	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 480GB SSD Storage	1

21	SFP-10G-SR-S	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module, Enterprise-Class	1
22	S9600UK9-1715	CISCO SYSTEMS (CISCOPRO)	CAT9300/9400/9500/9600 UNIVERSAL	1
23	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	80
24	QSFP-100G-LR-S=	CISCO SYSTEMS (CISCOPRO)	100G QSFP28 100G-LR, 10km SMF, duplex, LC Connector	10
25	C8375-E-G2	CISCO SYSTEMS (CISCOPRO)	Cisco C8300 Series Secure Router, C8375-E-G2	1
26	CON-L1NBD-C8375EG2	CISCO SYSTEMS (CISCOPRO)	CX LEVEL 1 8X5XNBD Cisco Secure WAN C83Service Duration: 60 Months	1
27	C8300-RM-4PT-1R	CISCO SYSTEMS (CISCOPRO)	Rack Mount Kit 4 Post - 1RU for Cisco 8300 Series	1
28	C-RFID-1R	CISCO SYSTEMS (CISCOPRO)	RFID - 1RU for Cisco 8200/8300/8400/8500L Series	1
29	C8300-SM-BLANK	CISCO SYSTEMS (CISCOPRO)	SM Blank for Cisco 8300 Series	1
30	C8300-PIM-BLANK	CISCO SYSTEMS (CISCOPRO)	PIM Blank for Cisco 8300 Series	1
31	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
32	TE-R-SW-G2	CISCO SYSTEMS (CISCOPRO)	TE agent for IOSXE on Enterprise Routing for G2 Platforms	1
33	R-OS-L-E	CISCO SYSTEMS (CISCOPRO)	Cisco OS Essentials - Large (Embedded, Perpetual)	1
34	IOSXE-AUTO-MODE	CISCO SYSTEMS (CISCOPRO)	IOS XE Autonomous for Unified image	1
35	SC83G2UK9-1718	CISCO SYSTEMS (CISCOPRO)	IOS XE 17.18	1
36	PWR-CC1-400WAC	CISCO SYSTEMS (CISCOPRO)	400W AC Power supply for Cisco 8300 Series	2
37	CAB-C13-C14-2M	CISCO SYSTEMS (CISCOPRO)	Power Cord Jumper, C13-C14 Connectors, 2 Meter Length	2
38	SFP-10G-SR	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module	2
39	MEM-C83G2-32GB	CISCO SYSTEMS (CISCOPRO)	32GB Memory for Cisco 8300-G2 Series	1

40	M2USB-32G	CISCO SYSTEMS (CISCOPRO)	M.2 USB 32GB for Cisco 8300/8400/8500L Series	1
41	C-NIM-4X	CISCO SYSTEMS (CISCOPRO)	Cisco NIM Switch Module 4-port 10G SFP/SFP+	1
42	SFP-10G-SR++=	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module	2
IDF-1054				
43	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	4
44	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	4
45	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	4
46	PWR-C2-1600WAC-I/ 2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	4
47	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	8
48	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	4
49	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	4
50	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	4
51	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	4
52	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	4
53	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	4
54	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	4
55	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	4
56	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	4
57	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	4
58	C9350-FAN-I	CISCO SYSTEMS	Cisco 9350 Port Inlet Fan	12

		(CISCOPRO)	Module	
59	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	4
60	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	4
61	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	19
62	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	19
63	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	19
64	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	19
65	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	38
66	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	19
67	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	19
68	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	19
69	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	19
70	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	19
71	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	19
72	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	19
73	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	19
74	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	19
75	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	19
76	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	19

77	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	57
78	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	19
79	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	19
80	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	4
81	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	16
IDF-2057				
82	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	3
83	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	3
84	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	3
85	PWR-C2-1600WAC-I/ 2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	3
86	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	6
87	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	3
88	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	3
89	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	3
90	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	3
91	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	3
92	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	3
93	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	3
94	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	3

95	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	3
96	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	3
97	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	9
98	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	3
99	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	3
100	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	16
101	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	16
102	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	16
103	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	16
104	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	32
105	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	16
106	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	16
107	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	16
108	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	16
109	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	16
110	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	16
111	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	16
112	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	16
113	C9350-RFID	CISCO SYSTEMS	RFID Selected	16

		(CISCOPRO)		
114	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	16
115	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	16
116	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	48
117	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	16
118	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	16
119	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	4
120	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	16
IDF-3058				
121	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2
122	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
123	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
124	PWR-C2-1600WAC-I/ 2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
125	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
126	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
127	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2
128	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
129	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
130	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2

131	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2
132	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
133	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
134	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2
135	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
136	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
137	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2
138	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
139	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	8
140	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	8
141	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	8
142	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	8
143	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	16
144	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	8
145	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	8
146	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	8
147	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	8
148	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	8

149	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	8
150	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	8
151	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	8
152	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	8
153	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	8
154	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	8
155	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	24
156	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	8
157	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	8
158	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2
159	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
IDF-4058				
160	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2
161	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
162	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
163	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
164	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
165	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
166	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2

167	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
168	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
169	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2
170	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2
171	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
172	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
173	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2
174	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
175	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
176	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2
177	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
178	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	9
179	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	9
180	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	9
181	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	9
182	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	18
183	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	9
184	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	9
185	CAB-SPWR-35CM	CISCO SYSTEMS	Stack Power Cable 35 CM	9

		(CISCOPRO)		
186	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	9
187	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	9
188	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	9
189	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	9
190	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	9
191	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	9
192	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	9
193	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	9
194	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	27
195	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	9
196	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	9
197	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2
198	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
IDF-1381				
199	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	1
200	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	1
201	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
202	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
203	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15	2

			Connectors	
204	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	1
205	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	1
206	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	1
207	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
208	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
209	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
210	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
211	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
212	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
213	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
214	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
215	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
216	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
217	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	1
218	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	1
219	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	1
220	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	1
221	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15	2

			Connectors	
222	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	1
223	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	1
224	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	1
225	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
226	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
227	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
228	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
229	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
230	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
231	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	1
232	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
233	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
234	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
235	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
236	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	1
237	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	4
IDF-1019				
238	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2

239	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
240	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
241	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
242	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
243	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
244	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2
245	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
246	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
247	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2
248	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2
249	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
250	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
251	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2
252	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
253	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
254	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2
255	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
256	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	8

257	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	8
258	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	8
259	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	8
260	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	16
261	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	8
262	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	8
263	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	8
264	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	8
265	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	8
266	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	8
267	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	8
268	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	8
269	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	8
270	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	8
271	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	8
272	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	24
273	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	8
274	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	8
275	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2

276	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
IDF-2045				
277	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2
278	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
279	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
280	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
281	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
282	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
283	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2
284	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
285	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
286	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2
287	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2
288	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
289	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
290	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2
291	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
292	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
293	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2

294	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
295	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	8
296	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	8
297	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	8
298	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	8
299	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	16
300	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	8
301	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	8
302	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	8
303	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	8
304	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	8
305	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	8
306	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	8
307	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	8
308	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	8
309	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	8
310	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	8
311	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	24
312	C9350-OS-ESS	CISCO SYSTEMS	Cisco C9350 OS Essentials	8

		(CISCOPRO)		
313	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	8
314	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2
315	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
IDF-3038				
316	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2
317	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
318	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
319	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
320	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
321	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
322	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2
323	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
324	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
325	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2
326	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2
327	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
328	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
329	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2

330	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
331	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
332	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2
333	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
334	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	6
335	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	6
336	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	6
337	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	6
338	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	12
339	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	6
340	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	6
341	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	6
342	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	6
343	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	6
344	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	6
345	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	6
346	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	6
347	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	6
348	C9350-NM-BLANK	CISCO SYSTEMS	Cisco 9350 Network Module	6

		(CISCOPRO)	Blank	
349	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	6
350	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	18
351	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	6
352	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	6
353	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2
354	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
IDF-4038				
355	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2
356	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
357	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
358	PWR-C2-1600WAC-I/ 2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
359	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
360	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
361	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2
362	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
363	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
364	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2
365	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2

366	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
367	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
368	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2
369	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
370	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
371	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2
372	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
373	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	5
374	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	5
375	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	5
376	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	5
377	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	10
378	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	5
379	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	5
380	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	5
381	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	5
382	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	5
383	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	5

384	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	5
385	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	5
386	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	5
387	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	5
388	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	5
389	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	15
390	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	5
391	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	5
392	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2
393	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
MDF-1013				
394	C9606R	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 6 Slot Chassis	1
395	CON-SNT-C9606R	CISCO SYSTEMS (CISCOPRO)	SNTC-8X5XNBD Cisco Catalyst 9600Service Duration: 60 Months	1
396	C9600-DNA-A	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 DNA Advantage Term License	1
397	C9600-DNA-A-5Y	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 DNA Advantage 5 Year LicenseService Duration: 60 Months	1
398	CAB-CONSOLE-USB	CISCO SYSTEMS (CISCOPRO)	Console Cable 6ft with USB Type A and mini-B	1
399	C9600-NW-A	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Network Advantage License	2
400	C9606-SLOT-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series Blank for Chassis Module Slot	2

401	C9600-CAMPUS-COLL	CISCO SYSTEMS (CISCOPRO)	Catalyst 9600 Collapsed Campus Core and Distribution	1
402	C9606-FAN	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series C9606 Chassis Fan Tray	1
403	C9600X-SUP-2	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series Supervisor 2 Module	1
404	C9600X-SUP-2/2	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series Redundant Supervisor 2 Module	1
405	C9600X-LC-56YL4C	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 56-Port 10G/25G/50G, 4-Port 100G	1
406	C9600X-LC-56YL4C	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 56-Port 10G/25G/50G, 4-Port 100G	1
407	C9600-PWR-2KWAC	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 2000W AC Power Supply	4
408	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
409	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
410	C9000-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license for Catalyst 9000	1
411	C9K-F2-SSD-480GB	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 480GB SSD Storage	1
412	SFP-10G-SR-S	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module, Enterprise-Class	1
413	C9K-F2-SSD-480GB	CISCO SYSTEMS (CISCOPRO)	Cisco Catalyst 9600 Series 480GB SSD Storage	1
414	SFP-10G-SR-S	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module, Enterprise-Class	1
415	S9600UK9-1715	CISCO SYSTEMS (CISCOPRO)	CAT9300/9400/9500/9600 UNIVERSAL	1
416	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	80
417	QSFP-100G-LR-S=	CISCO SYSTEMS (CISCOPRO)	100G QSFP28 100G-LR, 10km SMF, duplex, LC Connector	10

418	C8375-E-G2	CISCO SYSTEMS (CISCOPRO)	Cisco C8300 Series Secure Router, C8375-E-G2	1
419	CON-L1NBD-C8375EG2	CISCO SYSTEMS (CISCOPRO)	CX LEVEL 1 8X5XNBD Cisco Secure WAN C83Service Duration: 60 Months	1
420	C8300-RM-4PT-1R	CISCO SYSTEMS (CISCOPRO)	Rack Mount Kit 4 Post - 1RU for Cisco 8300 Series	1
421	C-RFID-1R	CISCO SYSTEMS (CISCOPRO)	RFID - 1RU for Cisco 8200/8300/8400/8500L Series	1
422	C8300-SM-BLANK	CISCO SYSTEMS (CISCOPRO)	SM Blank for Cisco 8300 Series	1
423	C8300-PIM-BLANK	CISCO SYSTEMS (CISCOPRO)	PIM Blank for Cisco 8300 Series	1
424	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
425	TE-R-SW-G2	CISCO SYSTEMS (CISCOPRO)	TE agent for IOSXE on Enterprise Routing for G2 Platforms	1
426	R-OS-L-E	CISCO SYSTEMS (CISCOPRO)	Cisco OS Essentials - Large (Embedded, Perpetual)	1
427	IOSXE-AUTO-MODE	CISCO SYSTEMS (CISCOPRO)	IOS XE Autonomous for Unified image	1
428	SC83G2UK9-1718	CISCO SYSTEMS (CISCOPRO)	IOS XE 17.18	1
429	PWR-CC1-400WAC	CISCO SYSTEMS (CISCOPRO)	400W AC Power supply for Cisco 8300 Series	2
430	CAB-C13-C14-2M	CISCO SYSTEMS (CISCOPRO)	Power Cord Jumper, C13-C14 Connectors, 2 Meter Length	2
431	SFP-10G-SR	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module	2
432	MEM-C83G2-32GB	CISCO SYSTEMS (CISCOPRO)	32GB Memory for Cisco 8300-G2 Series	1
433	M2USB-32G	CISCO SYSTEMS (CISCOPRO)	M.2 USB 32GB for Cisco 8300/8400/8500L Series	1
434	C-NIM-4X	CISCO SYSTEMS (CISCOPRO)	Cisco NIM Switch Module 4-port 10G SFP/SFP+	1
435	SFP-10G-SR++=	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module	2
436	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	1

437	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	1
438	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
439	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
440	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	2
441	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	1
442	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	1
443	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	1
444	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
445	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
446	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
447	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
448	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
449	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
450	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
451	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
452	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
453	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
454	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	4

455	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	4
456	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	4
457	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	4
458	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	8
459	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	4
460	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	4
461	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	4
462	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	4
463	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	4
464	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	4
465	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	4
466	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	4
467	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	4
468	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	4
469	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	4
470	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	12
471	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	4
472	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	4
473	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	1

474	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	4
IDF-2013				
475	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	2
476	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	2
477	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
478	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	2
479	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	4
480	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	2
481	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	2
482	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	2
483	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	2
484	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	2
485	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	2
486	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	2
487	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	2
488	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	2
489	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	2
490	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	6
491	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	2

492	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	2
493	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	5
494	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	5
495	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	5
496	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	5
497	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	10
498	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	5
499	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	5
500	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	5
501	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	5
502	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	5
503	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	5
504	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	5
505	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	5
506	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	5
507	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	5
508	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	5
509	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	15
510	C9350-OS-ESS	CISCO SYSTEMS	Cisco C9350 OS Essentials	5

		(CISCOPRO)		
511	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	5
512	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	2
513	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	8
IDF-3016				
514	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	3
515	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	3
516	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	3
517	PWR-C2-1600WAC-I/ 2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	3
518	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	6
519	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	3
520	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	3
521	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	3
522	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	3
523	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	3
524	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	3
525	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	3
526	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	3
527	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	3

528	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	3
529	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	9
530	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	3
531	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	3
532	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	11
533	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	11
534	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	11
535	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	11
536	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	22
537	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	11
538	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	11
539	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	11
540	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	11
541	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	11
542	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	11
543	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	11
544	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	11
545	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	11
546	C9350-NM-BLANK	CISCO SYSTEMS	Cisco 9350 Network Module	11

		(CISCOPRO)	Blank	
547	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	11
548	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	33
549	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	11
550	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	11
551	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	3
552	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	12
IDF-4008				
553	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	3
554	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	3
555	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	3
556	PWR-C2-1600WAC-I/ 2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	3
557	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	6
558	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	3
559	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	3
560	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	3
561	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	3
562	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	3
563	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	3

564	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	3
565	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	3
566	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	3
567	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	3
568	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	9
569	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	3
570	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	3
571	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	14
572	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	14
573	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	14
574	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	14
575	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	28
576	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	14
577	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	14
578	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	14
579	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	14
580	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	14
581	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	14

582	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	14
583	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	14
584	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	14
585	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	14
586	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	14
587	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	42
588	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	14
589	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	14
590	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	3
591	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	12
OEH-2405				
592	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	1
593	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	1
594	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
595	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
596	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	2
597	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	1
598	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	1
599	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	1

600	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
601	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
602	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
603	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
604	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
605	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
606	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
607	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
608	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
609	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
610	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	1
611	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	1
612	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	1
613	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	1
614	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	2
615	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	1
616	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	1
617	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	1

618	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
619	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
620	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
621	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
622	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
623	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
624	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	1
625	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
626	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
627	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
628	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
629	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	1
630	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	4
WWTP IDF-2009				
631	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	1
632	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	1
633	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
634	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
635	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15	2

			Connectors	
636	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	1
637	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	1
638	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	1
639	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
640	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
641	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
642	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
643	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
644	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
645	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
646	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
647	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
648	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
649	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	1
650	CON-L1NBD-C935048P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	1
651	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	1
652	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	1
653	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15	2

			Connectors	
654	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	1
655	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	1
656	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	1
657	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
658	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
659	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
660	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
661	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
662	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
663	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	1
664	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
665	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
666	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
667	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
668	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	1
669	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	4
IDF-1005				
670	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	1

671	CON-L1NBD-C935048H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	1
672	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
673	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	1
674	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	2
675	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	1
676	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	1
677	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	1
678	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	1
679	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	1
680	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	1
681	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	1
682	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	1
683	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	1
684	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	1
685	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	3
686	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	1
687	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	1
688	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	4
Router				

Licensing				
689	CISCO-ROUT-SUB	CISCO SYSTEMS (CISCOPRO)	Cisco Secure Routing Subscription	1
690	LIC-ROS-L-A	CISCO SYSTEMS (CISCOPRO)	Cisco Routing Advantage Lic - Large - Each	2
Switch Licensing				
692	CISCO-NETWORK-SUB	CISCO SYSTEMS (CISCOPRO)	Cisco Networking Subscription	1
693	SVS-L0SPT-CN	CISCO SYSTEMS (CISCOPRO)	Cisco Network Product Support - Each	1
694	LIC-CS-AC1-L-E	CISCO SYSTEMS (CISCOPRO)	Cisco Switching Essentials Tier 1, Large - License	148
Optional Spares				
727	C9350-48HX	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 48-port 10G-mGig with 90W UPOE+	4
728	CON-L1NBD-C93504 8H	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco C9350 48-port 10G-mGig with 90W UPService Duration: 60 Months	4
729	PWR-C2-1600WAC-I	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	4
730	PWR-C2-1600WAC-I/2	CISCO SYSTEMS (CISCOPRO)	1600W AC 80+ Titanium Port-Inlet Config 2Power Supply	4
731	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	8
732	C9350-NM-8Y	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4x 50G SFP56 network module	4
733	STACK-T1A-1M	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	4
734	CAB-SPWR-100CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 100 CM	4
735	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	4
736	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	4
737	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	4

738	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	4
739	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	4
740	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	4
741	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	4
742	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	12
743	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	4
744	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	4
745	C9350-48P	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 48-port 30W PoE+	28
746	CON-L1NBD-C93504 8P	CISCO SYSTEMS (CISCOPRO)	ENH 8X5XNBD Cisco 9350 48port 3Service Duration: 60 Months	28
747	PWR-C2-850WAC-I	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	28
748	PWR-C2-850WAC-I/2	CISCO SYSTEMS (CISCOPRO)	850W AC 80+ platinum Port-Inlet Power Supply	28
749	CAB-C15-CBN	CISCO SYSTEMS (CISCOPRO)	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors	56
750	C9350-NM-NONE	CISCO SYSTEMS (CISCOPRO)	No Network Module Selected	28
751	STACK-T1A-50CM	CISCO SYSTEMS (CISCOPRO)	50CM Type 1 Stacking Cable	28
752	CAB-SPWR-35CM	CISCO SYSTEMS (CISCOPRO)	Stack Power Cable 35 CM	28
753	SC9350UK9-1718	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 IOS XE 17.18 K9 Universal Software Image	28
754	C9350-SSD-NONE	CISCO SYSTEMS (CISCOPRO)	No SSD Card Selected	28
755	C9350-HSEC	CISCO SYSTEMS (CISCOPRO)	U.S. Export Restriction Compliance license	28

756	C9K-ACC-SCR-4	CISCO SYSTEMS (CISCOPRO)	12-24 and 10-32 SCREWS FOR RACK INSTALLATION, QTY 4	28
757	CAB-GUIDE-1RU	CISCO SYSTEMS (CISCOPRO)	1RU CABLE MANAGEMENT GUIDES 9200 and 9300	28
758	C9350-RFID	CISCO SYSTEMS (CISCOPRO)	RFID Selected	28
759	C9350-NM-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Network Module Blank	28
760	C9350-PWR-BLANK	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 power supply blank cover	28
761	C9350-FAN-I	CISCO SYSTEMS (CISCOPRO)	Cisco 9350 Port Inlet Fan Module	84
762	C9350-OS-ESS	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 OS Essentials	28
763	NETWORK-PNP-LIC	CISCO SYSTEMS (CISCOPRO)	Network Plug-n-Play Connect for zero-touch device deployment	28
764	C9350-NM-8Y=	CISCO SYSTEMS (CISCOPRO)	Cisco C9350 8 x 25G/10G/1G or 4 x 50G SFP56 NM, spare	5
765	QSFP-100G-LR-S=	CISCO SYSTEMS (CISCOPRO)	100G QSFP28 100G-LR, 10km SMF, duplex, LC Connector	10
766	SFP-10/25G-LR-S=	CISCO SYSTEMS (CISCOPRO)	10/25GBASE-LR SFP28 Module	20
767	SFP-10G-SR-S=	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module, Enterprise-Class	10
768	SFP-10G-SR++=	CISCO SYSTEMS (CISCOPRO)	10GBASE-SR SFP Module	10
769	SFP-1G-SX=	CISCO SYSTEMS (CISCOPRO)	1000BASE-SX SFP transceiver module for SFP+ ports	10
770	STACK-T1A-1M=	CISCO SYSTEMS (CISCOPRO)	1M Type 1 Stacking Cable	10
771	STACK-T1A-3M=	CISCO SYSTEMS (CISCOPRO)	3M Type 1 Stacking Cable	10
772	LCLCSD9Y-3M-AX	AXIOM	Axiom LC/LC Singlemode Duplex OS2 9/125 Fiber Optic Cable 3mDUPLEX OS2 9/125 CABLE	264
Optional Switch Licensing				
692	CISCO-NETWORK-SU	CISCO SYSTEMS	Cisco Networking Subscription	1

	B	(CISCOPRO)		
693	SVS-L0SPT-CN	CISCO SYSTEMS (CISCOPRO)	Cisco Network Product Support - Each	1
694	LIC-CS-AC1-L-E	CISCO SYSTEMS (CISCOPRO)	Cisco Switching Essentials Tier 1, Large - License	32

B. PDUs

Line #	Manufacturer Part #	Description	Qty
1	AP7911B	RACK PDU, SWITCHED, 2U, 30A, 208V, (16)C13	6
2	APDU11151SW	APC NetShelter Rack PDU Advanced Gen 2, Switched, 5.0kW, 1Phase, 208V, 30A, L6-30P, 40 Outlet	158

C. Wireless Access Points and Controllers

Line #	Manufacturer Part #	Description	Qty
Cisco Catalyst CW9800M Wireless Controller			
1	CW9800M++	Cisco Catalyst CW9800M Wireless Controller	2
2	CON-SNT-CW9800MC	SNTC-8X5XNBD Cisco Catalyst CW9800M Wireless ControllService Duration: 60 Months	2
3	SW-CW9800M-1714	CW9800M Software IOS-XE 17.14	2
4	C8500-RFID-1R	Cisco C8500 RFID - 1RU	2
5	PWR-CH1-750WACR	750W AC Power Supply	2
6	CAB-C13-C14-2M	Power Cord Jumper, C13-C14 Connectors, 2 Meter Length	2
7	PWR-750WACR-RED	Cisco CW9800 750W AC Redundant Power Supply	2
8	CAB-C13-C14-2M	Power Cord Jumper, C13-C14 Connectors, 2 Meter Length	2
9	SFP-10G-SR-S=	10GBASE-SR SFP Module, Enterprise-Class	2
10	SFP-10/25G-CSR-S=	Dual Rate 10/25GBASE-CSR SFP Module	16
Cisco Catalyst Center Appliance			
11	DN3-HW-APL	Cisco Catalyst Center Appliance (Gen 3) - 32	1

		Core	
12	CON-SNT-DN3HBAPL	SNTC-8X5XNBD Cisco DNA Center Appliance (Gen 3) - 32Service Duration: 60 Months	1
13	DNA-SW-2.3.7	Cisco Catalyst Center SW 2.3.7	1
14	DN3-HW-APL-LIC	Cisco Catalyst Center Appliance License- 32 Core	1
15	SFP-10G-SR-S	10GBASE-SR SFP Module, Enterprise-Class	2
16	CAB-C19-CBN	Cabinet Jumper Power Cord, 250 VAC 16A, C20-C19 Connectors	2
17	DN3-CPU-I6326	Intel 6326 2.9GHz/185W 16C/24MB DDR4 3200MHz	2
18	DN3-MR-X32G2RW	32GB RDIMM DRx4 3200 (8Gb)	8
19	DN3-SD19TKA1X-EV	1.9TB 2.5 inch Enterprise Value 12G SAS SSD	2
20	DN3-RAID-220M6	Cisco 12G SAS RAID Controller w/4GB FBWC (16 Drv) w/1U Brkt	1
21	DN3-PSU1-2300W	Cisco UCS 2300W AC Power Supply for Rack Servers Titanium	2
22	DN3-GPURKIT-C220	GPU Riser Bracket assy kit C220 / C225 1U	1
23	DN3-TPM-002C	TPM 2.0, TCG, FIPS140-2, CC EAL4+ Certified, for M6 servers	1
24	DN3-SDB960SA1V	960GB 2.5in 6G SATA Enter Value 1X Samsung G1PM893A SSD	2
25	DN3-SDB1T9SA1V	1.9TB 2.5in 6G SATA Enter Value 1X Samsung G1PM893A SSD	6

26	DN3-P-I8Q25GF	Cisco-Intel E810XXVDA4L 4x25/10 GbE SFP28 PCIe NIC	1
27	DN3-P-I8D25GF	Cisco-Intel E810XXVDA2 2x25/10 GbE SFP28 PCIe NIC	1
28	SFP-10G-SR-S=	10GBASE-SR SFP Module, Enterprise-Class	2
Outdoor APs			
29	CW9163E-B	Catalyst 9163E AP(W6E, tri-band 2x2,Outdoor) w/Reg-B	47
30	CON-SNT-CW9163EB	SNTC-8X5XNBD Catalyst 9163E AP(W6E, tri-band 2x2,OutdService Duration: 60 Months	47
31	NETWORK-PNP-LIC	Network Plug-n-Play Connect for zero-touch device deployment	47
32	AIR-DNA-A-T	Wireless Cisco DNA On-Prem Advantage, Term, Tracker Lic	47
33	AIR-DNA-A-T-5Y	Wireless Cisco DNA On-Prem Advantage, 5Y Term, Tracker LicService Duration: 60 Months	47
34	AIR-DNA-NWSTACK-A	Wireless DNA Perpetual Network Stack - Advantage	47
35	CDNA-A-C9163	Wireless Cisco DNA On-Prem Advantage, 9163 Tracking	47
36	DNA-A-5Y-C9163	C9163 Cisco DNA On-Prem Advantage,5Y Term,Trk LicService Duration: 60 Months	47
37	SW9163E-CAPWAP-K9	Capwap software for Catalyst 9163E	47
38	AIR-DNA-A	Wireless Cisco DNA On-Prem Advantage,	47

		Term Lic	
39	AIR-DNA-A-5Y	Wireless Cisco DNA On-Prem Advantage, 5Y Term LicService Duration: 60 Months	47
40	SPACES-ACT-T	Cisco Spaces Act	47
41	SPACES-ACT-5Y	Cisco Spaces ActService Duration: 60 Months	47
Indoor APs			
42	CW9176I-CFG++	Cisco Wireless 9176I(W7,3 radio,3 band 4x4,UWB),Global	396
43	CON-ROB-CW917ICF	RMA UPGRADE 8X5XNBD Cisco Wireless 9176IService Duration: 60 Months	396
44	AIR-AP-BRACKET-1	802.11 AP Low Profile Mounting Bracket (Default)	396
45	AIR-AP-T-RAIL-F	Flush Mount for APs & Cellular Gateways-Recessed	396
46	CW9176-MULTI	Multi-AP packaging, minimum order qty is 6 APs	396
47	CISCO-NETWORK-SUB	Cisco Networking Subscription	1
48	LIC-CW-A	Cisco Wireless License - Advantage - License	396
49	LIC-SPACES-A-ACT	Cisco Spaces Act for Unified Advantage Licensing - Device	396
50	SVS-L0SPT-CN	Cisco Network Product Support - Each	1

D. Telephone System

Line #	Manufacturer Part #	Description	Qty
Cisco Desk Phone 9861 - TAA			
1	DP-9861-K9++=	Cisco Desk Phone 9861, TAA, Carbon Black	850

2	CON-SNT-DP9861K9	SNTC-8X5XNBD Cisco Desk Phone 9861, Carbon BlackService Duration: 60 Months	850
Desk Phone 9841 - TAA			
3	DP-9841-K9++=	Cisco Desk Phone 9841, with NFC, TAA, Carbon Black	500
4	CON-SNT-DP9841K9	SNTC-8X5XNBD Cisco Desk Phone 9841, Carbon BlackService Duration: 60 Months	500
Cisco Desk Phone 9800 Wall Mount Kit			
5	DP-9800-WMK=	Cisco Desk Phone 9800 Wall Mount Kit - SPARE	285
Cisco Desk Phone 9800 Key Expansion Module			
6	DP-9800-KEM=	Cisco Desk Phone 9800 Key Expansion Module, Carbon Black	76
7	CON-SNT-DP9KE8MA	SNTC-8X5XNBD Cisco Desk Phone 9800 Key Expansion ModuService Duration: 60 Months	76
8	CP-PWR-ADPT-3-NA=	Cisco Power Adapter 3 with North America/Japan Clip	10
9	CP-PWR-CLIP-3-NA	Power Adapter Clip for CP-PWR-ADPT-3=, North America	10
Cisco Conference Phone			
10	CP-8832-K9++	8832 base TAA in charcoal color for North America	30
11	CON-SNT-P8TK93T3	Cisco 8832 in Charcoal with accessories for North AmericaSNTService Duration: 60 Months	30
12	CP-8832-POE	Cisco IP Conference Phone 8832 PoE Accessories for Worldwide	30
Cisco Analog Voice Gateway VG410			
13	VG410-24FXS	Cisco Analog Voice Gateway VG410 - 24FXS	2
14	CON-SNT-VG410FXS	SNTC-8X5XNBD Cisco Analog Voice Gateway VG410 - 24FXSService Duration: 60 Months	2
15	SL-VG410-UC-K9	Unified Communication License for VG410 Series	2
16	SL-VG410-SEC-K9	Unified Communication Security License for Cisco VG410	2
17	CAB-C13-C14-2M	Power Cord Jumper, C13-C14 Connectors, 2 Meter Length	2
18	PWR-VG410-250	Cisco VG410 250W AC Power supply	2

19	WAC VG410-RM-19-1R	Cisco VG410 Rack mount kit - 19" 1R	2
20	NETWORK-PNP-LIC	Network Plug-n-Play Connect for zero-touch device deployment	2
21	SVG410UK9-1712	Cisco VG410 Series IOS XE Universal Image	2
Cisco Voice Routers			
22	C8300-1N1S-6T	Cisco Catalyst C8300-1N1S-6T Router	2
23	CON-L1NBD-C830IN6T	CX LEVEL 1 8X5XNBD Cisco Catalyst C8300Service Duration: 60 Months	2
24	MEM-C8300-16GB	Cisco Catalyst 8300 Edge 16GB memory	2
25	M2USB-16G	Cisco Catalyst 8000 Edge M.2 USB 16GB	2
26	C-RFID-1R	RFID - 1RU for Cisco 8200/8300/8400/8500L Series	2
27	C8300-RM-19-1R	Rack mount kit - 19" 1RU for Cisco 8300 Series	2
28	C8300-PIM-BLANK	PIM Blank for Cisco 8300 Series	2
29	NETWORK-PNP-LIC	Network Plug-n-Play Connect for zero-touch device deployment	2
30	TE-R-SW	TE agent for IOSXE on Enterprise Routing	2
31	DNA-C8300-SW	Cisco DNA subscription for C8300 series	2
32	DNA-P-T1-A-5Y	Cisco DNA Advantage On-Prem Lic 5Y - upto 250M (Aggr, 500M) - Each	2
33	SVS-PSTL1-T1-A5Y	Success Track L1 - DNA Advantage OnPrem Lic, T1, 5Y - Each	2
34	DSTACK-T1-A	Cisco DNA Advantage Stack - upto 200M (Aggr, 400M) - Each	2
35	NWSTACK-T1-A	Cisco Network Advantage Stack - upto 200M (Aggr, 400M) - Each	2
36	TE-EMBED-WANI	Cisco ThousandEyes WAN Insights Embedded - License	2
37	SDWAN-UMB-ADV	Cisco Umbrella for DNA Advantage - Each	2
38	DNAC-ONPREM-PF	Cisco DNA Center On Prem Deployment Option for WAN - Each	2
39	C83-1N1S-6T-PF	C8300-1N1S-6T Platform Selection for DNA Subscription - Each	2
40	IOSXE-AUTO-MO	IOS XE Autonomous or SD-Routing mode for Unified	2

	DE-PF	image - Each	
41	C8000-HSEC	U.S. Export Restriction Compliance license for C8000 series	2
42	SC8KBEUK9-171 2	UNIVERSAL	2
43	IOSXE-AUTO-MO DE	IOS XE Autonomous or SD-Routing mode for Unified image	2
44	C-SM-NIM-ADPT	Cisco Catalyst SM to NIM Module Adaptor	2
45	PWR-CC1-250W AC	Cisco C8300 1RU 250W AC Power supply	4
46	CAB-C13-C14-2 M	Power Cord Jumper, C13-C14 Connectors, 2 Meter Length	4
47	GLC-SX-MMD	1000BASE-SX SFP transceiver module, MMF, 850nm, DOM	4
48	NIM-PVDM-256	NIM with 256 Channel DSP	2
49	SFP-1G-SX=	1000BASE-SX SFP transceiver module for SFP+ ports	4
Cisco UC Licensing			
50	A-FLEX-3-FEDRA MP	Webex for Government	1
51	SVS-FLEXG-SUPT -BAS	Basic Support - FedRAMP and UCM Cloud for Gov - Each	1
52	A-FLEX-ENH-CUB E	CUBE Enhanced Trunk Session License - Each	450
53	A-FLEX-EAPL	EntW On-Premises Calling - Each	1345
54	A-FLEX-EXP-PAK	Expressway Product Authorization Key (1) - User	1
55	A-FLEX-SME-S	Session Manager (1) - User	1
56	A-FLEX-SRST-E	SRST Endpoints (1) - User	2690
57	A-FLEX-EXP-RMS	Expressway Rich Media Session - User	269
58	A-FLEX-P-EA	On-Premises Smart License - EA (1) - User	1614
59	A-FLEX-P-UCXN	Unity Connection Smart License (1) - User	1614
60	A-FLEX-P-ER	Emergency Responder Smart License (1) - User	4035
61	A-FLEX-P-ACC	Access Smart License (1) - User	269
62	A-FLEX-P-C-ENH	Enhanced Smart License (1) - User	673
63	A-FLEX-SW-15-K 9	On-Premises SW Bundle v15 - User	1
Cisco Desk Phone 9800 - Spare Items			
64	DP-9800-WMK=	Cisco Desk Phone 9800 Wall Mount Kit - SPARE	10
65	DP-9861-FS=	Desk Phone 9861 Replacement Footstand, Carbon	20

		Black - SPARE	
66	DP-9800-CORD=	Desk Phone 9800 Replacement Handset Cord, Carbon Black-SPARE	20
67	DP-9800-HS=	Desk Phone 9800 Replacement Handset, Carbon Black-SPARE	20

E. PCs and Peripherals

Line #	Manufacturer Part #	Manufacturer	Description	Qty
New Dell Pro 16 Plus Laptop				
1	210-BPCV	DELL	New Dell Pro 16 Plus Laptop	121
2	379-BFXM	DELL	Intel(R) Core(TM) Ultra 7 255U (12 TOPS NPU, 12 cores, up to 5.2 GHz)	121
3	619-BBQD	DELL	Windows 11 Pro	121
4	370-BCND	DELL	32 GB: 1 x 32 GB, DDR5, 5600 MT/s (5200 MT/s with Intel Core processors)	121
5	338-CRKB	DELL	Integrated Intel® graphics for Intel® Core™ Ultra 7 255U processor	121
6	400-BSLJ	DELL	512 GB SSD	121
7	391-BJPT	DELL	16", Non-Touch, FHD+, 300 nit, 45% NTSC, Anti-Glare, FHD+IR Cam	121
8	346-BLHY	DELL	Fingerprint Reader, Smart Card Reader with NFC, Control Vault 3+, includes RJ-45, US English backlit keyboard	121
9	319-BBKH	DELL	FHD HDR + IR Camera, Facial Recognition, TNR, Camera Shutter, Microphone	121
10	583-BMLJ	DELL	English US backlit Copilot key keyboard	121
11	555-BLRW	DELL	Intel® AX211 WLAN Driver	121
12	555-BLLZ	DELL	Intel® Wi-Fi 6E AX211, 2x2, 802.11ax, Bluetooth® 5.3 card	121
13	451-BDKX	DELL	3-cell, 55 Wh, ExpressCharge Capable, ExpressCharge Boost Capable	121

14	492-BDTG	DELL	65W AC adapter, USB Type-C	121
15	537-BBDO	DELL	E4 Power Cord 1M for US	121
16	340-DTVT	DELL	Quick Start Guide	121
17	340-DNBV	DELL	Documentation	121
18	387-BBLW	DELL	ENERGY STAR Qualified	121
19	817-BBBB	DELL	Custom Configuration	121
20	340-DSMH	DELL	Dell Pro 16 Plus Mix Model	121
21	379-BDZB	DELL	EPEAT 2018 Registered (Gold)	121
22	389-FGBC	DELL	Intel Core Ultra 7 Processor Label	121
23	409-BCYN	DELL	Intel(R) Rapid Storage Technology Driver	121
24	321-BLQH	DELL	No WWAN (WLAN only) Tray	121
25	631-BCCG	DELL	Intel® vPro® Management Disabled	121
26	619-BBPD	DELL	English, French, Spanish, Brazilian Portuguese	121
27	630-ABBT	DELL	Activate Your Microsoft 365 For A 30 Day Trial	121
28	658-BFVB	DELL	Dell Additional SW - Dell Pro Laptop	121
29	714-0464	DELL	Dell Limited Hardware Warranty	121
30	714-6667	DELL	ProSupport Plus: Next Business Day Onsite, 1 Year	121
31	714-6671	DELL	ProSupport Plus: Next Business Day Onsite, 2 Year Extended	121
32	714-6689	DELL	ProSupport Plus: Accidental Damage Service, 3 Years	121
33	714-6690	DELL	ProSupport Plus: Keep Your Hard Drive, 3 Years	121
34	714-6691	DELL	ProSupport Plus: 7x24 Technical Support, 3 Years	121
35	975-3461	DELL	Dell Limited Hardware Warranty Extended Year(s)	121

36	997-8367	DELL	Thank you for choosing Dell ProSupport Plus. For tech support, visit www.dell.com/contactdell or call 1-866-516-3115	121
Laptop Peripherals				
37	210-BRQV	DELL	Dell Pro Thunderbolt 4 Dock WD25TB4 GOV	121
38	718-2132	DELL	Dell Limited Hardware Warranty	121
39	718-2133	DELL	Advanced Exchange Service 3 Years	121
40	275-BBCB	DELL	DELL Optical MOUSE - MS116	121
41	319-BBHP	DELL	Dell UltraSharp Webcam WB7022	121
42	332-1571	DELL	Dell Keyboard - Smartcard USBDISC PROD SPCL SOURCING SEE NOTES	121
43	520-BBHQ	DELL	Dell Pro Premium Wireless ANC Headset - WL7024	121
Laptop Dual Dell Pro 27 Plus Monitor				
44	210-BMFG	DELL	Dell Pro 27 Plus Monitor - P2725H	242
45	814-5380	DELL	Standard Hardware Support Service	242
46	814-5381	DELL	Standard Hardware Support Service	242
Dell Pro Slim Desktop Dual Monitor (Discrete Graphics AMD)				
47	210-BQBH	DELL	New Dell Pro Slim Desktop	1300
48	338-CRZM	DELL	Intel(R) Core(TM) Ultra 7 265 vPro(R) (13 TOPS NPU, 20 cores, up to 5.3GHz)	1300
49	619-BBQD	DELL	Windows 11 Pro	1300
50	370-BCXG	DELL	32GB: 1 x 32GB, DDR5, up to 5600 MT/s, non-ECC	1300
51	400-BSWX	DELL	512GB SSD TLC	1300
52	773-BBBC	DELL	1st M.2 2280 SSD Screw	1300

53	490-BKST	DELL	AMD Radeon(TM) RX 6300, 2GB GDDR6, low profile, 2 DP	1300
54	555-BLXL	DELL	No Wireless LAN Card	1300
55	329-BLFN	DELL	Dell Pro Slim chassis with 180W PSU	1300
56	580-BCCW	DELL	Dell Pro Smartcard Keyboard - KB813 - US English	1300
57	570-BBKP	DELL	Dell Wired Mouse - MS116	1300
58	387-BBLW	DELL	ENERGY STAR Qualified	1300
59	450-AAOJ	DELL	System Power Cord (Philipine/TH/US)	1300
60	340-DNBV	DELL	Documentation	1300
61	379-BFYR	DELL	Watch Dog SRV	1300
62	340-DTTW	DELL	Quick Start Guide	1300
63	389-FKHG	DELL	US/Canada Battery Warning Label	1300
64	329-BBJL	DELL	Trusted Platform Module (Discrete TPM Enabled)	1300
65	340-DTSR	DELL	Shipping Material (DAO)	1300
66	389-BBUU	DELL	Shipping Label	1300
67	389-FJYS	DELL	FSJ Reg label for 180W PSU	1300
68	658-BFTS	DELL	Driver/APP for IRST	1300
69	389-FGBC	DELL	Intel Core Ultra 7 Processor Label	1300
70	800-BBIO	DELL	Desktop BTO Standard shipment	1300
71	210-BQBH	DELL	Dell Pro Slim QCS1250	1300
72	379-BDTO	DELL	EPEAT 2018 Registered (Silver)	1300
73	631-BCGG	DELL	No vPro(R) support	1300
74	817-BBBB	DELL	Custom Configuration	1300
75	429-BBCH	DELL	No Optical Drive	1300
76	575-BBKX	DELL	No Hard Drive Bracket	1300
77	632-BBBJ	DELL	CMS Software not included	1300
78	520-BBKW	DELL	Internal speaker	1300
79	461-BBCC	DELL	Intrusion cable switch	1300
80	382-BBHX	DELL	No Additional Add In Cards	1300
81	555-BBJO	DELL	No Additional Network Card Selected (Integrated NIC included)	1300

82	379-BBBW	DELL	TAA Information	1300
83	492-BCKH	DELL	No Additional Video Ports	1300
84	619-BBPD	DELL	English, French, Spanish, Brazilian Portuguese	1300
85	630-ABBT	DELL	Activate Your Microsoft 365 For A 30 Day Trial	1300
86	658-BFWC	DELL	Dell Pro Slim QCS1250	1300
87	716-4083	DELL	ProSupport Plus: Keep Your Hard Drive, 3 Years	1300
88	716-4088	DELL	ProSupport Plus: Next Business Day Onsite, 3 Years	1300
89	716-4093	DELL	ProSupport Plus: 7x24 Technical Support, 3 Years	1300
90	716-9303	DELL	Dell Limited Hardware Warranty Plus Service	1300
91	716-9334	DELL	ProSupport Plus: Accidental Damage Service, 3 Years	1300
92	997-8367	DELL	Thank you for choosing Dell ProSupport Plus. For tech support, visit www.dell.com/contactdell or call 1-866-516-3115	1300
Desktop Peripherals				
93	319-BBHP	DELL	Dell UltraSharp Webcam WB7022	1300
94	520-BBHQ	DELL	Dell Pro Premium Wireless ANC Headset - WL7024	1300
Desktop Single Dell Pro 27 Plus Monitor				
95	210-BMFG	DELL	Dell Pro 27 Plus Monitor - P2725H	430
96	814-5380	DELL	Standard Hardware Support Service	430
97	814-5381	DELL	Standard Hardware Support Service	430
Desktop Dual Dell Pro 27 Plus Monitor				
98	210-BMFG	DELL	Dell Pro 27 Plus Monitor - P2725H	1740
99	814-5380	DELL	Standard Hardware Support	1740

100	814-5381	DELL	Service Standard Hardware Support Service	1740

F. Copiers and Printers

Line #	Manufacturer Part #	Manufacturer	Qty
1	3PZ55A#201	HP INC	7
2	1PV67A#BGJ	HP INC	20
3	3WT91A#BGJ	HP INC	17
4	PA03740-B505	RICOH ELECTRONICS INC	17
5	ZQ61-HUXA004-00	ZEBRA TECHNOLOGIES	33
6	Z1AE-ZQ6H-3C0	ZEBRA TECHNOLOGIES	33
7	P1065668-008	ZEBRA TECHNOLOGIES	33
8	P1065668-021	ZEBRA TECHNOLOGIES	33
9	DS8108-HCBU2104Z VW	ZEBRA TECHNOLOGIES	153
10	Z1AE-DS8108-3C00	ZEBRA TECHNOLOGIES	153
11	ZD6AH43-301F00EZ	ZEBRA TECHNOLOGIES	39
12	Z1AE-ZD6X1-3C0	ZEBRA TECHNOLOGIES	39
13	5QK08A#201	HP INC	74

G. 60 GHz mmWave Point to Point Network

1. Contractor to provide and install 60 GHz mmWave point to point connection for network connectivity from the main hospital to the Waste Water Treatment Plant on the Utility Campus.
   a. Basis of Design Manufacturer: Cambium Networks

Line #	Manufacturer Part #	Qty
1	N000900L031	2
2	C000000L033	2
3	N000082L173	2
4	C600500C024	2
5	MSX-SUB-5-3	1
6	C000000L123	1
7	C000000L124	1
8	SFP-10G-LR	4
9	J-ARM UNIVERSAL MOUNT	2
10	C000000L141	2
11	C000000L138	2
12	C600500D003	2
13	C600500D004	2
14	C000000L190	2
15	CCADV-SUP-V3000-5	2

16	C000000L125	2
17	C000000L139	2
18	OUTDOOR SINGLE MODE FIBER WITH INSTALL	1
19	PROFESSIONAL INSTALLATION	1

PART 3 - EXECUTION

3.1 SUBMITTALS

A. General
   1. The Contractor shall maintain a Master Set of this entire Specification, including all drawings and addenda, at the site at all times during the installation. Any deviations from the Specification made during the installation shall be marked on this Master Set. The Master Set along with all relevant support documentation shall be provided as part of the As Built submittal in the format outlined under Final Documentation.

B. Project Milestones
   1. With the bid response, the Contractor shall provide a schedule of major project milestones to the Owner, Architect and Consultant. The schedule shall show the following milestones, but may include others as required for overall site-work coordination:
   2. Systems flow diagrams.
   3. Shop Drawings and Submittals.
   4. Delivery of materials to the work site for installation by Others (if any).
   5. Delivery of major system components to the work site.
   6. 50% completion of work by area.
   7. 95% completion of work by area.
   8. Final punch list.
   9. Submittal of Final Documentation.
   10. Training.
   11. If the Contractor anticipates issues with meeting the scheduled project milestone deadlines, the contractor must inform the Owner, Architect, or Consultant at the earliest possible opportunity.

C. Systems Configuration
   1. The Contractor shall secure from the Owner or Owner's Representative, in writing, approval for all telephone extension plans, voicemail scripts, or other customized product applications directly impacting end-user interfaces prior to installation.

D. Shop Drawings
   1. The Contractor must receive written approval from the Owner or an authorized representative of the Owner, in writing, prior to purchasing, fabricating, or installing any equipment or materials. Approval will be given based upon shop drawings.

2. The shop drawings shall indicate complete details of work to be performed. The Contractor shall submit shop drawings electronically for owner and design team review. Drawings shall include a title block naming the Project, Consultant, and Contractor, shall include a drawing title, drawing number, revision number if applicable and date.
3. The shop drawings listed below are required of the Contractor. Submit all Shop Drawings complete as a single submission. Isolated items will not be accepted, except with prior approval.
4. System Signal Flow - Complete functional system signal flow of all systems described herein and meeting the functions indicated in the Specification.
5. Others, as may be required by the Architect, Consultant or Owner.

3.2 INSTALLATION

A. General
1. All equipment shall be installed in accordance with this Specification, approved shop drawings, and manufacturer's recommendations.
2. All equipment with the exception of portable equipment shall be firmly fastened or attached in place. A safety factor of at least four shall be utilized for all brackets, fasteners, and attachments.
3. The Contractor shall insure that all equipment is installed such that proper cooling and ventilation is insured.
4. All equipment shall be protected from construction dust and debris until final acceptance of the system.
5. All equipment shall be protected from theft until final acceptance of the system.
6. The Contractor shall be under obligation to protect completed work and uncompleted work against damage or loss until the Owner has given final acceptance. Should the need arise to repair work or replace items, The Contractor shall do so at no cost to the Owner.

B. Technical Power and Grounding
1. General
   a. All devices shall be grounded, and all ground conductors shall follow a star topology. This section offers guidelines for grounding and shielding methodology. Grounding and shielding methodology may need to be augmented or modified for certain pieces of equipment or interconnections in order to meet the requirements of other sections of this specification.
   b. The Contractor shall be responsible for establishing the appropriate grounding scheme, for grounding cables and associated hardware where needed, and for making any necessary alterations to the overall system grounding scheme, in accordance with industry practices, such that system performance standards are met.
   c. Under no circumstances shall an AC neutral conductor be used to ground equipment.
   d. Equipment rack power distribution systems shall be grounded by way of the 3- conductor AC line cord(s) provided with such equipment.
   e. Active components having a grounded AC line cord shall be grounded using the supplied AC line cord connected to the equipment rack power distribution system. Removing the ground pin from a 3-conductor equipment power cord, or the use of ground defeat plugs is prohibited.

C. Field Quality Control
   1. Verify proper installation, labeling, and physical integrity of all network electronics, end-user devices (PCs, printers, phones), and associated cabling. Confirm power, grounding, and environmental conditions meet manufacturer and project requirements. Inspect connections for compliance with design drawings and ensure all equipment boots without errors.

D. Testing/Acceptance requirements for all systems and
   1. Perform functional tests to validate connectivity, configuration, and performance for each device type. For network hardware, confirm link speed, VLAN assignments, and routing as specified. For end-user devices, verify operating system readiness, peripheral functionality, and network access. Acceptance requires submission of test results demonstrating compliance with project specifications and manufacturer standards.

E. Owner Training / Demonstration Requirements
   1. Provide training on system operation, routine maintenance, and troubleshooting for all installed equipment. Deliver complete documentation including as-built diagrams, configuration files, warranty information, and quick-reference guides for common tasks such as password resets, firmware updates, and device replacement.

END OF SECTION

SECTION 273226 - TWO-WAY COMMUNICATIONS SYSTEM

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 RELATED REQUIREMENTS

A. Section 260400 "Common Work Results for Electrical"

B. Section 260533 "Raceways and Boxes for Electrical Systems"

C. Section 260553 "Identification for Electrical Systems"

D. Section 260800 "Commissioning of Electrical Systems"

E. Section 270413 "Common Submittal Requirements for Communications"

F. Section 270526 "Grounding and Bonding for Communications Systems"

G. Section 270528 "Pathways for Communications Systems"

H. Section 271300 "Communications Backbone Cabling"

I. Section 275123 "Intercommunications and Program Systems"

J. Section 283111 "Digital, Addressable, Fire-Alarm System"

1.3 SUMMARY

A. Section Includes:
1. Call stations.
2. Command station
3. Cabling.
4. Signage.

1.4 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. TIA 569-E - Commercial Building Standard for Telecommunications Pathways & Spaces

C. NFPA 72 - National Fire Alarm and Signaling Code

D. NFPA 101 - The Life Safety Code

E. IBC - International Building Code

1.5 DEFINITIONS

A. ADA: Americans with Disabilities Act

B. BICSI: Building Industry Consulting Service International.

C. EF: Entrance Facility

D. EMI: Electromagnetic interference.

E. NRTL: Nationally Recognized Testing Laboratory

F. RCDD: Registered Communications Distribution Designer.

G. TR: Telecommunications Room

1.6 SUBMITTALS

A. Informational Submittal: Submit a detailed bill-of-materials listing all part numbers and quantities for this project.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes units. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:
   1. Riser diagrams to show system component interconnections.
   2. Wiring diagrams to show typical wiring schematics.

D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

1.8 COORDINATION

A. Coordinate layout and installation of communication units with other trades and Owner.

1.9 WARRANTY

A. The unit shall be warranted for a period of two (2) years from date of final acceptance.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Provide planning, coordination, labor, materials, apparatus, hardware, wiring, tools and equipment required for a complete and operational two-way communications system in accordance with federal, state and local codes. The system shall consist of head-end equipment, command station, calling stations, rough-in, wiring, programming, instructional signage and connection to the designated outside phone line. Refer to plans for location of devices.

B. System Requirements:
   1. Fulfill the requirements of the applicable building code and all subparts and related references relative to two-way communications.
   2. Meet applicable ADA requirements.
   3. Cabling shall be 2-hour fire rated.

C. System Operation:

1. When a call is initiated from any calling (intercom) station, the System shall establish a dedicated and uninterrupted hands-free, full duplex, two-way communications session between the calling station and a command station (effectively acting as an intercom).
2. The call station shall produce a visual annunciation to indicate that a call has been placed. Annunciation may be fulfilled as an LED integrated into call station. The LED should illuminate as blinking when a call is placed and in queue and should illuminate as solid when a call session has been established with the command station.
3. The command station shall produce visual and audible annunciations to indicate an incoming call from a call station. Visual annunciation may be fulfilled as an LED integrated into the command station or as a separate strobe. Audible annunciation shall be fulfilled as a loud ring integrated into the command station.
4. The command station (or associated annunciation panel) shall display requisite information - identify the call station showing the station identifier, story/floor/level, and location on the given level.
5. When the command station has an active conversation with one calling station, the System shall automatically queue additional calls from other calling stations and shall automatically put through the calls in order received when the previous call is completed.
6. When the central control point is not staffed or not answered, the System shall automatically route calls from call stations to an emergency outside line that is constantly monitored. This will allow a call placed from a call station to ultimately reach a monitored rescue team. The local AHJ shall approve the location of the command station and central control point.
7. The System shall be able to initiate a call at the command station to any calling station.
8. The System shall connect to the Owner network and utilize the existing telephone system to call the Owner designated public safety personnel.
9. The Contractor shall integrate the two-way communication system with the IT network and telephone system.
10. Coordinate installation with Owner and IT staff.
11. Contractor shall provide all components, wiring, hardware, labor, etc. for a complete and operational system.

2.2 PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:
   1. Alpha Communications.
   2. Code Blue Corporation.
   3. Rath Communications.
   4. Talk-a-Phone LLC.
   5. Jeron Electronics Systems, Inc.

B. Call Station:
   1. Color: Stainless steel faceplate suitable for interior or exterior environments.
   2. Graphics: Push for help button.
   3. Graphics Color: Red letters.

4. Description: Single button station, full duplex, vandal resistant, recess flush mount, weatherproof NEMA 4 enclosure with gasketed access door and self-monitoring. LED to indicate status of call. Provide Braille face plate in accordance with applicable ADA requirements.
5. Provide built in battery back up to maintain back up power for a minimum of 4 hours of talk time.
6. Provide ADA compliant and vandal resistant speakerphone.
7. Communication:
    a. Call Station shall be hand-free and be a push-button-once to talk system
    b. Once the button has been pushed, the call station will call the command station. If no answer at the command station, it will automatically call pre-programmed emergency numbers. The call station must be capable of being programmed with up to 5 emergency numbers.
    c. Call station shall have location message capability. Call Station must have a minimum 18 second recordable message capability, programmable to play 1 or 2 times. Call Station shall notify called party of the location of the call upon being received at the emergency dispatch center.

C. Command Station:
1. Command station consists of network switch(es), router, distribution module, power supply and desk phone.
2. Command station shall have stainless steel housing and include red coil emergency handset.
3. Connect call stations to Owner provided network switch (if Owner approved) or provide a separate switch and router, as required, for internet connectivity.
4. Distribution module shall include power supply with 4-hour battery backup.
5. Desk phone shall be located in designated command center. Coordinate location with Owner.
6. Provide audible and visual indicator that a call station has been activated.

D. Cables and terminations: Refer to manufacturer requirements for product and code specific cable, termination and labeling requirements. Cabling shall be 2-hour fire rated. Cabling shall be red in color.

E. Power Supply: Provide required number of 24vdc power supply capable of provide power to a minimum of 10 call boxes and the command station.

F. Instructional Signage:
1. Provide laminated plastic signage with black text and graphics on white background. Text shall comply with the local building code requirements for two-way communication systems.
2. Mount signage in compliance with ADA requirements.
3. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
4. Comply with requirements in Division 26 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of call stations with the Owner.

B. Deliver equipment to the site and install in final location.

C. Using Owner-supplied parameters, properly configure equipment.

D. Test equipment in accordance with the approved test plan and provide written/electronic evidence of satisfactory completion of the testing.

E. Provide 120-volt power from nearest available source.

3.2 MOUNTING

A. Command Center is to be wall mounted 48 inches above finished floor.

B. Call Stations are to be recessed mounted no higher than 48 inches above finished floor and in accordance with applicable ADA requirements.

3.3 INSTALLATION OF PATHWAYS AND CABLES

A. Comply with TIA/EIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Communications Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Cabling shall meet the applicable requirements for pathway survivability level 3.

F. Coordinate installation with other trades and the Owner.

G. Comply with NECA 1.

H. Comply with Division 26 and 27 for installation of cables and wires.

3.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-D. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems".

B. Call stations and signage shall be installed in accordance with ADA requirements.

3.6 SIGNAGE

A. Provide signage indicating special accessibility provisions:

B. Each door providing access to an area of refuge from an adjacent floor area shall be identified by a sign stating: AREA OF REFUGE.

C. Each door providing access to an exterior area for assisted rescue shall be identified by a sign stating: EXTERIOR AREA FOR ASSISTED RESCUE.

D. Signage shall comply with the ICC A117.1 requirements for visual characters and include the International Symbol of Accessibility. The Area of Refuge and Exterior Area for Assisted Rescue signs shall be illuminated. Additionally, visual characters, raised character and braille signage complying with ICC A117.1 shall be located at each door to an area of refuge and exterior area for assisted rescue.

E. Directional Signage indicating the location of all other means of egress, and which of those are "accessible" means of egress shall be provided at the following:
   1. At exits serving a required accessible space but not providing an approved accessible means of egress.
   2. At elevator landings.
   3. Within area(s) of refuge.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections in accordance with Division 26 and 27 requirements.

B. Tests and Inspections: Visually inspect cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-B.1.
   1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   2. Test cabling for resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. The local AHJ shall approve installation.

3.8 REPAIR/RESTORATION

A. Protect adjacent surfaces. Repair damage to any surfaces occurring as a result of the work of this Section. Repair of surfaces shall include re-painting in accordance with Division 09.

END OF SECTION

SECTION 274116 – INTEGRATED AUDIOVISUAL SYSTEMS AND EQUIPMENT

PART 1 - General

1.1 SUMMARY

A. This specification outlines the Audiovisual Systems requirements for the IHS Whiteriver project.

1.2 DEFINITIONS

A. Reference Division 01 for all terms and definitions. Definitions below are specific to this section. Division 01 will supersede any conflicts.

B. Audiovisual Specification: Written documentation outlining the requirements of the audiovisual systems; includes audiovisual systems drawings, appendices, bidding equipment list, and modifications issued via addenda, bulletins, or other contractual document.

C. Audiovisual System: The equipment, software, and installation materials that when installed, interconnected, programmed and/or configured provide the functional requirements as indicated within the Audiovisual Specification.

D. Audiovisual Equipment: Equipment and materials provided by the AV Contractor as well as equipment and materials furnished by others and installed in the Audiovisual System.

E. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.

F. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

G. Closeout Documentation: Written and graphic information including construction records, as-built drawings, manuals, and reports.

1.3 RELATED DOCUMENTS

A. Reference the following documents to ensure compliance of the audiovisual systems with other project requirements.
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   2. Division 27 - Communications
   3. Appendix with AV Systems one-line diagrams.

1.4 SCOPE OF WORK

A. Provide all labor, materials, and services, unless specifically noted otherwise, to provide complete and functional audiovisual systems as required per the Audiovisual Specification. **This covers anything implied by the systems' functionality, even if not explicitly stated herein.**

This scope of work includes, but is not limited to, the following:

1. Coordinate with the Construction Manager/ General Contractor and construction trades to ensure the seamless integration and functionality of the Audiovisual Systems within the project. Request any construction documentation as necessary to enable coordination with other trades and the audiovisual systems scope of work outlined herein.
2. Confirm building systems interconnected with the audiovisual systems are functional and the required hardware to facilitate secondary control and/or monitoring of the building system has been provided by the building system installing contactor.
3. Coordinate project delivery schedule and plan with the Construction Manager/ General Contractor's overall project schedule.
4. Provide all required system design to completely develop the audiovisual systems described herein.
5. Obtain all equipment, hardware, and materials necessary to provide functional Audiovisual Systems.
6. Complete software setup, configuration, and programming required to develop fully functional audiovisual systems.
7. Supply all equipment to test, adjust, and configure the installed audiovisual systems for conformance with this Specification and the AV Contractor's designs.
8. Demonstrate the operation of the interconnected audiovisual and building systems to the Construction Manager / General Contractor prior to final acceptance and hand-over.
9. Demonstrate the operation of the Audiovisual systems to the Owner and the AV Designer prior to Owner acceptance and hand-over.
10. Provide training sessions with the Owner's staff for operating, maintaining, and troubleshooting the installed audiovisual systems.
11. Warranty the Audiovisual Systems in accordance with the terms of this Specification.
12. Exclusions
    a. Junction boxes, conduits and pathways are provided by the Division 26 (Electrical) or 27 (Structured Cabling) contractor and are not provided as part of the Audiovisual Specification. This specification encompasses the supply and installation of any additional miscellaneous low-voltage junction boxes and pathways necessary for fully functional audiovisual systems, particularly in cases where they are not covered within Division 26 or 27.

1.5 COMPLIANCE / REFERENCE STANDARDS

A. Compliance with these standards is required for the safe, efficient, and reliable operation of audiovisual systems while meeting regulatory obligations. The AV Contractor to update compliance measures to adapt to industry regulations.

B. The AV Contractor is responsible for acquiring and covering any costs associated with permits and inspections required by juridical authority relative to their scope of work.
   1. General Requirements
      a. All audiovisual systems and components must comply with relevant federal, state, and local regulations, as well as industry standards and best practices.
      b. Equipment, wiring, materials, and installation must adhere to:
         1) National Board of Fire Underwriters Standards

2) National Fire Protection Association (NFPA)
3) National Electrical Code (NEC)
4) AVIXA/InfoComm Standards and Guidelines
5) Audio Engineering Society (AES)
6) Telecommunications Industry Association (TIA) Standards and Guidelines
7) International Electrotechnical Commission (IEC)
8) American Society for Testing Materials (ASTM)
9) Building Industry Consulting Service International (BICSI)
10) ASHRAE
11) American National Standards Institute
12) International Code Council (ICC)
13) International Building Code (IBC)
14) International Organization for Standardization (ISO)
15) Americans with Disabilities Act (ADA)
16) Occupational Safety and Health Administration (OSHA) Guidelines and Regulations

2. Follow all manufacturer specifications and guidelines for installation, operation, and maintenance of all equipment.

1.6 SUBMITTALS

A. Bid Submittals
1. Provide bids in accordance with all instructions and requirements per Division 00 and the Audiovisual Specification.
2. All bidders must be qualified to perform the scope of work herein.
3. Examination
   a. Examine all documents, including drawings, specifications, addenda, and any other related materials as well as the construction site to ensure full understanding of the current site conditions.
   b. Any discrepancies, errors, conflicts or ambiguities related to the examination must be submitted per a Request for Information (RFI).
4. Pre-Bid Meeting
   a. Attend the mandatory pre-bid meeting.
      1) The pre-bid meeting is mandatory. Those not in attendance will not be considered for this project.
   b. Any clarifications or changes discussed during the pre-bid meeting will be communicated through official addenda.
      OR
   c. Attend the mandatory pre-bid meeting as required per the project manual.
5. Request for Information (RFI): All inquiries, requests for clarifications must be submitted in writing per the requirements of Division 00/01 documentation.
6. Bidding Equipment List
   a. Equipment listed herein indicates a quality and performance standard for the audiovisual system.
   b. The bidding equipment list should be considered a basis of design and a starting point, providing a foundation upon which the AV Contractor can base their bid. It serves as a guideline to ensure that the fundamental components are addressed during the bidding process.

c. The Bidding Equipment list is not a Bill of Materials. Additional equipment and materials such as power supplies, cables, connectors, mounts and hardware may not be included within the Bidding Equipment list and will need to be provided as part of the Scope of Work.

7. Substitutions
   a. If proposing substitutions for specified audiovisual equipment or materials, submit a formal request for substitution.
   b. Provide detailed information about the proposed substitution, including product specifications, performance capabilities, and any deviations from the specified items. Include a justification for the substitution, demonstrating that it meets or exceeds the performance, quality, and compatibility requirements of the original specified item.
   c. Provide pricing for the originally specified products and indicate any pricing adjustments associated with the substitution.
   d. The bidder bears all responsibility for providing functional audiovisual systems.
8. Submission
   a. Submit bid on the forms and per the instructions within Division 00/01 and the per the following.
   b. Include Line-Item Pricing
      1) Provide a detailed breakdown of all costs per system type. Identify and itemize pricing for each piece of equipment. Include unit prices, quantities, and extended totals for each line item. Pricing to be inclusive of labor and all materials.
      2) Provide any applicable taxes, fees, or surcharges.
   c. Qualifications
      1) Provide a list of similar projects. Include project scope, size, and references for each project submitted.
      2) Provide resumes for key personnel assigned to this project, to include: Project Executive, Project Manager, Audiovisual Systems Designer, Installation Foreman, Control Systems Programmer and Audio DSP Programmer. Include all manufacturer qualifications and certifications.
         a) The Control System and Audio DSP programmer must have certifications relative to the control system and Audio DSP that is specified as part of this project.
      3) AVIXA certifications
         a) CTS-D
         b) CTS-I
         c) Audiovisual Network Professional
   d. Provide documentation of the ability to be bonded to 100% of the value of the contract.
   e. Provide a list of all subcontractors that will be utilized
   f. Provide a list of all test equipment and last date of calibration.
   g. Warranty
      1) See Section 3.7 for warranty requirements.
   h. List any audiovisual equipment required for installation that requires a long lead time to procure.

1) Utilize best judgement based on current product delivery times to identify long-lead items. Omission of an item that necessitates an extended procurement time will not exempt the AV Contractor from the obligation to provide complete and functional audiovisual systems per the final project completion date.

i. Provide a preliminary project schedule outlining the following key milestones
   1) Shop Drawings and Bill of Materials
   2) Equipment Ordering
   3) Equipment Receiving
   4) Receipt of Owner Furnished Equipment
   5) Control System Development
   6) Installation

j. Provide any notes, comments or other information necessary to qualify the bid.

k. Provide a statement outlining in-house policies for recycling and environmental offset goals.

l. Failure to provide any of the requirements per this article will result in the bid being rejected.

9. Bids may be withdrawn by written request submitted prior to the award of the contract to the successful bidder.
10. Cost increases will not be approved for manufacturer cost increases or substitutions. All bids will be valid for 45 days from receipt of bid.

B. Installation Submittals
1. Provide all submittals in a digital format as specified in the project requirements per Division 00 and 01. Digital copies to be submitted via email or through a designated document management system.
2. Provide all submittals concurrently; partial or incomplete submittals will be rejected unless prior authorization from the AV Designer or Owner's Representative has been provided.
3. All Action Submittals will be reviewed by the AV Designer for compliance with the project specifications and design intent. Do not proceed with procurement, installation, or any work requiring submittal approval until written approval has been provided by the AV Designer.
4. Failure to Provide Shop Drawings / Submittals
   a. Any errors, defects, or issues that arise if installation of audiovisual systems equipment occurs in the absence of reviewed shop drawing submittals will be the responsibility of the AV Contractor. The AV Contractor, at their cost, will provide any and all necessary corrective actions to the installation.
5. Delivery Schedule
   a. Refer to Division 01 project specification for scheduling requirements.
   b. Provide a detailed project schedule within the timeframe outlined in Division 01.
6. Action Submittals
   a. Audiovisual System Shop Drawings

1) Signal flow drawings including single line diagrams illustrating the flow of audio, video and other signals through the system. Include cable type, cable numbering and equipment tags.
    a) Show all devices within the system.
    b) Show all unused or empty connection points on each piece of equipment.
2) Equipment rack layouts/elevations
3) Equipment plate and panel drawings
4) Technical furniture layout/elevations
5) Display elevations
6) Equipment mounting details for loudspeakers, projectors, flat panel displays, LED displays.
7) The following will be shown on scaled drawings. Coordinate location with other services
    a) Equipment layout to show locations of major equipment and technical furniture within the space
    b) Loudspeaker location and coverage.
    c) Microphone locations
    d) Projector location: confirm lensing requirements and no obstructions in the beam path.
8) Equipment that will be fabricated or modified under this scope.
9) Samples
    a) Coordinate requirements of samples to provide with the AV Designer and the Architect.
10) Examples of cable and equipment labeling
11) Other drawings and sketches as required by the Architect or AV Designer during project installation.

b. Bill of materials organized by individual system type and include at a minimum product make, model number, quantity and price

c. Control System and Touch Panel Submittal
    1) Provide examples of the touch panel or button panel layouts.
        a) Include functionality and descriptions of the buttons.
        b) Utilize a browser-based wireframe layout tool that allows an interactive review of the workflow.
    2) The AV Contractor should expect this to be an iterative process involving multiple submittals and meetings with the Owner as the user interface and programming is finalized.
    3) Sixty (60) days after final acceptance schedule a follow-up review with the Owner. Provide minor adjustments to the user interface and programing based on end-user feedback.

d. Delegated-Design Submittal: For seismic restraints.
    1) Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
    2) Design Calculations: Calculate requirements for selecting seismic restraints.
    3) Detail fabrication, including anchorages and attachments to structure and to supported equipment.

7. Informational Submittals
    a. Manufacturer Product Data Sheets
        1) Provide as a PDF with bookmarks for each piece of equipment.
        2) Sheets to indicate systems in which the product is installed.
        3) If multiple products are shown on a single sheet, highlight make and model number of product utilized.
    b. Seismic Qualification Data: Certificates, from manufacturer.
        1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
        2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. For equipment racks, base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
        3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Progress Reports
1. Provide progress reports on a weekly basis.
2. Email progress reports to the AV Designer and to the Owner's representative.
3. Report to include:
    a. Work completed to date
    b. Work in progress
    c. Upcoming work
    d. Schedule update
    e. Risk Assessment

D. Close-out Documentation
1. As-Built Drawings
    a. Utilize the shop drawing submittal as the basis for the As-Built drawing requirements
    b. Reflect any changes made during the installation, including cable pathways, equipment placement, and equipment interconnection.
2. Bill of Materials
    a. Provide a comprehensive list of all installed equipment by system type.
    b. Include the following:
        1) Manufacturer
        2) Make
        3) Model
        4) Serial Number
        5) MAC Address (if applicable)
        6) Assigned static or DHCP Reserved IP address (if applicable)
        7) VLAN (if applicable)
        8) Others as required by the AV Designer and Owner
3. Operations and Maintenance Manuals
    a. Manuals for each component of the AV system, including user guides, troubleshooting instructions, and maintenance schedules.
    b. Initial configuration settings for all AV equipment, including source inputs, signal routing, control system programming, and network settings.

4. Software: Software code for AV Control System, digital signal processors, and other programmable devices. Include complete job-specific source code files. The Owner to be granted use of Custom Software as provided for this project in perpetuity.
5. Commissioning Reports: Provide reports that demonstrate the successful commissioning of the AV system, including test results and calibration data.
6. System Passwords and Usernames: Provide all relevant passwords and usernames for system and individual equipment access, including administrative and user accounts.
7. Punch List Completion: Document the resolution of any outstanding punch list items and provide confirmation of their completion.
8. Warranty Information: Provide warranty details for all equipment and systems, specifying coverage periods, conditions and contact information for warranty support.

1.7 QUALITY ASSUARANCE

A. Project Management
1. Designate a qualified individual as the AV project manager responsible for overseeing the project, ensuring compliance with the contract documents, and managing all activities on and off-site relative to the project. This individual will be the primary point of contact.
2. Participate in and when necessary, lead regularly scheduled project meetings with the Construction Manager/ General Contractor, Owner, AV Designer, Architect, and other relevant parties to discuss progress, resolve issues, and ensure the project remains on schedule and within budget.

B. Contract Documents
1. Ensure that all contract documents are kept up-to-date and readily accessible to all project stakeholders.
2. Any discrepancies or conflicts between drawings, specifications and on-site conditions to be brought to the attention of the AV Designer and Construction Manager/ General Contractor via Request for Information (RFI).
   a. Propose solutions for any discrepancies or conflicts as part of the RFI.
3. Adhere to the contract documents throughout the duration of the project. Any proposed changes or deviations must be submitted in writing for approval by the AV Designer and Owner.

C. Fabrication and Installation
1. Equipment and materials to meet or exceed the manufacturer's specifications and must be installed and configured in accordance with these specifications.
2. Install equipment in a workmanlike manner, ensuring that all components are securely mounted, properly terminated, and free from defects.

D. Sub-contractors
1. Ensure subcontractors are qualified and have relevant experience on a project of this size and scope.
2. Maintain control and oversight of all subcontractors and suppliers to guarantee project requirements and deliverables are met.

E. Substitutions

1. If proposing substitutions for specified audiovisual equipment or materials, submit a formal request for substitution.
2. Provide detailed information about the proposed substitution, including product specifications, performance capabilities, and any deviations from the specified items. Include a justification for the substitution, demonstrating that it meets or exceeds the performance, quality, and compatibility requirements of the original specified item.
3. Provide pricing for the originally specified products and indicate any pricing adjustments associated with the substitution.
4. The AV Contractor bears all responsibility for providing functional audiovisual systems.

F. Source Limitations
1. Third-Party Equipment and Software
a. Install and integrate with third-party equipment, software, and services as described herein. This includes the initial configuration of all software. Support and warranty terms are subject to the terms and conditions of the respective manufacturers and/or vendors.

1.8 PROJECT / SITE CONDITIONS

A. Sequencing and Scheduling
1. Coordinate work with other trades
2. Staff the job to keep pace with the other trades.
3. Ensure space is available for other trades to carry out their work and store materials.

B. Space conditions
1. Verify all site conditions prior to the submission of shop drawings. Field conditions may vary from the construction documentation.
2. Verify locations for all audiovisual equipment. This includes
a. Verification of dimensions for equipment within millwork or furniture provided by others.
b. Confirmation of adequate ventilation for equipment that will be installed.
3. Examine all infrastructure provided by others to ensure all pathways are adequate and power and data required for functionality are installed.
4. Confirm that blocking has been installed in all locations where required.
5. Ensure that access to equipment is maintained during and after installation for service and/or maintenance.
6. Notify the AV Designer / Construction Manager / General Contractor of any defects in work by other trades affecting installation or of any instances where the site conditions will not provide for a properly installed or functional audiovisual system as specified herein.
7. If conditions change after the issuance and approval of shop drawings, the AV Contractor to propose solutions for the issue. Include any cost or schedule impact.

C. Abide by the decision of the Construction Manager/ General Contractor in instances of conflict or interference by other trades.

D. Adhere to the safety standards established by the Construction Manager/ General Contractor while performing work on site.

E. Park vehicles in areas designated by the Owner and/or the Construction Manager/ General Contractor.

F. Refuse and Repair
1. Remove all associated debris, waste, refuse, and rubbish from premises. Leave all areas and equipment within the scope of this contract clean, free of blemishes, and operational.
2. Repair any damage to the premises, at no cost to the Owner, caused by the AV Contractor's scope of work.

G. Delivery Storage and Handling
1. Secure storage at the job site. Coordinate with Project Manager and/or Owner to determine the location and size of the storage area.
2. All AV Contractor equipment and material stored offsite or installed at the Project site will remain the property of the AV Contractor unless ownership is legally transferred and accepted in writing by the Owner. The AV Contractor is responsible for the protection of all equipment from damage, theft or vandalism regardless of cause, until the work described herein is accepted by the Owner.
3. Protect all work and equipment from damage by others.
4. Protect all existing work in place by others from damage. The AV Contractor will be solely responsible for any/all damage to work in place by others.

1.9 PUBLICATION/PROMOTION

A. Reference Division 01.

PART 2 - Products

2.1 GENERAL

A. The following System Descriptions provide a comprehensive overview of the essential functional capabilities, operational requirements, and specific product details for the Audiovisual Systems. System functional requirements may be inferred from the equipment integrated within the system, as such, some functionality may not be explicitly described.

2.2 COMMON REQUIREMENTS FOR ALL AUDIOVISUAL SYSTEMS

A. The descriptions below indicate general requirements for the audiovisual systems. Not all systems will utilize these.
1. See Section 3.3 CONTROL SYSTEMS for control system and programming requirements.
2. Obtain from the Owner their Unified Communications platform standard. Configure the Unified Communications and Collaboration (UCC) system with this standard.
3. Utilize manufacturer assistance as necessary for audiovisual equipment installation and configuration.
4. Reference Division 27 Communications for standards for patch cables and other telecommunications cable requirements. Any audiovisual equipment connected to the facility LAN must utilize the Owner's standard.
5. Coordinate with the Owner on the audio level requirements for any digital signage locations.

6. Provide a secure mounting solution for any remote controls that are required to be utilized within the finished space. Coordinate solution with the Owner.
7. Coordinate with the Owner and/or Architect on the color or finish of any exposed audiovisual equipment provided by the AV Contractor. Provide submittals as required per Submittal Requirements.
8. Coordinate with the Owner regarding the location of any user devices located within furniture or millwork. This includes both surface mounted equipment or equipment that requires a cut out. Provide a mockup of the locations as required.
9. Coordinate with the Construction Manager / General Contractor and Architect for modifications to any millwork or furniture for the integration of audiovisual equipment. Provide cut-out templates and other information as required.
10. Provide any installation materials necessary for cabling within owner provided furniture to ensure cable is installed in an organized manner. Cabling within conference-style tables should not be seen hanging beneath the table.
11. Coordinate the installation location of any ceiling-mounted video cameras with the Owner. If necessary, mock-up the location in the space and provide a video output of the camera on a display.
12. Provide all software and hardware licenses as required for fully functional systems.
13. Provide mounts for equipment located behind displays, at conference-style tables, within millwork, or other locations.
14. Provide all installation materials, this includes but not limited to custom wall/floor/ceiling box plates; pre-made or loose cabling, field cabling; equipment rack panels, vents, mounts, shelves; wall mounts, ceiling mounts, equipment mounts, mounting hardware; power supplies, power distribution, cable terminations, cable dressing, labels, ties, cable management.

2.3 AV SYSTEM DESCRIPTIONS, DRAWINGS, & BIDDING EQUIPMENT LIST

A. Bidding Equipment List
   1. A bidding equipment list has been provided following each system description. This bidding equipment list may not be all-inclusive and is not a bill of materials for procurement. The bidding equipment list quantities are per room instance unless otherwise noted.
      a. Verify all functionality and equipment requirements through the submittal process.

B. System Drawings
   1. Contractor to reference ***Appx Audiovisual One-line Diagrams for Bidding*** for audiovisual systems interconnectivity and diagrams for bidding purposes in the conferencing and collaboration spaces.
   2. Digital Signage / Dashboard Monitors

32" DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-32BZ30J** **Peerless-AV ST632** **Dell Pro Micro Desktop QCM1250**	**1**

43"DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-43BZ30L Peerless-AV ST632 Dell Pro Micro Desktop QCM1250**	**3**
50" DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-50BZ30L Peerless-AV ST650 Dell Pro Micro Desktop QCM1250**	**55**
50" EXAM ROOM MEDICAL MONITOR (BY OTHERS), SIGNAL EXTENSION KIT	**Monitor and Mount by Medical Equipment AV ProEdge AC-EX40-444-KIT-TAA**	**3**
55" DIGITAL SIGNAGE/DASHBOARD DISPLAY, PORTRAIT MODE MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-55BZ35L Peerless-AV ST650P Dell Pro Micro Desktop QCM1250**	**5**
55" DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-55BZ35L Peerless-AV ST650 Dell Pro Micro Desktop QCM1250**	**12**
65" DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-65BZ35L Peerless-AV ST650 Dell Pro Micro Desktop QCM1250**	**20**
65" DIGITAL SIGNAGE/DASHBOARD DISPLAY, PORTRAIT MODE MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-65BZ35L Peerless-AV ST650P Dell Pro Micro Desktop QCM1250**	**2**
75" INTERACTIVE DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-75BZ35L Sony Pro STP-75IF Peerless-AV ST650 Dell Pro Micro Desktop QCM1250**	**4**
75" DIGITAL SIGNAGE/DASHBOARD DISPLAY, MOUNTING HARDWARE AND PC	**SONY Pro BRAVIA FW-75BZ35L Peerless-AV ST650 Dell Pro Micro Desktop QCM1250**	**13**

3. Digital Signage / Dashboard Monitors Software and Services (22 Miles)

Content Manager Lite (Annual for Cloud or Onprem)	***Lic-CM-Lite***	**1**

Emergency Alert/Security System, Queuing System, Script Pro, Patient Education content Pull, St. Onge Inventory data, Pneumatic Tube, BAS, Cerner All APIs will need to be confirmed that they are available to pull with no Patient personal data, this would be non HIPPA based data pulls. 22Miles will not be charged any 3rd party costs to pull data, any such charges will be handled by general contractor. Contractor to confirm APIs for final bidding / pricing.	**CUST-Service**	**1**
	Sub-total Multi-API Connectors-Integrations and Setup Support:	**1**
AdSlide Enterprise SaaS Site License Bundle MOQ100	***SaaS-ntPL-ASENT100S***	**118**
Touch & Wayfinding SaaS	***SaaS-tpcPL-WF***	**2**
Basic HTML5 Mobile/Web Wayfinder (Cloud)	***Lic-MwPL-WFy1***	**1**
Map Optimization Interactive 3D Map; 1 Buildings; 4 Floors; 70 Hotspots/Destinations;	***Svc-MAP-Promo***	**1**
120-hour Content Full Services with Project Management Design Scope	***Svc-CustWFx120***	**1**
Iframe- RTLS Web App Setup (Hourly Rate)	**Svc-Cons-HR175**	**15**
3-hour Remote Software and Content Configuration Services	***Svc-CFG-REMOTE4HR***	**15**
12-hour Online Training	***Spt-TRN-REMOTE12HR***	**1**
Content Manager Lite (Annual for	***Lic-CM-Lite***	**1**

Cloud or Onprem)		
AdSlide Enterprise SaaS Site License Bundle MOQ100	***SaaS-ntPL-ASENT100S***	**118**
Basic HTML5 Mobile/Web Wayfinder (Cloud)	***Lic-MwPL-WFy1***	**1**
Touch & Wayfinding SaaS	***SaaS-tpcPL-WF***	**2**

4. Patient Education / Entertainment Systems

DISPLAY TYPE DESCRIPTION	**MAKE AND MODEL**	**QUANTITY**
55" PATIENT ROOM DISPLAY AND MOUNTING HARDWARE	**LG Electronics 55UM672MOUE Peerless-AV ST650**	**20**
50" PATIENT ROOM DISPLAY AND MOUNTING HARDWARE	**LG Electronics 50UM672MOUE Peerless-AV ST650**	**5**
43" PATIENT ROOM DISPLAY AND MOUNTING HARDWARE	**LG Electronics 43UM672MOUE Peerless-AV ST635**	**8**
65" PATIENT ROOM DISPLAY AND MOUNTING HARDWARE	**LG Electronics 65UM672MOUE Peerless-AV ST650**	**20**
PATIENT ROOM CORRIDOR DISPLAY AND MOUNT	**Apple iPad Air 13-inch Heckler H650-BG**	**31**
MENTAL HEALTH TREATMENT ROOMS ANTI-LIGATURE MOUNTING HARDWARE	**Display Shield TV Shield PRO Lite and Anti-Ligature Hood for 42"-50" Displays.**	**6**
Sonifi Software - Patient Education and Entertainment Systems	**Sonifi**	**1**

5. Patient Education / Entertainment Software

SONIFI Health Platform	**Quanti**

	ty
SONIFI Health Platform Enablement (SKY) 1x / Site	1
Interactive Television Solution (ITV)	**Quanti ty**
Setup & Configuration (SKY ITV) 1x / Site	1
TV Provisioning & Endpoint Activation (SKY ITV) 1x / Endpoint	53
Swank Cloud Movies Server	1
Swank Movie Content	53
Support & Maintenance (SKY ITV)	53
STAYCAST Solution	
STAYCAST Setup & Configuration (Enablement Fee) 1x / Site	1
STAYCAST Licenses, Hardware & Installation 1x / Unit	53
STAYCAST Solution Annual Recurring Maintenance Fee (per unit)	53
Digital Door Sign Solution	**Quanti ty**
Setup & Configuration (SKY DDS) 1x / Site	1

Provisioning & Endpoint Activation (SKY DDS) 1x / Endpoint	31
Support & Maintenance (SKY DDS)	31
Digital Whiteboard Solution (DWB)	**Quantity**
Setup & Configuration (SKY DWB Split Screen with ITV) 1x / Site	1
Insights Portal Solution (Reporting)	**Quantity**
Insights Portal	1
Insights Annual Licenses (Viewer Licenses)	2

6. Audiovisual and Conferencing

Line #	Manufacturer Part #	Description			Qty
WEL-1106					
1	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			2
2	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE			2
3	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding			2
4	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding			2
5	60-1607-01	Two Output 4K/60 HDMI Distribution Amplifier			1
6	SLXD14/SM35-G58	Combo System with SLXD1 Bodypack, SLXD4 Receiver, and SM35 Headworn Microphone			1

7	AD-P6T-BK	6.5" Two-way pendant speaker, 70/100V transformer with 16 bypass, 135 conical DMT coverage, Includes	9
8	AD-S112-SW-BK	12" Surface subwoofer, includes mounting yoke and weather input cup. Color - Black.	2
9	M10 KIT-C	Eyebolt kit for suspending loudspeakers (composite-based enclosures). For K/K.2 Series, KLA12, Acoustic Design S8T, S10T - S12 models. Includes: 3x M10□□1.5, 20 mm stainless, forged shoulder eyebolts and 3x M10 black conical spring wash	2
10	CX-Q 8K8	8-Channel 1000W/CH Q-SYS Network Amplifier, Lo-Z, 70V, 100V direct drive, FlexAmp, with Mic/line Inp	2
11	CORE 8 FLEX	Q-SYS Core Processor with 8 local audio I/O channels, 64x64 network I/O channels with 8x8 Software-b	1
12	SLQBR-P	Q-SYS AV Bridging feature license. One license is required per TSC Series Gen 3 touch screen control	1
13	TSC-101-G3	Q-SYS 10.1 PoE Touch Screen Controller for In-Wall Mounting. Color - Black only	1
14	TSC-710T-G3	Table Top Mounting Accessory For TSC-70-G3 And TSC-101-G3 TAA COMPLIANT	1
15	GSM4210PD-100NAS	M4250-9G1F-POE+ FULLY MANAGED DESKTOP SWITCH	1
16	MFR-1227GE	12SP27D MOBILE F RACK GE	1
17	SM1000RM1UTAA	1000VA 800W UPS Smart Rackmount AVR 120V USB DB9 1URM TAA GSA	1
18	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

WEL-110					

7					
19	AD-P6T-BK	6.5" Two-way pendant speaker, 70/100V transformer with 16 bypass, 135 conical DMT coverage, Includes			6
20	AD-S112-SW-BK	12" Surface subwoofer, includes mounting yoke and weather input cup. Color - Black.			1
21	M10 KIT-C	Eyebolt kit for suspending loudspeakers (composite-based enclosures). For K/K.2 Series, KLA12, Acoustic Design S8T, S10T - S12 models. Includes: 3x M10□□1.5, 20 mm stainless, forged shoulder eyebolts and 3x M10 black conical spring wash			1
22	CX-Q 8K4	4-Channel 2000W/CH Q-SYS Network Amplifier, Lo-Z, 70V, 100V direct drive, FlexAmp, Mic/line Inputs,			1
23	CORE 8 FLEX	Q-SYS Core Processor with 8 local audio I/O channels, 64x64 network I/O channels with 8x8 Software-b			1
24	SLQBR-P	Q-SYS AV Bridging feature license. One license is required per TSC Series Gen 3 touch screen control			1
25	TSC-50-G3	Q-SYS 5 PoE Touch Screen Controller for In-Wall Mounting. Color - Black only			1
26	GSM4210PD-100 NAS	M4250-9G1F-POE+ FULLY MANAGED DESKTOP SWITCH			1
27	C5-FF27-1	C5 FURN FRAME,27D,1 BAY			1
28	C5KH-VAR	C5 Credenza Wood Kit (See Quote for Style, Finish, and Options)			1
29	ACC-HANDLE1-MAH	ACCY HNDL,1 BAY,MOD ALUM			1
30	ACC-LOCK1-BKH	ACCY LOCK,1 BAY,BLACK			1
31	C5-VENT1-BK	C5 VENT 1 BAY FLAT BLACK			1

32	SM1000RM1UTAA	1000VA 800W UPS Smart Rackmount AVR 120V USB DB9 1URM TAA GSA	1
33	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

WEL-1111			
34	CS-KIT-EQ-Z-K9	Cisco Room Kit EQ, Room Vision PTZ	1
35	CON-SNT-CSKITQK9	STD 8X5XNBD Cisco Room Kit EQ, Room Vision PTZService Duration: 60 Months	1
36	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
37	CS-CAM-RVPTZ-C+	Cisco Room Vision PTZ Camera, Carbon Black	1
38	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)	1
39	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)	1
40	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
41	CS-CAM-RVPTZ-CBKC	Ceiling-Wall Bracket EH RoomVision PTZCam-Carbon Black	1
42	CS-MIC-CLGPRO	Cisco Ceiling Microphone Pro, Arctic White	1
43	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
44	CS-MIC-CLGP-DMK	Drop Ceiling Grid Mounting Kit for Ceiling Microphone Pro	1
45	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack	1

46	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
47	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
48	CS-CODEC-EQ-K9+	Cisco Codec EQ unit	1
49	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
50	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
51	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2
52	FW55BZ30L	Sony BRAVIA FW-55BZ30L Digital Signage Display	2
53	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
54	XCM7000	EXTRA LARGE, DUAL COLUMN, CEILING MOUNT	2
55	CMS0305	C. PIPE 36" TO 60"	4
56	CMA110-G	8" FLAT CEILING PLATE, TAA	4
57	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	5
58	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	5
59	60-1607-01	Two Output 4K/60 HDMI Distribution Amplifier	1
60	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
61	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
62	RC5+UNI	Designed for broadcast-quality production, live	1

		event and high-end collaboration PTZ camera applicat	
63	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
64	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
65	C5-FF27-1	C5 FURN FRAME,27D,1 BAY	1
66	C5KH-VAR	C5 Credenza Wood Kit (See Quote for Style, Finish, and Options)	1
67	ACC-HANDLE1-MAH	ACCY HNDL,1 BAY,MOD ALUM	1
68	ACC-LOCK1-BKH	ACCY LOCK,1 BAY,BLACK	1
69	SM1500RMXL2UTAA	1500VA 1000W UPS Smart Rackmount AVR 120V USB DB9 2URM TAA GSA	1
70	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	2
71	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

WEL-1116					
72	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
73	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
74	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
75	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1

76	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
77	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
78	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
79	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
80	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
81	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
82	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
83	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
84	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
85	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
86	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
87	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
88	CAB-16AWG-AC	AC Power cord, 16AWG	1
89	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2
90	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
91	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
92	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio	1

		De-Embedding	
93	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
94	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
95	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
96	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
97	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
98	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
99	L5-SD7	L5 STORAGE DRAWER,7 IN	1
100	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
101	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
102	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-1324					
103	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
104	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
105	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
106	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1

107	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
108	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
109	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
110	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
111	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
112	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
113	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
114	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
115	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
116	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
117	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
118	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
119	CAB-16AWG-AC	AC Power cord, 16AWG	1
120	FW85BZ30L	85" 3840x2160 4K 440nit,24/7 display	2
121	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
122	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
123	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio	1

		De-Embedding	
124	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
125	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
126	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
127	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
128	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
129	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
130	L5-SD7	L5 STORAGE DRAWER,7 IN	1
131	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
132	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
133	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-1325					
134	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
135	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
136	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
137	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1

138	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
139	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
140	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
141	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
142	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
143	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
144	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
145	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
146	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
147	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
148	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
149	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
150	CAB-16AWG-AC	AC Power cord, 16AWG	1
151	FW85BZ30L	85" 3840x2160 4K 440nit,24/7 display	2
152	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
153	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
154	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio	1

		De-Embedding	
155	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
156	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
157	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
158	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
159	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
160	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
161	L5-SD7	L5 STORAGE DRAWER,7 IN	1
162	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
163	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
164	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-1326					
165	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
166	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
167	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
168	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1

169	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
170	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
171	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
172	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
173	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
174	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
175	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
176	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
177	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
178	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
179	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
180	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
181	CAB-16AWG-AC	AC Power cord, 16AWG	1
182	FW85BZ30L	85" 3840x2160 4K 440nit,24/7 display	2
183	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
184	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
185	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio	2

		De-Embedding	
186	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
187	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
188	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
189	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
190	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
191	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

DTY-1163/TCC-2105					
192	CS-KIT-EQ-Z-K9	Cisco Room Kit EQ, Room Vision PTZ			1
193	CON-SNT-CSKITQK9	STD 8X5XNBD Cisco Room Kit EQ, Room Vision PTZService Duration: 60 Months			1
194	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A			1
195	CS-CAM-RVPTZ-C+	Cisco Room Vision PTZ Camera, Carbon Black			1
196	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)			1
197	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)			1
198	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
199	CS-CAM-RVPTZ-	Ceiling-Wall Bracket EH RoomVision			1

	CBKC	PTZCam-Carbon Black	
200	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack	1
201	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
202	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
203	CS-CODEC-EQ-K9+	Cisco Codec EQ unit	1
204	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
205	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
206	CS-CAM-RVPTZ-C=	Cisco Room Vision PTZ Camera, Carbon Black - SPARE	1
207	CON-SNT-CSCAM1ZC	SNTC-8X5XNBD Cisco Room Vision PTZ Camera, Carbon BlaService Duration: 60 Months	1
208	CS-CAM-RVPTZ-CBKC=	Ceiling-Wall Bracket EH RoomVision PTZCam-Carbon Black-SPARE	1
209	FW98BZ30L	98" 3840x2160 4K 440nit,24/7 display	2
210	XTM1U-G	EXTRA LARGE TILT MOUNT ASSEMBLY, TAA	2
211	FCAV1U	FUSION PULLOUT	2
212	CSMP9X12	PROX,MOUNT PLATE,9X12	2
213	NV-32-H (CORE CAPABLE)	4K60 4:4:4 Network Video Endpoint for the Q-SYS Ecosystem, software configurable as Encoder or Decod	6
214	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	8
215	CORE 24F	Q-SYS Core Processor with 24 local audio I/O channels, 160x160 total network I/O channels with	1

		8x8 S	
216	CX-Q 4K4	4-Channel 1000W/CH Q-SYS Network Amplifier, Lo-Z, 70V, 100V direct drive, FlexAmp, Mic/line Inputs,	1
217	MXA920W-S-TA	920 CLNG ARR,WHT,SQR,24IN TAA	4
218	TSC-101-G3	Q-SYS 10.1 PoE Touch Screen Controller for In-Wall Mounting. Color - Black only	2
219	GSM4230UP-100NAS- US	NETGEAR M4250-26G4F-POE++ MNGD SWITCH PERP	1
220	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	2
221	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	2
222	L5-SD7	L5 STORAGE DRAWER,7 IN	2
223	L5-DCD23	L5 DOC CAM DRAWER,23IN	2
224	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	2
225	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	2
226	SM1500RMXL2UTAA	1500VA 1000W UPS Smart Rackmount AVR 120V USB DB9 2URM TAA GSA	1
227	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

DTY-1163					
228	CS-KIT-EQ-Z-K9	Cisco Room Kit EQ, Room Vision PTZ			1
229	CON-SNT-CSKITQK9	STD 8X5XNBD Cisco Room Kit EQ, Room Vision PTZService Duration: 60 Months			1
230	PWR-CORD-US	Power Cord for United States of America 2m 10A			1

	A-B		
231	CS-CAM-RVPTZ-C+	Cisco Room Vision PTZ Camera, Carbon Black	1
232	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)	1
233	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)	1
234	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
235	CS-CAM-RVPTZ-CBKC	Ceiling-Wall Bracket EH RoomVision PTZCam-Carbon Black	1
236	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack	1
237	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
238	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
239	CS-CODEC-EQ-K9+	Cisco Codec EQ unit	1
240	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
241	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
242	CS-CAM-RVPTZ-C=	Cisco Room Vision PTZ Camera, Carbon Black - SPARE	1
243	CON-SNT-CSCAM1ZC	SNTC-8X5XNBD Cisco Room Vision PTZ Camera, Carbon BlaService Duration: 60 Months	1
244	CS-CAM-RVPTZ-CBKC=	Ceiling-Wall Bracket EH RoomVision PTZCam-Carbon Black-SPARE	1

PVM-211					

8					
245	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
246	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
247	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
248	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
249	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
250	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
251	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
252	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
253	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
254	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
255	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
256	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE			1
257	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months			1
258	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE			1
259	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo			1
260	CON-SNT-C1200	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full			1

	82G	PoE, 2x1GService Duration: 60 Months	
261	CAB-16AWG-AC	AC Power cord, 16AWG	1
262	FW85BZ30L	85" 3840x2160 4K 440nit,24/7 display	2
263	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
264	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
265	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
266	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
267	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
268	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
269	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
270	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
271	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

EFS-2188					
272	AD-P6T-BK	6.5" Two-way pendant speaker, 70/100V transformer with 16 bypass, 135 conical DMT coverage, Includes			4
273	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40			1
274	CORE 8 FLEX	Q-SYS Core Processor with 8 local audio I/O			1

		channels, 64x64 network I/O channels with 8x8 Software-b	
275	SLQBR-P	Q-SYS AV Bridging feature license. One license is required per TSC Series Gen 3 touch screen control	1
276	TSC-101-G3	Q-SYS 10.1 PoE Touch Screen Controller for In-Wall Mounting. Color - Black only	1
277	GSM4210PD-100NAS	M4250-9G1F-POE+ FULLY MANAGED DESKTOP SWITCH	1
278	C5-FF27-1	C5 FURN FRAME,27D,1 BAY	1
279	C5KH-VAR	C5 Credenza Wood Kit (See Quote for Style, Finish, and Options)	1
280	ACC-HANDLE1-MAH	ACCY HNDL,1 BAY,MOD ALUM	1
281	ACC-LOCK1-BKH	ACCY LOCK,1 BAY,BLACK	1
282	C5-VENT1-BK	C5 VENT 1 BAY FLAT BLACK	1
283	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-2193					
284	CS-KIT-EQ-K9++	Cisco Room Kit EQ, TAA, Quad Cam, First Light			1
285	CON-SNT-VSXLBMDC	SNTC-8X5XNBD SNTC-8X5XNBD Room KiService Duration: 60 Months			1
286	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A			2
287	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)			1
288	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)			1

289	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
290	CS-MIC-CLGPRO	Cisco Ceiling Microphone Pro, Arctic White	2
291	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	2
292	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack	1
293	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
294	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
295	CS-QUADCAM2+	Cisco Quad Camera, First Light (White)	1
296	PSU-12VDC-70W-GR+	Powersupply - AC/DC, 12V, 6.25A, grey	1
297	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
298	CS-CODEC-EQ++	Cisco Codec EQ unit for TAA	1
299	BRKT-QCAM2-WMK-	Wall Mount Bracket (Carbon Black) for Quad Camera	1
300	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
301	CS-MIC-CLGP-DMK	Drop Ceiling Grid Mounting Kit for Ceiling Microphone Pro	2
302	CS-CAM-RVPTZ-C	Cisco Room Vision PTZ Camera, Carbon Black	1
303	CS-CAM-RVPTZ-CBKC	Ceiling-Wall Bracket EH RoomVision PTZCam-Carbon Black	1

304	FW98BZ30L	98" 3840x2160 4K 440nit,24/7 display	2
305	XTM1U-G	EXTRA LARGE TILT MOUNT ASSEMBLY, TAA	2
306	FCAV1U	FUSION PULLOUT	2
307	CSMP9X12	PROX,MOUNT PLATE,9X12	2
308	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
309	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
310	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
311	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
312	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
313	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	6
314	RC8-CQC-K	Project Pack: RemoteCam8Extension Kit + RC-CUBBY-CQC	1
315	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
316	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
317	L5-SD7	L5 STORAGE DRAWER,7 IN	1
318	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
319	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
320	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	2

321	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-2194					
322	CS-KIT-EQ-K9++	Cisco Room Kit EQ, TAA, Quad Cam, First Light			1
323	CON-SNT-VSXLBMDC	SNTC-8X5XNBD SNTC-8X5XNBD Room KiService Duration: 60 Months			1
324	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A			2
325	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)			1
326	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)			1
327	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
328	CS-MIC-CLGPRO	Cisco Ceiling Microphone Pro, Arctic White			2
329	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months			2
330	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack			1
331	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo			1
332	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months			1
333	CS-QUADCAM2+	Cisco Quad Camera, First Light (White)			1
334	PSU-12VDC-70W-GR+	Powersupply - AC/DC, 12V, 6.25A, grey			1

335	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
336	CS-CODEC-EQ++	Cisco Codec EQ unit for TAA	1
337	BRKT-QCAM2-WMK-	Wall Mount Bracket (Carbon Black) for Quad Camera	1
338	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
339	CS-MIC-CLGP-DMK	Drop Ceiling Grid Mounting Kit for Ceiling Microphone Pro	2
340	FW98BZ30L	98" 3840x2160 4K 440nit,24/7 display	2
341	XTM1U-G	EXTRA LARGE TILT MOUNT ASSEMBLY, TAA	2
342	FCAV1U	FUSION PULLOUT	2
343	CSMP9X12	PROX,MOUNT PLATE,9X12	2
344	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
345	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	2
346	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
347	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
348	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
349	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
350	RC8-CQC-K	Project Pack: RemoteCam8Extension Kit + RC-CUBBY-CQC	1

351	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	3
352	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-2195					
353	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
354	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
355	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
356	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
357	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
358	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
359	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
360	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
361	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
362	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
363	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
364	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			2
365	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE			2

366	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
367	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
368	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
369	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
370	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
371	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-2196					
372	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
373	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
374	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
375	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
376	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
377	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
378	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
379	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
380	CS-BARPRO-MO	Mounting Kit for Cisco Room Bar Pro			1

	UNT-		
381	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
382	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
383	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	2
384	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
385	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
386	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
387	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
388	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
389	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
390	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

OEH-2214					
391	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
392	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
393	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
394	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1

395	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
396	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
397	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
398	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
399	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
400	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
401	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
402	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	1
403	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
404	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
405	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
406	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
407	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
408	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
409	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
410	L5-TURFR-33LD	L5 TURRET FRAME,LD,LW33W	1

	W		
411	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
412	L5-SD7	L5 STORAGE DRAWER,7 IN	1
413	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
414	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
415	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-2282					
416	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
417	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
418	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
419	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
420	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
421	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
422	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
423	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
424	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
425	CS-T10-WM-L-K	Room Navigator Wall Mount, TAA, First Light -			1

	9++=	SPARE	
426	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
427	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
428	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
429	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
430	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
431	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
432	CAB-16AWG-AC	AC Power cord, 16AWG	1
433	FW65BZ30L	65" 3840x2160 4K 440nit,24/7 display	2
434	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
435	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
436	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
437	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
438	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
439	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
440	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
441	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1

442	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-2283					
443	CS-KIT-EQ-K9++	Cisco Room Kit EQ, TAA, Quad Cam, First Light			1
444	CON-SNT-VSXLBMDC	SNTC-8X5XNBD SNTC-8X5XNBD Room KiService Duration: 60 Months			1
445	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A			2
446	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)			1
447	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)			1
448	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
449	CS-MIC-CLGPRO	Cisco Ceiling Microphone Pro, Arctic White			2
450	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months			2
451	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack			1
452	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo			1
453	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months			1
454	CS-QUADCAM2+	Cisco Quad Camera, First Light (White)			1
455	PSU-12VDC-70W-GR+	Powersupply - AC/DC, 12V, 6.25A, grey			1

456	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
457	CS-CODEC-EQ++	Cisco Codec EQ unit for TAA	1
458	BRKT-QCAM2-WMK-	Wall Mount Bracket (Carbon Black) for Quad Camera	1
459	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
460	CS-MIC-CLGP-DMK	Drop Ceiling Grid Mounting Kit for Ceiling Microphone Pro	2
461	FW85BZ30L	85" 3840x2160 4K 440nit,24/7 display	2
462	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
463	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
464	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
465	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
466	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
467	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
468	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	6
469	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
470	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1

471	L5-SD7	L5 STORAGE DRAWER,7 IN	1
472	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
473	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
474	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-3226					
475	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
476	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
477	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
478	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
479	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
480	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
481	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
482	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
483	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
484	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
485	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1

486	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
487	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
488	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
489	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
490	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
491	CAB-16AWG-AC	AC Power cord, 16AWG	1
492	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2
493	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
494	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
495	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
496	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
497	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
498	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
499	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
500	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
501	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

TCC-3229					
502	CS-KIT-EQ-4K-K9++	Cisco Room Kit EQ, TAA, PTZ4K Cam			1
503	CON-SNT-CSKIT4EQ	SNTC-8X5XNBD Cisco Room Kit EQ, PTZ 4K CamService Duration: 60 Months			1
504	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A			2
505	CS-CAM-PTZ4K+	Pan-Tilt-Zoom 4K 20x Camera			1
506	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)			1
507	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)			1
508	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
509	CS-CAM-PTZ4K	Pan-Tilt-Zoom 4K 20x Camera			1
510	CON-SNT-CS1F4KCA	Pan-Tilt-Zoom 4K 20x camera SNTC-8X5XNBDService Duration: 60 Months			1
511	CS-PTZ4K-BRKT	Bracket for wall mounting of PTZ 4K camera			2
512	PSU-12VDC-40W2	Power Supply 12 VDC 40W			1
513	CS-MIC-CLGPRO	Cisco Ceiling Microphone Pro, Arctic White			2
514	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months			2
515	CS-MIC-CLGP-DMK	Drop Ceiling Grid Mounting Kit for Ceiling Microphone Pro			2
516	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack			1

517	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
518	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
519	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
520	CS-CODEC-EQ++	Cisco Codec EQ unit for TAA	1
521	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	2
522	FW98BZ30L	98" 3840x2160 4K 440nit,24/7 display	2
523	XTM1U-G	EXTRA LARGE TILT MOUNT ASSEMBLY, TAA	2
524	FCAV1U	FUSION PULLOUT	2
525	CSMP9X12	PROX,MOUNT PLATE,9X12	2
526	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
527	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
528	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
529	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
530	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
531	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	6
532	RC8-CQC-K	Project Pack: RemoteCam8Extension Kit + RC-CUBBY-CQC	1

533	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
534	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
535	L5-SD7	L5 STORAGE DRAWER,7 IN	1
536	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
537	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
538	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	2
539	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

PCC-3269					
540	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			1
541	MTM1U	Chief Fusion Medium TV Wall Mount - For 32-65 inch Displays - Tilt TV Mount - VESA Wall MountMEDIUM			1
542	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets			1
543	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)			1

PCC-3270					
544	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			1
545	MTM1U	Chief Fusion Medium TV Wall Mount - For 32-65 inch Displays - Tilt TV Mount - VESA Wall MountMEDIUM			1

546	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	1
547	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

PCC-3271					
548	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			1
549	MTM1U	Chief Fusion Medium TV Wall Mount - For 32-65 inch Displays - Tilt TV Mount - VESA Wall MountMEDIUM			1
550	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets			1
551	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)			1

PCC-3273					
552	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			1
553	MTM1U	Chief Fusion Medium TV Wall Mount - For 32-65 inch Displays - Tilt TV Mount - VESA Wall MountMEDIUM			1
554	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets			1
555	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)			1

PCC-3274					
556	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			1

557	MTM1U	Chief Fusion Medium TV Wall Mount - For 32-65 inch Displays - Tilt TV Mount - VESA Wall MountMEDIUM	1
558	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	1
559	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

PCC-3275					
560	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display			1
561	MTM1U	Chief Fusion Medium TV Wall Mount - For 32-65 inch Displays - Tilt TV Mount - VESA Wall MountMEDIUM			1
562	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets			1
563	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)			1

PCC-3276					
564	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
565	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
566	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
567	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
568	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
569	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light			1

		(White)	
570	CAB-2HDMI-1.5 M-GR-	1.5m GREY HDMI 2.0	1
571	CAB-ETH-5M-GR -	CAB (16,4 feet / 5m) GREY ETHERNET	1
572	CS-BARPRO-MO UNT-	Mounting Kit for Cisco Room Bar Pro	1
573	CS-T10-WM-L-K 9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
574	CON-SNT-CST1 0LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
575	CS-MIC-CLGPR O++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
576	CON-SNT-CSMI CPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
577	CS-MIC-CLGP-D MK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
578	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
579	CON-SNT-C1200 82G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
580	CAB-16AWG-AC	AC Power cord, 16AWG	1
581	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2
582	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
583	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
584	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
585	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1

586	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
587	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
588	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
589	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
590	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

PCC-3283					
591	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
592	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
593	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
594	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
595	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
596	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
597	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
598	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
599	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1

600	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
601	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
602	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	2
603	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
604	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
605	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
606	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
607	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
608	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
609	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

PCC-3292					
610	CS-KIT-EQ-K9++	Cisco Room Kit EQ, TAA, Quad Cam, First Light			1
611	CON-SNT-VSXLBMDC	SNTC-8X5XNBD SNTC-8X5XNBD Room KiService Duration: 60 Months			1
612	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A			2
613	CS-T10-TS-L+	Cisco Room Navigator Table Stand, First Light (White)			1
614	CS-T10-WM-L-K9	Cisco Room Navigator Wall Mount, First Light (White)			1

615	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
616	CS-MIC-CLGPRO	Cisco Ceiling Microphone Pro, Arctic White	2
617	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	2
618	CS-CODEC-EQ-RCK	Rack ears for the Codec EQ - for mounting in rack	1
619	C1200-8FP-2G-OPT	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
620	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
621	CS-QUADCAM2+	Cisco Quad Camera, First Light (White)	1
622	PSU-12VDC-70W-GR+	Powersupply - AC/DC, 12V, 6.25A, grey	1
623	CS-CODEC-EQ-ANT+	Antennas for Cisco Codec EQ	1
624	CS-CODEC-EQ++	Cisco Codec EQ unit for TAA	1
625	BRKT-QCAM2-WMK-	Wall Mount Bracket (Carbon Black) for Quad Camera	1
626	PWR-CORD-USA-B	Power Cord for United States of America 2m 10A	1
627	CS-MIC-CLGP-DMK	Drop Ceiling Grid Mounting Kit for Ceiling Microphone Pro	2
628	FW98BZ30L	98" 3840x2160 4K 440nit,24/7 display	1
629	XTM1U-G	EXTRA LARGE TILT MOUNT ASSEMBLY, TAA	1
630	FCAV1U	FUSION PULLOUT	1

631	CSMP9X12	PROX,MOUNT PLATE,9X12	2
632	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
633	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	2
634	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
635	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
636	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
637	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	6
638	RC8-CQC-K	Project Pack: RemoteCam8Extension Kit + RC-CUBBY-CQC	1
639	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	3
640	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

MHS-3300 requires Display Shield TV Shield PRO Lite and Anti-Ligature Hood for 75-86" Displays.

MHS-3300					
641	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
642	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
643	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1

644	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro	1
645	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
646	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
647	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
648	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
649	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
650	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
651	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
652	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
653	CON-SNT-C1200082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
654	CAB-16AWG-AC	AC Power cord, 16AWG	1
655	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	1
656	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
657	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
658	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
659	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
660	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1

661	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
662	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

IPC-3292					
663	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
664	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
665	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
666	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
667	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
668	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
669	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
670	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
671	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
672	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
673	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
674	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo			1
675	CON-SNT-C1200082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months			1

676	CAB-16AWG-AC	AC Power cord, 16AWG	1
677	FW65BZ30L	65" 3840x2160 4K 440nit,24/7 display	2
678	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
679	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
680	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
681	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
682	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
683	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
684	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
685	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
686	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

DTL-4115					
687	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
688	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
689	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
690	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1

691	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
692	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
693	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
694	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
695	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
696	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
697	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
698	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
699	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
700	CAB-16AWG-AC	AC Power cord, 16AWG	1
701	FW65BZ30L	65" 3840x2160 4K 440nit,24/7 display	2
702	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
703	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
704	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
705	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
706	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
707	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1

708	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
709	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
710	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

SCC-4231					
711	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
712	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
713	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
714	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
715	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
716	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
717	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
718	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
719	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
720	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
721	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
722	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE			1

723	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
724	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
725	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
726	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
727	CAB-16AWG-AC	AC Power cord, 16AWG	1
728	FW65BZ30L	65" 3840x2160 4K 440nit,24/7 display	2
729	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
730	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
731	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
732	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
733	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
734	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
735	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
736	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
737	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

RHB-4285					
738	CS-BARPRO-K9	Cisco Room Bar Pro, First Light - TAA			1

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739	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months	1
740	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A	1
741	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro	1
742	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
743	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
744	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
745	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
746	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
747	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
748	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
749	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	1
750	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
751	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
752	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
753	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
754	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1

755	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
756	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
757	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
758	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

RES-4249					
759	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
760	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
761	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
762	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
763	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
764	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
765	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
766	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
767	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
768	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
769	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1

770	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	1
771	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
772	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	1
773	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

RES-4250					
774	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
775	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
776	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
777	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
778	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
779	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
780	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
781	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
782	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
783	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
784	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1

785	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	1
786	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
787	SA-82	FlatPak Series Mode Surge and Power Conditioner, Includes Mounting Brackets	1
788	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

ADM-4 311					
789	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
790	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
791	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
792	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
793	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
794	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
795	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
796	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
797	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
798	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			2
799	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			2

800	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
801	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
802	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
803	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
804	CON-SNT-C1200082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
805	CAB-16AWG-AC	AC Power cord, 16AWG	1
806	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2
807	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
808	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
809	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
810	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
811	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
812	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
813	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
814	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
815	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
816	L5-SD7	L5 STORAGE DRAWER,7 IN	1

817	L5-DCD23	L5 DOC CAM DRAWER,23IN	1
818	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
819	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

ADM-4 312					
820	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
821	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
822	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
823	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
824	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
825	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
826	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
827	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
828	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
829	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			2
830	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			2
831	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE			1

832	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
833	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
834	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
835	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
836	CAB-16AWG-AC	AC Power cord, 16AWG	1
837	FW65BZ30L	65" 3840x2160 4K 440nit,24/7 display	2
838	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
839	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	1
840	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	1
841	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
842	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
843	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
844	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
845	L5-TURFR-33LDW	L5 TURRET FRAME,LD,LW33W	1
846	L5KBB2SEHD0ZP002	L5K,33W,TUR,SOT,H,D0,DZP	1
847	L5-SD7	L5 STORAGE DRAWER,7 IN	1
848	L5-DCD23	L5 DOC CAM DRAWER,23IN	1

849	SX-1115-RT	SurgeX SX1115RT Surge Eliminator & Power Conditioner 15A at 120 Volts	1
850	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

ADM-4 316					
851	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
852	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
853	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
854	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
855	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
856	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1
857	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0			1
858	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET			1
859	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro			1
860	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE			1
861	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months			1
862	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE			1
863	CON-SNT-CSMI	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic			1

	CPROC	WhiService Duration: 60 Months	
864	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
865	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
866	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
867	CAB-16AWG-AC	AC Power cord, 16AWG	1
868	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2
869	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
870	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
871	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	2
872	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
873	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
874	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
875	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
876	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
877	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

ADM-4365					
878	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1

879	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months	1
880	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A	1
881	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro	1
882	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
883	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
884	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
885	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
886	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
887	CS-T10-WM-L-K9++=	Room Navigator Wall Mount, TAA, First Light - SPARE	1
888	CON-SNT-CST10LKW	SNTC-8X5XNBD Cisco Room Navigator-Wall Mount, First LService Duration: 60 Months	1
889	CS-MIC-CLGPRO++=	Cisco Ceiling Mic Pro, TAA, Arctic White-SPARE	1
890	CON-SNT-CSMICPROC	SNTC-8X5XNBD Cisco Ceiling Microphone Pro, Arctic WhiService Duration: 60 Months	1
891	CS-MIC-CLGP-DMK=	Drop Ceiling Grid Mounting Kit Ceiling Mic Pro - SPARE	1
892	C1200-8FP-2G	Catalyst 1200 8-port GE, Full PoE, 2x1G Combo	1
893	CON-SNT-C120082G	SNTC-8X5XNBD Catalyst 1200 8-port GE, Full PoE, 2x1GService Duration: 60 Months	1
894	CAB-16AWG-AC	AC Power cord, 16AWG	1
895	FW75BZ30L	75" 3840x2160 4K 440nit,24/7 display	2

896	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	2
897	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
898	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	2
899	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
900	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
901	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
902	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	6
903	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
904	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

ADM-4 366					
905	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
906	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1
907	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A			1
908	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro			1
909	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray			1
910	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)			1

911	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
912	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
913	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
914	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	1
915	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
916	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
917	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	2
918	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
919	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
920	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
921	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
922	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
923	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

ADM-4368					
924	CS-BARPRO-K9++	Cisco Room Bar Pro, First Light - TAA			1
925	CON-SNT-CSBARPK9	SNTC-8X5XNBD Cisco Room Bar Pro First LightService Duration: 60 Months			1

926	PWR-CORD-USA-F	Power Cord for United States of America 4.5m 10A	1
927	CS-BARPRO-CAMCOV	Camera Cover for Room Bar Pro	1
928	CAB-CAT5E-8M-	Ethernet CAT5E Round Cable - 8 meter - Gray	1
929	CS-T10-TS-L-	Cisco Room Navigator Table Stand, First Light (White)	1
930	CAB-2HDMI-1.5M-GR-	1.5m GREY HDMI 2.0	1
931	CAB-ETH-5M-GR-	CAB (16,4 feet / 5m) GREY ETHERNET	1
932	CS-BARPRO-MOUNT-	Mounting Kit for Cisco Room Bar Pro	1
933	FW55BZ30L	55" 3840x2160 4K 440nit,24/7 display	1
934	AS3LDP7	TEMPO FP WALL MOUNT SYSTEM, PDU BUNDLE	1
935	60-1869-62	4K/60 HDMI DTP3 Transmitter with Input Loop-Through and Audio Embedding	2
936	60-1869-63	4K/60 HDMI DTP3 Receiver with Audio De-Embedding	2
937	ICRON 0000491	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender LEX, Black, 100-240V Power Adapter NA	1
938	ICRON 0000496	1 Port USB-C 100m CAT6a USB-C 4K +USB 3 Extender REX, Black, 100-240V Power Adapter NA	1
939	SPA2-200	1/2 RU 2 Channel ENERGY STAR amplifier / Stereo Operation 200 watts into 8 & 4, Bridged operation 40	1
940	AD-C6T-LPZB-WH	6.5" Two-way ceiling speaker, 70/100V transformer with 16bypass, zero bezel design, low profile, 150	4
941	PD-815SC	SLIM PWR STRP,8OUT,15A,W/	1
942	MISC_HDW_INSTALL	Installation Hardware (Screws, Ties, Velcro, LV Boxes, Plates, Etc.)	1

Bulk Cabling					
943	C2G56053	1000FT CAT6A SOLID STP CMP BLUE TAA			20
944	6100UE 877U1000	14/2 Stranded Speaker Cable, Plenum-CMP, stranded bare copper conductors with Flamarrest insulation,			10
945	MISC_CABLE_PREMADE	Premade Video, Audio, Data, Control, Etc. Patch Cables			1

Professional Services					
946	PROFESSIONAL SERVICES	PS SOW R-00872821			1

1. Simulation Capture Software

Laerdal	227-00950 SimCapture Pro Cloud Annual Subscription Includes: SimCapture Node with warranty and support, Cloud based storage and access, software support and maintenance, and SimCapture Mobile App. Internet access required for operation.	**1**
Laerdal	227-B-86050 SimCapture Pro Cloud Implementation Includes Software set up and Educational Services for all SimCapture Form Factors quoted.	**1**
Laerdal	Include: 227-83550 QTY: 1 SimCapture Pro Cloud Installation Includes installation of Node end points, configuration of networked SimCapture devices, integration with installed audio and video components, LLEAP integration, integration with our cloud provider, end to end system testing, and control room demonstration.	**1**

Laerdal	Include: 227-VT1015SC-PC QTY: 1 SC Pro Getting Started System Setup This 2-hour course is on the understanding of Configuration, Users and Security, and Recording and Sessions that are available to an organization. This course is intended for System Administrators or those responsible for system set-up and administration.	**1**
Laerdal	Include: 227-VT2025SC-PC QTY: 1 SC Pro Getting Started Features & Function Upon completion of this training, participants should possess the skill necessary to operate the SimCapture system. This training is targeted toward Faculty and is focused on providing the tools necessary to support and advance their educational goals based on current operational abilities.	**1**
Laerdal	227-51150 Advanced Audio Package for Ceiling- Mount Installation This package includes the ceiling mount installation of: (2) Overhead Microphones, (1) PoE+ Digital Signal Processor (DANTE) and Ethernet, (1) PoE Audio Module, (1) Ceiling Tile Rack. This package requires Customer installation of (1) PoE+, (1) PoE, and (1) Ethernet (for DANTE) data drop in the plenum space per package.	**1**
Laerdal	227-54150 Hardware Paging Speaker Package for Ceiling-Mount Installation This package includes the ceiling mount installation of: (1) Ceiling Speaker, (1) POE+ Speaker Amp (DANTE). This package requires Customer installation of (1) PoE+ in the plenum space per package.	**1**
Laerdal	227-54250 Hardware Paging Speaker Package for Surface-Mount Installation This package includes the surface mount installation of: (1) Ceiling Speaker, (1) POE+ Speaker Amp (DANTE). This package requires Customer installation of (1) PoE+ in the plenum space per package. For use with Hardware Paging or as a Pillow Speaker.	**2**

Laerdal	227-53150 Paging Speaker Package for Ceiling- Mount Installation This package includes the installation of: (1) Ceiling Speaker. For use as an additional speaker for Hardware Paging (limit 1). For use with Software Paging or as an additional speaker for Hardware Paging.	**1**
Laerdal	227-56150 PTZ Camera Package This package includes the installation of: (1) Pan/Tilt/Zoom (PTZ) Camera. This package requires Customer installation of (1) PoE data drop in the plenum space per package.	**5**
Laerdal	227-56550 HDMI to IP Encoder Pkg This package includes installation of HDMI Video Encoder and cables/adapters to turn a video output of a device or computer to stream over IP to SimCapture.	**4**
Laerdal	227-B-Install SimCapture AV Installation	**1**
Laerdal	227-83025 SimCapture Site Survey When purchasing SimCapture a Laerdal representative is required to assess the customers environment. We will discuss usage and all aspects of your installation and requirements for your site.	**1**
Laerdal	227-57150 Hardware Paging Station Package This package includes the installation and programming of: (1) Desktop Microphone, (1) Closed-back Headphones, (1) Digital Signal Processor. This package requires Customer installation of (1) PoE+ and (1) Ethernet (for DANTE) data drop in the plenum space per package.	**1**

2.4 EQUIPMENT AND MATERIALS

A. Cable
   1. The following manufacturers of cable are approved for use: Belden, Liberty, West Penn, C2G, and Windy City.
      a. Equipment manufacturer proprietary cabling is approved for use when the manufacturer requires it.
      b. Other manufacturer's cabling must meet or exceed the specification of the approved manufacturers. See Section 1.7E - Substitutions for further details.

c. See Division 27 specification 271500 for patch cords and telecommunications cabling required for audiovisual systems connectivity to the Owner's network.

2. Provide cable that is applicable for the application.
3. Provide cable for the environment in which it is being installed.

B. Connectors and adapters
1. Provide connectors from the following manufactures for all field-made cabling. Connectors must be compatible with the cabling and signal type.
a. Neutrik
b. Switchcraft
c. Harting
d. Amphenol
e. REAN
f. Molex

C. Miscellaneous Equipment
1. Provide equipment as required for functional audiovisual systems. This includes equipment that may not be specifically noted within the bidding equipment list such as equipment power supplies, POE injectors, USB extenders, cable, in rack power distribution and others as required.
2. Provide equipment as required for installation. This includes equipment that may not be specifically noted within the bidding equipment list such as I/O Panels, cover plates, audiovisual equipment racks accessories (blank panels, vented rack panels, screws, drawers), wire ties, flexible cable wrap, and others as required.

2.5 Seismic REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing for equipment racks and wall and ceiling mounted equipment.

B. Seismic Performance: Audiovisual equipment and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit or equipment will remain in place without separation of any parts when subjected to the seismic forces specified and the unit or equipment will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.
3. Component Amplification Factor: Determined per Delegated Design.
4. Component Response Modification Factor: Determined per Delegated Design.

PART 3 - Execution

3.1 PREPARATION

A. Prior to installation verify the following work provided by others: All audiovisual infrastructure has been installed per the contract documents. This includes, but is not limited to, all projection screens. junction boxes, pathways, pull boxes, power, millwork and fixed furniture.

3.2 INSTALLATION

A. General
1. Contractor to include an additional 150 hours of professional services for digital signage / dashboard / content development and coordination as required.
2. Install all equipment per the Audiovisual Specification, approved shop drawings and per the manufacturer's installation instructions. Provide safety cables for all overhead equipment.
3. Install audiovisual equipment and supports in compliance with the seismic-restraint details according to the approved seismic restraint Delegated Design.
4. Take precautions to prevent electromagnetic and electrostatic interference.
5. Install all equipment to ensure a safe operating environment for the end-user.
6. Ensure that all equipment is installed to allow for ventilation and cooling.
7. Provide all portable equipment to the Owner.
8. Keep areas around audiovisual equipment and equipment racks free from dust, dirt, and debris throughout the duration of the project. Equipment that is not properly maintained during installation must be replaced at no cost to the Owner before final payment is made.

B. Pathways
1. Utilize audiovisual cable pathways provided per the construction documentation.
2. Do not exceed the recommended conduit fill amount.
3. Provide a pull string in all conduits after installation.

C. Cabling
1. Coordinate the length of any premade cable with as-built site conditions.
2. Route and secure cables to minimize tension, twisting, or bending at connection points.
    a. Securely fasten strain relief devices to equipment or enclosures, and cables should pass through these devices to distribute stress evenly.
    b. Provide sufficient slack in cables near the strain relief point to allow for flex and movement.
    c. Ensure that cable bends and loops are within recommended bending radius limits.
3. Dressing
    a. Neatly dress and organize all cables.
    b. Arrange cable bundles adjacent to each other and secure to prevent tangling, kinking, or damage.
    c. Ensure appropriate separation between signal and power cables to minimize electromagnetic interference.
4. Supports
    a. Utilize cable supports, J-hooks or other raceway to securely route and support cables.
    b. Ensure cable supports are rated for the total weight and quantity of cables.
5. Utilize Velcro straps, hook-and-loop cable ties, or other non-constricting cable fasteners for bundling and securing cables.
6. Ensure cable dressing and support do not obstruct access to equipment.
7. Gather any exposed cabling of two or more cables within a flexible cable wrap or sleeve.

D. Equipment Racks
   1. Anchor equipment racks to the floor, wall, or within millwork, unless noted otherwise.
   2. Ensure placement allows for accessibility, adequate ventilation, and maintenance. It is recommended that there be 36" of space to the front, rear and to one side of floor standing equipment racks.
   3. Provide blank panels to cover any unused rack spaces.
   4. Provide adequate ventilation within equipment racks to prevent overheating.
   5. Provide doors, fans, power distribution units, and other accessories with and within the rack as specified.
   6. Provide security panels over equipment with adjustable controls.
   7. Install adjustable mounting rails to accommodate various equipment sizes. Provide mid-rails for equipment greater than 45 lbs.
   8. Provide lacing strips and other cable management accessories for organized and secure cable routing.
   9. Provide hardware to gang adjacent racks together.
   10. Provide interior lighting on all equipment racks.

E. Grounding
   1. Provide grounding for audiovisual equipment and components utilizing appropriate grounding conductors.
   2. Ensure that grounding conductors meet the requirements for the application in accordance with electrical codes and standards.
   3. Ensure that all conduits are properly grounded to the power system ground. Insulate and isolate conduits and electrical boxes from equipment racks and the audio system ground.
   4. Insulate all conductors within conduits, including their shields, from contact with the conduit, back boxes, and from one another along the entire conduit length.
   5. Attach grounding lugs and connectors to equipment, enclosures, and grounding electrodes.
   6. Verify that non-conductive coatings on equipment do not interfere with grounding.
   7. Install surge protection devices, such as surge suppressors or transient voltage surge protectors (TVSS), in accordance with electrical codes and standards.

F. Labeling
   1. Utilize the Owner's scheme to label all equipment and cable. If the owner does not have a standard, provide an example for approval by the Owner and AV Designer.
   2. Ensure the labeling scheme is consistent through the installation.
   3. Label each piece of equipment with a unique identifier or asset tag.
   4. Maintain documentation detailing all labeling conventions for reference.
   5. Panels and Plates
      a. Provide anodized aluminum or similar.
         1) Characters to be 1/8" high minimum with a contrasting fill.
         2) Plates to match other finish plates utilized on the project.
   6. Cables
      a. Provide heat-shrink labels on both ends of all installed cabling.
      b. Label both ends of each cable with a unique identifier.
      c. Use color-coding for different cable types, such as audio, video, data, or power.

d. Include cable destination information
e. Ensure that labels are positioned to allow technicians to easily read the labels. Do not locate within cable bundles.

7. Racks and Enclosures: Label equipment racks and enclosures.

G. Flat panel Displays
1. Install flat panel displays in the locations as shown on the construction documentation.
a. Ensure wall-mounted flat panel displays are mounted to blocking or other structure.
b. Confirm all locations and mounting heights of flat panel displays with the Owner prior to installation.
2. Bypass all eco or energy saving modes.
3. Disable any automatic adjustments to the image based on light level or similar within the space.
4. Ensure image color uniformity of all flat panel displays within a space or area.

H. Direct View LED
1. Prior to installation, examine the location for the installation. Ensure the following:
a. The wall is flat and smooth to allow for alignment of the individual LED panels.
b. Adequate blocking or support structure has been provided to carry the weight of the display wall.
c. Adequate power has been provided by others.
d. All locations and mounting heights have been coordinated in the field with the Owner.
2. Install Direct View LED walls in the locations as shown on the construction documentation.
3. Provide all materials necessary for a complete installation including mounting brackets, rails, frames, controllers, power supplies, and cabling.
4. Examine the installed video wall for any defects in the panels or installation such as dead pixels, color uniformity, brightness variation, or panel alignment. Remedy any issues.
5. Review and adjust the final brightness of the installed video wall with the Owner.
6. Utilize manufacturer assistance for installation, configuration, calibration, and testing of the installed video wall.
7. Hand-over any attic stock LED panels or unused installation materials to the Owner.

I. Projectors
1. Install all projectors in the locations as indicated on shop drawings.
2. Mount projectors so they are level and in alignment with the centerline of the projection screen.
3. Provide all materials necessary for a complete installation, including the projector mounts, pipe, extension column and ceiling plate.
4. Ensure projectors are mounted free of sway or rotation. Provide vibration isolation, as necessary, to ensure a stable image.
5. Ensure image color uniformity of all projectors within a space or area.
6. Keystoning or other noticeable image manipulation cannot be utilized to align the image on the screen. Horizontal and vertical shift are acceptable.

7. Implement final travel limits on all projection screens whether provided by Others or the AV Contractor as part of this specification.
    a. Ensure that all screens are flat and wrinkle free.
    b. Adjust tab tensioning on screens provided within this feature.
8. Coordinate final lighting presets with the lighting designer and installer.

J. Loudspeakers
1. Install all loudspeakers in the locations as indicated on shop drawings.
    a. Ensure mounting and installation drawings, for line arrays, speaker clusters, or other loudspeaker assemblies attached to building structure are stamped by a professional engineer in the local jurisdiction and approved by the structural engineer prior to installation.
2. Ensure loudspeakers are installed to provide even sound coverage, minimizing dead zones and excessive sound reflections.
3. Coordinate the color of all loudspeaker assemblies and grill colors with the Architect.

K. Audio
1. Tune the audio system to provide a uniform sound pressure level throughout the entire space.
    a. For spaces with speech reinforcement, the signal to be a minimum of 10 dB above the room's ambient noise floor.
2. Provide sufficient headroom within the system to allow for peaks without distortion. Provide 9 dB of headroom above desired SPL.

L. Video Cameras
1. Provide appropriate mounting hardware for the location of the installation.
2. Adjust camera white balancing once room finishes are complete and lighting systems are configured.
3. Coordinate the final location of all video cameras with the Owner prior to installation, including wall and ceiling mounted cameras. If the infrastructure on the wall has not been installed in an optimal location, provide a mud ring or old work box and fish the cable to the new location.
4. Install ceiling-mounted cameras with an extra 12' of cabling neatly coiled above the ceiling to allow for the repositioning of the camera.
5. If required by the Owner, within 100-days of final acceptance, adjust the locations of any installed cameras per the direction of the Owner. If the new location requires additional labor to modify a wall or inaccessible ceiling, provide cost information for approval prior to performing any work.
6. For auto-tracking cameras, follow the manufacturer's applicable installation and configuration protocols including but not limited to:
    a. Set up basic network parameters as required for connectivity to components within the audiovisual system.
    b. Configure advanced settings such as motion sensitivity, tracking speed, and tracking area boundaries.
    c. Perform all calibration procedures per manufacturers instructions to optimize for optimal performance.
    d. Test tracking performance

M. Room Scheduling Panels

1. Install room scheduling panels in the locations as shown on the construction documentation.
2. Reference installation details as shown in construction documentation.
3. Coordinate final location with the Owner and Architect.
4. Provide all installation accessories required for a complete installation whether wall or glass mounted.

N. Network
1. Procure IP Addresses from the Owner for ethernet-enabled audiovisual equipment.
2. Maintain a list of ethernet-enabled audiovisual equipment including IP Addresses and other configuration parameters such as network segmentation, VLAN and firewall rules through the duration of the project.
   a. Provide this list to the Owner upon completion of the project.
3. Assist in loading and configuring Owner's custom SSL certificates to audiovisual equipment that supports this capability.

3.3 CONTROL SYSTEM

A. The audiovisual control system will manage the operation of the audiovisual equipment within the audiovisual systems noted herein.

B. Audiovisual system control may be provided via a touch panel or push-button user interface. Overall control requirements are dependent upon the space or system type. Each space or system type may include the control functionality as described herein at a minimum. If further control functionality is required, it will be noted within the system description in Part 2.
1. For systems, such as web-conference system that include a touch panel user interface, these may be pre-programmed or configured to function per the manufacturer. Many of the following requirements of the user-interface and control functionality are not able to be adjusted and are excluded from the following requirements. Provide any configuration adjustments to these systems with coordination of the Owner.

C. The control system should integrate seamlessly with all audiovisual components, including but not limited to projectors, screens, audio equipment, and lighting systems. The system includes the following, unless noted otherwise:
1. Control system processor
2. Touch panel control interface
3. Push button control interface
4. Room scheduling panels
5. Control system monitoring and management system

D. Touch Panel User Interface
1. Provide an intuitive and easy to use Graphical User Interface (GUI) for the operation of the audiovisual system. The interface should comply with standards set forth by InfoComm International/AVIXA.
2. Ensure that the GUI designs comply with the Owner's graphic standards and guidelines, incorporating logos, graphics and colors provided through the Owner's design guide or similar.
3. Functionality
   a. Power the system on/off

1) In divisible spaces, provide the option to start the system in combined or divided mode.

b. Control of source selection

c. Video routing to displays and other devices
   1) Coordinate with the Owner on the default video source on system start-up for each system.
   2) Provide administrator functionality to allow modification of the default routing schemes.
   3) Provide an intuitive methodology on the touch panel to assign routing assignments.
   4) Confirm with the owner that audio embedded within the video for the last selected video source should be heard within the space.

d. Audio Control
   1) Provide volume up/down/mute functionality.
   2) For program audio, a nominal level should be set so that it is clearly audible to all of those within the space. Provide ample headroom before distortion above the nominal audio level to allow the user to raise the overall volume.
   3) In systems with microphones, provide individual microphone control for volume up/down/mute. Ensure a nominal level is set and there is ample headroom to raise each microphone's volume.
   4) Provide administrator functionality to allow modification to the default audio settings.

e. Lighting Control
   1) Coordinate with the Construction Manager / General Contractor, AV Designer and Architect to determine which spaces will have supplemental lighting control through the audiovisual system.
   2) The audiovisual system will recall presets set by the lighting designer or lighting installer from the lighting system control module or headend.
   3) Ensure coordination with the lighting installer as necessary. Review all project submittals relative to lighting control systems to ensure all interfaces required for integration of the audiovisual system into the lighting system have been provided.

f. Video Cameras
   1) Coordinate presets for PTZ cameras with the owner.
      a) Users will be able to override the presets by utilizing the touch panel control system to adjust the camera pan, tilt and zoom. If the users want to establish a new preset, there will be an intuitive method on the control interface to accomplish this.
      b) As part of the control system design, an Owner's administrator will be able to adjust the presets within an administration section of the touch panel user interface. These adjustments will become default presets.
      c) When the system is powered off or reset, all user established camera settings will return to their default presets.

g. Provide a help button that will direct users on how to contact the technical support team in systems with a touch panel controller.

h. Raise, lower, and stop the projections screens.
i. System Reset
   1) Provide a system reset button.
   2) This button will reset all routes, sources, cameras, and volume levels to their base start-up configuration.
j. System Shutdown
   1) Provide a system shutdown button.
   2) On shutdown reset all routes, sources, camera and volume levels to their base start-up configuration.

E. Push Button User Interface
1. The control functionality available through the push button user interface will be dependent upon the interface itself and the quantity of buttons provided.
2. At a minimum, the following is required for control:
   a. Power the system on/off
   b. Control of source selection
   c. Volume up/down/mute functionality.

F. Control Processors must be password-protected to allow remote access through a web interface for end-user monitoring and controlling via the LAN.

G. Control system monitoring and management system
1. Coordinate with the Owner and software manufacturer for software configuration.
2. Provide and set administration levels for the Owner's representatives.
3. Utilize manufacturer assistance, as necessary, in deploying or integrating these systems into an existing monitoring and management system.

H. Room Scheduling Panels
1. Coordinate with the Owner regarding the configuration of the panel to enable communication with the Owner-provided scheduling platform. Utilize manufacturer assistance when necessary.
2. Utilize manufacturer assistance, as necessary, in deploying or integrating the Owner-provided scheduling platform when integrated with the control system monitoring and management system.
3. Providing design of the room schedule user interface is excluded from this scope of work. The room scheduling panel is provided with a standard interface.

I. Provide control of all audiovisual systems through a manufacturer specific application on a phone, tablet or computer. Coordinate the purchase, installation, and configuration of the application with the Owner on the Owner provided devices.

3.4 AUDIOVISUAL SYSTEMS TESTING AND PERFORMANCE VERIFICATION

A. Verify audiovisual systems are installed and function in accordance with the requirements of the written specification, AVIXA/InfoComm performance standards, and manufacturer's performance specifications. This includes any implied functionality based on the systems.

B. Reference *ANSI/InfoComm (Current Version), Audiovisual Systems Performance Verification* for all performance requirements of all systems and subsystems within each space. This includes but is not limited to the following systems:
1. Audio System
2. Video System

3. Audio/Video System
4. Cable Management, Termination and Labeling
5. Control System

C. Reference Section 1.5 Compliance / Reference Standards

D. Provide a final test report of all the Audiovisual Systems Testing and Performance Verification prior to a punch list review for approval.

3.5 FINAL ACCEPTANCE

A. Punch List
1. Once the final test report is reviewed and approved, schedule a final punch list review with the AV Designer and Owner to perform final system adjustments and acceptance tests. The AV Contractor's representatives must have a thorough understanding of the system and will be required to show the full functionality of the audiovisual systems.
2. Plan for the punch list review to last a total of 16 hours over two days.
3. Provide labor, materials, tools, and measurement equipment to perform the review. Measurements of frequency response, distortion, noise, and video signals may be required during the punch list review to show that the audiovisual systems is compliant with this Specification.
4. If final acceptance is delayed due to non-compliance with the specifications, the AV Contractor to cover the additional time and expenses for Owner-designated observers during the extended testing period.

B. Punch List Report
1. Following the on-site punch list review the AV Designer will provide a written report outlining the deficiencies of the audiovisual system exhibited during review.
2. Provide corrections to all punch list items within the AV Designer provided report and provide written confirmation to the Owner, Construction Manager / General Contractor, and AV Designer that all adjustments have been made.
3. Following receipt of this report, if required, schedule a follow-up review of the Audiovisual Systems with the Owner.

C. Final Acceptance
1. Coordinate with Division 01 for requirements.

3.6 TRAINING

A. Provide training with representatives of the Owner's staff.

B. Training to include:
1. Systems operation per space or system type
2. Maintenance guidelines
3. Troubleshooting recommendations

C. The Owner may record these training sessions for future reference. Refer to Division 01 for requirements and video recordings of training sessions.

D. Provide 4 hours per department with an additional 16 hours of administrative / technical training for IT and support staff. This 16 hours of training may be broken down as required by the Owner. Contractor to submit training plan and syllabus for Owner review and approval.

3.7 WARRANTY

A. Provide a comprehensive warranty for a minimum period of 1 year, commencing from the date of Final Acceptance.
   1. As part of the bid response provide costs for warranty coverage for years 2 - 5. This coverage to be the same as the year 1 coverage.

B. In the event of a warranty claim, the Owner will promptly notify the AV Contractor, specifying the issue and initiate the necessary actions to address the problem.

C. Provide repair or replacement of equipment for system malfunctions or component failures.
   1. Provide a response time not more than 72 hours for addressing non-critical systems.
   2. Provide emergency service support with a response time not more than 24 hours for critical system failures.
   3. If a component cannot be repaired, provide a replacement part or viable temporary solution for which the Owner agrees for short-term system operation.

D. The warranty must cover all aspects of workmanship and installation quality.

E. Provide telephone or live chat support during regular business hours (excluding holidays) for system troubleshooting and assistance.

F. Provide a preventative maintenance schedule, outlining routine inspections, cleaning, and maintenance tasks to ensure long-term performance and reliability.

G. Provide support for any custom software, code, or programming integral to the Audiovisual System. Support to include: updates, bug fixes, and maintenance as necessary.

H. Warranty coverage will exclude damage resulting from misuse, abuse, or unauthorized modifications. It also does not cover consumable components.

END OF SECTION

SECTION 275113 - PAGING SYSTEMS

PART 1 - GENERAL

1.1 GENERAL INFORMATION

A. This section includes the Paging System for the IHS Whiteriver project.

B. Products Installed, but Not Furnished, under This Section:
   1. See Section 260553 "Identification for Electrical Systems" for electrical equipment.

C. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of an IP based Bell, PA and Unified Paging System in operating condition as indicated on the drawings and/or specification herein.

D. All materials, equipment and apparatus provided shall be new and of the latest design or model offered for sale by the manufacturer.

E. Acceptability for use in the systems shall be determined by the Owner's Representative. Such items shall be installed only after receipt of written approval by the Owner's Representative.

F. CONTRACTOR approval for system programming, configuration and interface shall be determined by the Owner's Representative. Owner's acceptance shall be obtained by receipt of written approval by the Owner's Representative.

G. Upon notification from the CONTRACTOR, the Owner's Representative shall contact the Network Operations, Telecommunications Branches, and VoIP administrator of the district to arrange for system programming, configuration, interface, and testing. Any vendor working on the Paging System Control Software must be pre-approved by the Owner's Representative prior to any work commencing.

H. The speaker output level of all areas shall meet the requirements of The Owner. Volume level changes shall be made to the Owner's satisfaction.

1.2 DEFINITIONS

A. Reference Division 01 for project definitions not listed below. Any duplicate definitions are superseded by Division 01.

B. Paging System Specification: Written documentation outlining the requirements of the paging system; includes paging system drawings, appendices, bidding equipment list, and modifications issued via addenda, bulletins, or other contractual document.

C. Paging System: The equipment, software, and installation materials that when installed, interconnected, programmed and/or configured provide the functional requirements as indicated within the Paging System Specification.

D. Paging Equipment: Equipment and materials provided by the Contractor as well as equipment and materials furnished by others and installed in the Paging System.

E. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.

F. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

G. Closeout Documentation: Written and graphic information including construction records, as-built drawings, manuals, and reports.

1.3 REFERENCES

A. ANSI S1.4 - Specification for Sound Level Meters. Calibrated Type 1 or Type 2.

B. ANSI S1.6 - Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements.

C. ANSI S1.11 - Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

D. ISO - International Organization for Standardization

E. NEC - National Electrical Code

F. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

G. FGI 2022 Guidelines for Design and Construction of Hospitals.

1.4 SYSTEM DESCRIPTION

A. Components of the Unified Paging System (UMCS) shall provide a complete network system solution including fully functioning Intercom System (IC), Public Address System (PAS), Emergency Notification System (ENS) and Master Clock System (MCS).

B. System shall include software from a single developer for complete control and monitoring of the system for a fully supported system.

C. System shall be digital and operate over the facility's Local Area Network (LAN) and Wide Area Network (WAN), with survivability/redundancy as shown on contract documents

D. System control software shall be capable of being configured for High Availability Multi-Server Deployments.

E. System shall be capable of being configured and controlled remotely via Owner provided connectivity.

F. System shall include General Purpose Input and Output (GPIO) trigger points for interfacing with other systems including Emergency and Security Systems to provide event driven system configuration scenarios.

G. System shall be capable of connecting to existing common area PAS, providing interface points from the LAN based system to existing analog systems.

H. Administration office IP Administrative Display Phone, IP Administrative Communication Console, or IP Master Paging Station shall be a PoE device attached to the hospital network.

I. Each shall be a zone on the system capable of individual intercom use or as part of a zone group or all call group during PAS use.

J. IP endpoint device shall be a PoE+ device attached to the hospital network.

K. System shall comply to ADA title II entities (State and local governments) and title III entities (businesses and nonprofit organizations that serve the public) communicate effectively with people who have communication disabilities. The goal is to ensure that communication with people with these disabilities is equally effective as communication with people without disabilities.

L. IP endpoints with LCD displays shall include integrated Master Clock providing accurate time display and support visual messaging including text and user defined background color styles for normal, warning and emergency notifications as directed by the Owner's Representative.

M. IP LCD display devices in common areas, including but not limited to hallways, cafeterias, gymnasiums, and auditoriums shall include integrated Master Clock providing accurate time display and support visual messaging including text and user defined background color styles for normal, warning and emergency notifications as directed by the Owner's Representative and shall be PoE+ devices attached to the hospital network.

N. Common areas, including but not limited to hallways, cafeterias, gymnasiums, and auditoriums shall be provided with PAS coverage from the system for general and emergency announcements.

O. System shall provide multicast or hybrid unicast/multicast for configuration of LAN and WAN using standard Ethernet protocols.

P. System shall be capable of operation with multiple telephone system manufacturers and mobile phone applications (iOS, Android) as directed by the Owner's Representative.

Q. System shall provide opening tones for announcements sent to IP endpoints equipped with speakers and scrolling text messages sent to IP endpoints equipped with visual displays.

R. System shall be Common Alerting Protocol (CAP) compliant to provide automated warning notifications for subscription alerts such as Weather and Amber alerts as directed by the Owner's Representative.

S. All common area loudspeakers shall operate on a 70-volt distributed system. The loudspeakers shall be grouped in modular zones allowing maximum flexibility for paging area assignment.

T. Software and operating system shall be provided and connected to Owner's LAN using system servers as directed in Contract documents.

1.5 SYSTEM OPERATION REQUIREMENTS

A. The following functional capabilities are required for the Paging System:
   1. System operation shall allow administrator to define user privileges, define loudspeaker zones, pre-recorded messages, bell schedules, bell designations, event logs, background music streams, system configuration and IP endpoint status.
   2. Manages dynamic requests for live, delayed and prerecorded messages (simple and assembled), record and playback of ad hoc messages, text-to-speech, mute actions (by zone or zone group) and two-way full duplex intercom connections.

3. Announcements and messages shall be initiated by contact closures, telephone call platforms, IP Administration Communication Console, IP Administrative Display Phone, IP Master Paging, Station mobile phone application (iOS, Android), tablets, computers using desktop clients and/or Microsoft Teams, using standard Ethernet protocols.
4. Includes a built-in comprehensive message/bell scheduling system that allows the creation of schedule profiles that can be applied to specific days of the week or date ranges. Multiple profiles can be applied simultaneously.
5. System shall interface with third party systems by IP endpoint device built-in logic inputs (2) and relay output (1) and/or balanced line level audio input (1) and balanced line level audio output (1) for connection to third party systems.
6. System shall support a minimum of 100 message priority levels.
7. System shall allow any authorized administrator to initiate an intruder on campus and hospital-wide and/or district-wide lockdown emergency notification via the hospital district supplied network-based call platform, IP Administration Communication Console, IP Administrative Display Phone, IP Master Paging, mobile phone application (iOS, Android), Microsoft Teams, or button touch.
8. System operation shall allow for user defined visual color notification scheme for each messaging priority level. Supported IP visual endpoint devices shall automatically change its default background color to user defined normal, warning and emergency notifications.
9. System shall provide occupants the ability to confirm they have heard and executed the required instructions for any emergency announcement. Confirmation shall be achieved utilizing existing network desktop phone, mobile phone application (iOS, Android), desktop client web console, email, or Microsoft Teams. The authorized administrator can view real-time status, either safely secured or non-secured via mobile phone application (iOS, Android) or web console user interface whether on-site or remote. Authorized administrator shall be able to initiate two-way communication, without a pre-announcement tone, to the zone.
10. System shall provide supervision and logging for all associated IP endpoint devices on the network with built-in email/SMS notification and SNMP capabilities and Active Failover.
11. System shall provide interface to digital signage for visual paging and ADA compliance requirements.
12. System shall provide full duplex intercom (hands free) sessions so that during an emergency event, the user can speak freely in the event they physically may not be able to work a push to talk feature
13. System shall manage thousands of audio and visual output zones over local or wide area networks utilizing industry standard IP-based protocols to eliminate distance limitations.
14. System shall allow push notifications to an unlimited number of IP endpoints using VoIP (Voice Over Internet Protocol) network architecture.
15. IP endpoints shall use IEEE 802.3 standard PoE implementation so they can be used with any IEEE 802.3at (PoE+) 10/100Base-T switch.
16. System shall be Cisco IVT (Interoperability Verifications Test) certified ensuring quality integration with Cisco products while not adversely affecting Cisco product operation.

17. System shall integrate with Code Blue Help Points located in exterior area as integrated blue phone paging speaker will be part of exterior paging system zone.
18. Voice paging and call systems shall be designed to achieve a minimum Speech Transmission Index (STI) of 0.50 or a Common Intelligibility Scale rating of 0.70 at representative points in the area of coverage to provide acceptable intelligibility from the system.
19. Performance of emergency notification systems shall achieve the following:
    a. 70 dBA minimum sound level or 10 dBA above background noise levels (whichever is higher)
    b. Coverage within +/- 4 dB at the 2000 Hz octave band throughout corridors, open treatment areas, and public spaces.

1.6 SYSTEM CONTROL SOFTWARE REQUIREMENTS

A. The following functional capabilities are required for the System Control Software (SCS):
1. The System Control Software shall be one of Singlewire's Notification Applications, InformaCast Advanced, or InformaCast Fusion based on system requirements.
2. SCS shall manage audio announcements and visual messages using dynamically routed data on a standard OSI Ethernet network.
3. Audio announcements shall support dynamic requests for live and delayed audio announcements, pre-recorded and scheduled messages, actions, defined events, and two-way full duplex intercom connections.
4. SCS shall support dynamic requests for intruder on campus and hospital-wide and/or district-wide lockdown emergency audio and/or visual notifications.
5. SCS shall support a minimum of 100 audio and visual message priority levels.
6. Visual messaging shall include text and user defined priority messaging color style profile to automictically change the default background color of supported visual displays including Visual IP endpoints, supported network connected desktop phones, desktop notification clients, digital signage and mobile phone application.
7. SCS shall include an integral interface for Microsoft Teams, Twitter, and Cisco Webex Calling.
8. SCS shall include an integral interface for RSS feeds, IPAWS, and Common Alerting Protocol (CAP).
9. Audio Announcements and visual messages shall be initiated via web console, Microsoft Teams, mobile phone application (iOS, Android), contact closures, IP Administration Communication Console, IP Administrative Display Phone, IP Master Paging and network connected desktop phones.
10. SCS shall include an integral interface to answer intercom call-ins registered at IP Administration Communication Console, IP Administrative Display Phone, IP Master Paging.
11. SCS shall include an integral interface for IP Administration Communication Console, IP Administrative Display Phone, IP Master Paging and connected phone to selectively monitor audio from any talkback IP endpoint during an emergency
12. SCS shall manage the on/off premise Response/Confirmation request via mobile phone application.

13. SCS shall include an internally hosted web console for sending notifications, configuration and monitoring.
14. SCS shall include internal support for IP endpoint logic inputs and relay output.
15. IP endpoint logic inputs shall activate intercom request and/or preconfigured notification.
16. IP endpoint relay output shall be activated by the SCS user defined priority messaging profile.
17. SCS shall include an integral interface for operation of multiple telephone system platforms.
18. Unified Communication / VoIP supported call platforms shall be Cisco, 8x8, Fortinet, Jive, Zoom Phone and Ringcentral.
19. SIP based call platforms shall interface via SIP trunking.
20. Call platform interface shall support standard G.711 and G.722 Codecs, and RTP protocols.
21. Network connected phones shall provide for both direct dial zone paging access as well as voice prompted actions for announcements and messages, and answer internal intercom call-ins.
22. SCS shall include an integral interface for Motorola Two-Way Police/Security Radios.
23. SCS shall include an integral interface for Shooter Detection Systems, and PatriotOne Technologies Shot detection system.
24. SCS shall supervise all associated IP endpoint devices, report system abnormalities, and log faults.
25. Developer: Singlewire InformaCast Advanced or InformaCast Fusion or approved equal

1.7 SCOPE OF WORK

A. Work shall include the furnishing of all materials, labor, tools, and transportation necessary to complete the installation of the paging system described in this specification and shown in the drawings. Refer to T9.X series drawings for loudspeaker locations and coverage areas. Contractor is responsible for determining quantity of loudspeakers required and installation location to meet performance requirements.

B. The work shall include, but not limited to:
1. Layout of loudspeakers and associated zones.
2. Design of centralized equipment to power loudspeakers.
3. Installation of equipment in rack cabinet provided in Telecom Room.
4. Internal wiring of rack
5. Installation of speakers and other equipment external to rack cabinet.
6. Wiring of all external equipment.
7. Making equipment function as intended.
8. Documentation of performance, functions and wiring.

1.8 QUALIFICATIONS

A. An authorized dealer for the major product components and is certified by the manufacturer to perform installation, setup, maintenance, and warranty.

B. A verifiable history of successful installations of at least three projects of similar scope and size.

C. Provide the necessary personnel experienced in operating the required test measurement equipment outlined herein to configure, test, and calibrate the paging system.

1.9 WARRANTY PERIOD

A. During the warranty period, maintain two or more technicians who are certified for the product(s) under warranty as stated in "Warranty for Paging Systems" Article.
PREINSTALLATION MEETINGS

B. Preinstallation Conference: contractor to attend as required.

1.10 ACTION SUBMITTALS

A. Product Data:
   1. Manufacturer's detailed technical data sheets for all major paging system components, including material descriptions, applicable product pictures or drawings, finishes, electrical characteristics, and regulatory certifications.

B. Shop Drawings:
   1. Complete floor plan and reflected ceiling plan drawing(s) denoting, at minimum, device locations that have been prepared by the paging system designer based on the paging system manufacturer guidelines.
   2. Mounting details for all devices.
   3. Wiring diagrams connecting all devices.

C. Field quality-control reports.

D. Sustainable design submittals.

1.11 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions:
   1. Paging systems equipment.

B. Field Reports:
   1. Manufacturer's field reports for field quality-control support.
   2. Manufacturer's field reports for system startup support.
   3. Field reports for software and firmware upgrades.

C. Paging Systems coverage based on device locations.

1.12 CLOSEOUT SUBMITTALS

A. All final control processor settings, loudspeaker zone maps, loudspeaker tap settings, one line diagrams, operational instruction, and testing results.

B. Location of each sound pressure level measurement.

C. Media with each documentation set utilizing the same software version as currently installed and operating and all configuration files created by the configuration software on the same media.

D. Sustainable design closeout documentation.

1.13 REGULATORY AGENCY APPROVALS

A. Submittals for paging systems connected to fire alarm require approval by authorities having jurisdiction.

1.14 WARRANTY FOR PAGING SYSTEM

A. Base-Warranty Period: Installer warrants that fabricated and installed paging system perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within the base-warranty period.
   1. The installation of all equipment, cabling, and labor for an initial period of one year from the date of final acceptance unless a longer term is specified elsewhere.
   2. Equipment to be free of faulty workmanship and defects for a minimum period of five years from date of final acceptance.
   3. Services, including telephone support, at no charge during the duration of the initial one-year warranty period.
   4. Semiannual visits to the site for routine adjustment and maintenance of all specified and installed systems during the initial warranty period.

B. Special Installer Extended Warranty: Installer warrants that fabricated and installed paging system perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
   1. Extended-Warranty Period: From the end of the Base Warrranty Period, four additional years; full coverage for labor, materials and equipment.

C. Special Manufacturer Extended Warranty: Manufacturer warrants that paging system perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

PART 2 - PRODUCTS

2.1 EQUIPMENT SPECIFICATIONS

A. Contractor to provide and install the below equipment and confirm exact quantities with drawings.

B. Provide all mounting hardware to support different ceiling/mounting conditions.

C. Below equipment represent basis of design, contractor to provide alternate design and equipment list of equivalent manufacturer option.

Item #	Manufacturer	Model	Description	Qty
AtlasIED Paging Solution				
1	ATLAS	IP-DDS	IP DBL CLCK/SPKR W/FLASH	20
2	ATLAS	FAP33T-W	STRAT 3, 3" SPKR SYSTEM WHT	850
3	ATLAS	IP-CONSOLE-GH	IP MIC STATION	4
4	ATLAS	CLA202	AMP PWR SHR 2CH 200W 1RU	12
5	ATLAS	IP-ZCM2RMK	KIT, (2) IP-ZCM (1) PA702-RMK	5
6	ATLAS	IP-ZCM	IP ZONE CONTROL MODULE ZCM	10
7	ATLAS	PA702-RMK	AMP, RACK MTG KIT PA702	5
8	ATLAS	IP-ZCM1RMK	KIT, (1) IP-ZCM (1) PA702-RMK	10
9	ATLAS	IP-ZCM	IP ZONE CONTROL MODULE ZCM	10
10	ATLAS	PA702-RMK	AMP, RACK MTG KIT PA702	10

11	ATLAS	EGS33B	EDGELESS BLACK SQUARE GRILLE FOR USE WITH FAP33T-W [WOOD SLAT CEILING IN RECEPTION AREAS]	60
Singlewire InformaCast				
12	SINGLEWIRE	SS-5YR-ICA-TIER 3	InformaCast Advanced Notification - 5 Year Subscription - TIER 3 (Qty 1,000 - 2,450)	2250
13	SINGLEWIRE	SS-ICA-R	InformaCast Advanced Notification - Resiliency - 1 Year Subscription - Per Endpoint	1

2.2 PERIPHERALS

A. Fire Alarm Control Panel Input:
   1. The system controller to accept a contact closure from a Fire Alarm Control Panel (FACP).
   2. The contact closure to be configured in the system controller to mute all masking, background music, and paging audio in the masking system.
   3. The controller to communicate with other masking system controllers on the network to also mute their audio when a contact closure is sensed.
   4. The systems to automatically be restored to normal operation when the contact closure is removed.

2.3 SPEAKER CABLE AND JACKS:

A. Analog Speaker Cable: Plenum rated, 18AWG, 70V speaker cable.

B. UTP Speaker Cable: Cable shall match horizontal UTP cable called out in Division 27 Section "Communications Horizontal Cabling".

C. Termination Jack: Surface mounted jack shall match 'biscuit' jack and modular connector called out in Division 27 Section "Communications Horizontal Cabling".

D. Patch Cable: Cable assembly shall match the patch cord called out in Division 27 Section "Communications Horizontal Cabling".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation, verify the site is suitable for system installation.

B. Verify all locations where system components are to be installed are free of conflicts with other trades prior to installation.

C. Verify that colors chosen (where applicable) have been coordinated with the Architect, building manager, and/or building owner.

D. Verify that site building conditions match the system design plans including ceiling finishes, wall locations, and obstructions. Immediately notify the project manager of any discrepancies prior to the commencement of work.

E. Ensure system power requirements, network connectivity, and any other third-party infrastructure requirements for the system have been provided and installed prior to installation.

3.2 DELIVERY, STORAGE AND HANDLING

A. Protect all system components from moisture, dust, and damage during shipping, storage, and handling.

B. Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.

C. Inspect all system components upon receipt and upon unpacking.

3.3 INSTALLATION

A. General
   1. Execute work in accordance with state and local codes, regulations, and ordinances.
   2. Install work neatly, plumb, and square and in a manner consistent with standard industry practice. Coordinate on-site installation with the Owner and carefully protect work from dust, paint and moisture as dictated by Owner requirements. The Contractor will be fully responsible for protection of his work during the construction phase up until final acceptance by the Owner.
   3. Install equipment according to manufacturer's recommendations. Provide any hardware, adaptors, brackets, rack mount kits or other accessories recommended by manufacturer for correct assembly and installation.
   4. Secure equipment firmly in place, including speakers, shelves, cables, etc.
      a. All supports, mounts, fasteners, attachments, and attachment points shall support their loads with a safety factor of at least 5:1 for static loads.
      b. Do not impose the weight of equipment or fixtures on supports provided for other systems.
      c. Any suspended equipment or associated hardware must be certified by the manufacturer for overhead suspension.
      d. The Contractor is responsible for means and methods in the design, fabrication, installation and certification of any supports, mounts, shelves, fasteners and attachments.
   5. Locate overhead ceiling-mounted speakers as shown on drawings, with minor changes not to exceed 12" in any direction for hard ceiling or one (1) tile space for drop ceiling spaces.
      a. Mount and adjust as needed to securely support speaker assembly.
      b. Speaker back boxes shall be completely filled with fiberglass insulation or as recommended by the manufacturer.
      c. Seal cone speakers to their enclosures to prevent air passing from one side of the speaker to the other.
   6. Finishes for any exposed work such as plates, shelves, panels, speakers, etc. shall be approved by the Owner.
   7. Coordinate cover plates with field conditions. Size and install cover plates as necessary to hide joints between back boxes and surrounding wall. Where cover plates are not fitted with connectors, provide grommeted holes in size and quantity required. Do not allow cable to leave or enter boxes without cover plates installed.
   8. Mount all equipment in telecommunications rooms on the T-series drawings. Coordinate equipment installation with other trades and other equipment in rooms.

3.4 CABLING PRACTICE

A. Execute all cabling in strict adherence to the National Electrical Code, applicable local building codes and standard industry practices.

B. Do not splice cabling anywhere along the entire length of the run.

C. Make sure cables are fully insulated from each other and from the raceway for the entire length of the run.

D. Do not pull cable through any enclosure where a change of raceway alignment or direction occurs. Do not bend cables to less than radius recommended by manufacturer.

E. Replace the entire length of the run of any cable that is damaged or abraded during installation. There are no acceptable methods of repairing damaged or abraded cabling.

F. Use cable pulling lubricants and pulling tensions as recommended by the manufacturer.

G. Use grommets around cut-outs and knockouts where conduit or chase nipples are not installed.

H. Do not use tape-based or glue-based cable anchors.

I. Provide ample service loops at harness breakouts and at plates, panels and equipment. Loops should be sufficient to allow removal of plates, panels and equipment for service and inspection.

J. Utilize permanent strain relief for any cable with an outside diameter of 1-inch or greater.

K. Dress non-UTP cables as follows:
   1. Cover the end of the overall jacket with a 1-inch (minimum) length of transparent heat-shrink tubing. Cut unused insulated conductors 2-inches (minimum) past the heat-shrink, fold back over jacket and secure with cable-tie. Cut unused shield/drain wires 2-inches (minimum) past the heat- shrink.
   2. Cover shield/drain wires with heat-shrink tubing extending back to the overall jacket. Extend tubing 1/4-inch past the end of unused cables, fold back over jacket and secure with cable-tie.
   3. For each solder-type connection, cover the bare wire and solder connection with heat-shrink tubing.

L. Labeling
   1. Clearly, consistently, logically, and permanently mark cables, connectors, and electronics and other equipment.
   2. For backboard/shelf-mounted equipment, use engraved Lamacoid labels with white 1/8" (minimum) high lettering on black background.
   3. Where multiple pieces of equipment reside in the same group, clearly and logically label each indicating to which room, channel, receptacle location, etc. they correspond.
   4. Permanently label cables at each end, including intra-room connections. Labels shall be covered by the same, transparent heat-shrink tubing covering the end of the overall jacket. Alternatively, computer generated labels of the type which include a clear protective wrap may be used.

5. Contractor's name shall appear no more than once within a given equipment room. The Contractor's name shall not appear on wall plates, emergency phones or speakers.

3.5 TEST EQUIPMENT

A. The Contractor shall furnish all test and computer equipment required for all testing and adjustments as well as any site visits by the Designer.

3.6 TEST AND MEASUREMENTS

A. Required audio system tests and measurements:
   1. Impedance measurements of all speaker lines at 50hz, 500Hz, and 5KHz with speakers installed and operating in their specified configuration.
   2. Polarity testing of all speaker lines.
   3. Overall hum & noise testing of each audio reinforcement system. Perform sweep frequency testing of speakers to check for rattles, buzzing, and/or functional problems. Sweeps shall not exceed the manufacturers rated bandwidth or one-quarter rated power for the device under test.
   4. Verification testing to ensure that systems are free from spurious oscillation, Radio Frequency Interference (RFI) or Electromagnetic Interference (EMI).
   5. Tests for audible clicks or pops caused by normal operation.

3.7 INSTRUCTION

A. Contractor shall provide a qualified individual to provide a minimum of sixteen (16) hours of instruction to the Owner regarding the design, features and proper operation of the systems.

3.8 FINAL CLEANING

A. At completion of work, remove all rubbish, tools, scaffolding, and surplus materials from the site. Site shall meet Owner's requirements for cleanliness.

B. At completion of work, thoroughly vacuum floors and flat surfaces such as shelves, counters and windowsills in the areas affected by the work.

C. Coordinate removal or storage of packing materials with the Owner. Contractor shall remove all packing materials from the site unless otherwise directed.

D. In the event the Contractor fails to perform final cleaning, Owner may do so and charge any associated costs back to the Contractor.

3.9 PROJECT CLOSE-OUT

A. Punch list:

B. Once notice of Substantial Completion is received, the Designer shall visit the site to review the work, and shall prepare a punch list of items determined to be incomplete, deficient or otherwise not in compliance with the intent of the Contract Documents.
   1. During the review of the work, if the Designer finds that the known exceptions/deviations list provided by the Contractor was insufficiently thorough, that the work is not substantially complete, or that deficiencies in the work are excessive, the Designer will cease review and inform the Contractor that the work is not substantially complete. The Contractor shall be responsible for fees incurred by the Designer for this partial review.

C. The Contractor shall perform corrective action for each item noted in the punch list. When complete, the Contractor shall submit the original punch list with each item initialed attesting to the fact that the item was corrected.
   1. If necessary, the Designer will perform a subsequent review after receipt of the Contractor initialed punch list.

D. Should additional reviews beyond the original punch list review be required of the Designer due to the Contractor's failure to correct all incomplete, deficient, or non-compliant work, the Contractor shall be responsible for fees incurred by the Designer for the additional reviews.
   1. Provide Operating & Maintenance (O&M) Manuals per the requirements of Part 1 - General: Operating & Maintenance (O&M) Manuals.

3.10 FOLLOW UP

A. After the system(s) and facility have been placed in operation and are in use by the Owner, provide technical assistance for the first two weeks of operation on a standby basis for troubleshooting, education, and problem solving.

END OF SECTION

SECTION 275119 - SOUND MASKING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Sound Masking Systems for the IHS Whiteriver project.

B. Products Installed, but Not Furnished, under This Section:
   1. See Section 260553 "Identification for Electrical Systems" for electrical equipment.

1.2 DEFINITIONS

A. Reference Division 01 for project definitions not listed below. Any duplicate definitions are superseded by Division 01.

B. Sound Masking Systems Specification: Written documentation outlining the requirements of the sound masking systems; includes sound masking drawings, appendices, bidding equipment list, and modifications issued via addenda, bulletins, or other contractual document.

C. Sound Masking System: The equipment, software, and installation materials that when installed, interconnected, programmed and/or configured provide the functional requirements as indicated within the Sound Masking Specification.

D. Sound Masking Equipment: Equipment and materials provided by the Contractor as well as equipment and materials furnished by others and installed in the Sound Masking System.

E. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.

F. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

G. Closeout Documentation: Written and graphic information including construction records, as-built drawings, manuals, and reports.

H. Amplifier: An electronic device required to amplify audio levels from certain masking controllers to drive masking emitters or loudspeakers to a usable sound pressure level.

I. Authorized Dealer: The company chosen to provide all sound masking system products described in Part 2. This dealer must be authorized by the manufacturer to provide, install, maintain, and warrant the products specified herein.

J. Direct Field Masking System: A sound masking system composed of emitters or loudspeakers that emit masking noise directly into a masking environment without permeating through an obstruction such as a ceiling or floor tile.

K. Hybrid Masking System: A sound masking system composed of direct field and indirect field masking systems monitored and controlled by a common network interface.

L. Indirect Field Masking System: A sound masking system composed of loudspeakers that emit masking noise into a space either above or below the masking environment and permeate into the masking environment through an obstruction such as a ceiling.

M. Loudspeaker or Emitter: These terms are used interchangeably to indicate a device in the sound masking system that emits masking sound and voice paging or music.

N. Sound Masking System: The electronic equipment and emitters or loudspeakers used to generate, distribute, and control masking sound throughout a treated area.

O. Manufacturer: The company that manufacturers the sound masking system products.

P. Masking Controller: A networkable electronic device that provides audio feeds to masking emitters or loudspeakers. Audio may include masking noise, background music, or paging or a combination thereof.

Q. Max Level Variation: The maximum variation, in decibels, of the equalized overall level or one-third octave level allowed in the masking system.

R. Network: An Ethernet based IP transport to facilitate communications from a PC to the sound masking system or between controllers within a sound masking system. The network must support system configuration, system control, and audio transport between devices.

S. Network Switch: A network device when connected to masking controllers allows controllers to share control and audio communications and, when connected to a computer, facilitates setup and control of an entire system from a single connection point.

T. Sound Masking System Designer: The person or team responsible for design of the sound masking system.

U. Spatial Uniformity: A condition where the sound pressure levels throughout a defined space do not vary significantly from a specified sound pressure level.

V. Spectral Uniformity: A condition where the sound pressure in each one-third octave band does not vary significantly from the specified one-third octave sound pressure level.

W. SPL: Sound pressure level in dB re 0.00002 Pa (0.0002 microbar).

X. Target Level Variation: The variation, in decibels, of the equalized overall level or one-third octave level used as a target in the sound masking system.

Y. Temporal Uniformity: At a given position, a condition where the average sound pressure level measured over a short time interval does not differ significantly from the average sound pressure level measured over a long time interval.

Z. Zone: One or more emitters or loudspeakers assigned to a masking controller and operating as a group.

AA. Transition Zone: Include emitters or loudspeakers at the perimeter of a masking zone set at 5 dB and 10 dB down from the main zone dBA goal to create a gradual increase of masking sound into the zone.

1.3 REFERENCES

A. ANSI S1.4 - Specification for Sound Level Meters. Calibrated Type 1 or Type 2.

B. ANSI S1.6 - Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements.

C. ANSI S1.11 - Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

D. ASTM E1130-16 - Standard Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index (Updated).

E. ASTM E1374-18e1 - Standard Guide for Office Acoustics and Applicable ASTM Standards (Updated).

F. ASTM E1573-22 - Standard Test Method for Measuring and Reporting of Masking Sound Levels Using A-Weighted and One-Third-Octave-Band Sound Pressure Levels (Updated).

G. ASTM E2638-10(2017) - Standard Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room.

H. ISO - International Organization for Standardization

I. NEC - National Electrical Code

J. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

K. FGI 2022 Guidelines for Design and Construction of Hospitals.

1.4 SYSTEM OPERATION REQUIREMENTS

A. Sound masking systems shall be designed for levels that do not exceed 48 dBA.

B. Loudspeaker coverage shall provide for spatial uniformity of +/- 2dBA. Contractor to provide EASE mapping to verify coverage.

C. Sound masking system shall provide a broad band random signal at the locations shown in the drawings in the frequency range 100 Hz to 10000 Hz (sound masking) capable of being adjusted in 1/3 octave bands to achieve a level and spectrum shape that will provide a specified degree of speech privacy in those areas covered by the signal. When paging signal is present, it should be mixed with sound masking signal. Paging signal shall override the sound masking without influence on it, but the masking shall not be muted.

1.5 SCOPE OF WORK:

A. Work shall include the furnishing of all materials, labor, tools, and transportation necessary to complete the installation of the sound masking system described in this specification and shown in the drawings. Refer to T8.X series drawings for zoning and performance requirements. Contractor is responsible for determining quantity of loudspeakers required and installation location to meet performance requirements.

B. The work shall include, but not be limited to:
1. Layout of loudspeakers and associated zones.
2. Design of centralized equipment to power loudspeakers.
3. Installation of equipment in rack cabinet provided in Telecom Room.
4. Internal wiring of rack.
5. Installation of speakers and other equipment external to rack cabinet.
6. Wiring of all external equipment.
7. Making equipment function as intended.
8. Documentation of performance, functions and wiring.

1.6 QUALIFICATIONS

A. An authorized dealer for the major product components and is certified by the manufacturer to perform installation, setup, maintenance, and warranty.

B. A verifiable history of successful installations of at least three projects of similar scope and size.

C. Provide the necessary personnel experienced in operating the required test measurement equipment outlined herein to configure, test, and calibrate the sound masking system.

D. During the warranty period, maintain two or more technicians who are certified for the product(s) under warranty as stated in "Warranty for Sound Masking Systems" Article.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: contractor to attend as required.

1.8 ACTION SUBMITTALS

A. Product Data:
   1. Manufacturer's detailed technical data sheets for all major sound masking system components, including material descriptions, applicable product pictures or drawings, finishes, electrical characteristics, and regulatory certifications.

B. Shop Drawings:
   1. Complete floor plan and/or reflected ceiling plan drawing(s) denoting, at minimum, device locations that have been prepared by the sound masking system designer based on the sound masking system manufacturer guidelines.
   2. Mounting details for all devices.
   3. Wiring diagrams connecting all devices.

C. Field quality-control reports.

D. Sustainable design submittals.

1.9 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:
   1. Sound masking system equipment.

B. Field Reports:
   1. Manufacturer's field reports for field quality-control support.
   2. Manufacturer's field reports for system startup support.
   3. Field reports for software and firmware upgrades.

C. Sound masking system coverage based on device locations.

1.10 CLOSEOUT SUBMITTALS

A. All final control processor settings, emitter or loudspeaker zone maps, loudspeaker tap settings, one line diagrams, operational instruction, and testing results.

B. Location of each sound pressure level measurement, privacy index measurement, and spatial uniformity measurement referenced within the final documents on the zone map.

C. Media with each documentation set utilizing the same software version as currently installed and operating and all configuration files created by the configuration software on the same media.

D. Sustainable design closeout documentation.

1.11 REGULATORY AGENCY APPROVALS

A. Submittals for sound masking systems connected to fire alarm and mass notification require approval by authorities having jurisdiction.

1.12 WARRANTY FOR SOUND MASKING SYSTEMS

A. Base-Warranty Period: Installer warrants that fabricated and installed sound masking systems perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within the base-warranty period.
   1. The installation of all equipment, cabling, and labor for an initial period of one year from the date of final acceptance unless a longer term is specified elsewhere.
   2. Equipment to be free of faulty workmanship and defects for a minimum period of five years from date of final acceptance.
   3. Services, including telephone support, at no charge during the duration of the initial one-year warranty period.
   4. Semiannual visits to the site for routine adjustment and maintenance of all specified and installed systems during the initial warranty period.

B. Special Installer Extended Warranty: Installer warrants that fabricated and installed sound masking systems perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
   1. Extended-Warranty Period: From the end of the Base Warranty Period, four additional years; full coverage for labor, materials, and equipment.

C. Special Manufacturer Extended Warranty: Manufacturer warrants that sound masking systems perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

PART 2 - PRODUCTS

2.1 NETWORKED SOUND MASKING SYSTEMS

A. Description: Electronic noise generators and associated controls for simultaneously operating multiple masking noise emission devices throughout facility.

B. Basis-of-Design Product: The design for this specification is based on the Atlas IED line of sound masking products. Comparable products from manufacturers below may be considered provided they meet all the criteria listed within this specification.
   1. Atlas IED, SoftdB, Biamp or equal

C. Equipment List:
   1. AtlasIED AZMP8
      a. Atmosphere™ 8-Zone Signal Processor with 1200-Watt Amplifier (qty 4)
   2. AtlasIED AP-S15LA
      a. 15LA Power Conditioner and Distribution Unit with IEC Power Cord and Lamp (qty 4)
   3. AtlasIED M1000R-W
      a. 8" Dual Cone Sound Masking Speaker with 4-Watt 70V Transformer and Enclosure - White and Round (qty 151)
   4. AtlasIED M1000
      a. 8" Dual Cone Sound Masking Speaker with 4-Watt 70V Transformer and Enclosure - Black (qty 457)
   5. AtlasIED MCHAIN72
      a. 72 inch Suspension Chain for Use with M1000 Speakers (qty 457)

6. AtlasIED WMA10-23
   a. 10RU High Strength Wall Cabinet with Adjustable Rails, 23.5 inch Deep (qty 4)
7. AtlasIED MPFD10
   a. 1 inch Deep Micro Perf Door for WMA 10RU (qty 4)
8. AtlasIED REMOTE-SVR-2HR
   a. SERV, REMOTE 2 HRS (qty 1)

D. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Include all masking, signal generation, signal processing, amplification, and emitters or loudspeakers with associated wiring, software, and controls.
3. The equipment to be procured from a single manufacturer.
4. The system to be composed of one or more logical zones capable of configuration and naming by the sound masking contractor. More than one physical output, including those from multiple control processors to be configured and assigned as a single zone. Each output within the zone to be controlled independently as to masking spectrum and level.
5. The system to be capable of automatically scheduling system parameter adjustments, including initial acclimatization, on a per-zone basis.
6. Control for the system to be facilitated through any combination of front panel hardware interface, manufacturer configuration software, and/or a web browser-based software interface.
7. The system to generate, amplify, and distribute a minimum of four noncorrelated sound masking signals on adjacent emitters or loudspeakers when their spacing is 12 ft or less. In this situation, adjacent emitter or loudspeaker devices to not reproduce coherent sound masking signals.
8. The system to be capable of accepting, at minimum, two external analog microphone or line level audio sources from ancillary audio equipment with control on a per-zone basis.
9. The system zones to be determined by the functional requirements of each area(s) with separate independent level control for each zone as indicated by the Project documents.
10. A new zone with separate level control to be required in instances where a change in emitter or loudspeaker mounting or ceiling height causes a greater than 0.5 dB increase or drop in level or where emitter or loudspeaker density changes from one area to another. This usually translates to a varying device level height of about 6 inches in a typical ceiling environment.
11. The masking volume shall be digitally adjustable in 0.5 dBA increments over a range of 35 dBA to 45 dBA at 1 meter.
12. Minimum pattern repeat shall not be less than 25 hours.
13. A transition zone shall be created around the coverage area a minimum of 12 feet around the coverage area. Transition zone may stop at a solid wall with a door into another area.

2.2 CONTROL PROCESSOR

A. Sound Controller:

1. General Characteristics:
   a. The sound controller to be DSP based.
   b. The sound controller to provide multi-zone processing that will facilitate adjustment of the masking level on a per-zone basis in 0.5 dB increments.
   c. The controller to provide per-zone scheduling function via internal clock source and/or NTP server, which can adjust the masking signal levels. Scheduling will, at a minimum, adjust for separate weekday and weekend level settings.
   d. The sound controller to provide an automatic, incremental level adjustment feature, allowing a gradual, one-time change of masking levels to commence upon completion of system commissioning, acclimating occupants to a newly sound masked environment (initial acclimatization).
   e. The sound controller to be separately capable of one-third octave equalization adjustment of the sound masking spectrum for each output as defined in this specification.
   f. The sound controller to have two configurable network ports.
      1) A single port configuration to simultaneously support communications, control, and audio, either AVB or Dante© (if applicable) with the second port being unused.
      2) A dual port configuration to support audio on one network port and communications and control on the second network port.
      3) Separate MAC addresses to be available for control, AVB and Dante© in either port configuration.
   g. The sound controller to have at least two mic/line level analog audio source inputs usable for paging or background music with phantom power available for microphones. The audio source inputs to be routable to other controllers over the audio network. A separate one-octave band equalizer, independent from the sound masking equalizer, to be provided for adjustment of each audio source separate from the masking equalization.
   h. The sound controller to accept six external audio channels via an eight-channel audio network transport usable for background music or paging. The audio transport to be based on industry standard 802.1X protocols. Dante© may be used as an acceptable alternate protocol for controllers that support Dante©. Routing of one or more audio channels to specific masking zones to be configured via the controller software.
   i. The sound controller to have the capability to mute or otherwise disable the sound masking signal and any other audio signals using a dry contact closure from a third-party source such as a fire alarm control panel (FACP). In a multiple processor system, a single contact closure at one processor will mute audio at all other processors when network communication exists.
   j. Means of control for the masking controller will be facilitated through any combination of front panel hardware interface, manufacturer configuration software, and/or a web browser-based software interface.
   k. Third-party supervision and control of the masking system will be facilitated via the industry standard RESTful API syntax. This feature will be protected from unauthorized access via multi-role security credentials.
   l. The sound controller to be networkable over standard Ethernet with dual network ports and will support a minimum of 90 controllers on a single network.

m. The sound controller to be capable of TCP/IP network connectivity via DHCP or Static IP address.
n. The sound controller to support 802.1X port authentication for network security.
o. The sound controller to support certificates. Users may select a Root or Client certificate based on the security requirements of the organization.
p. The sound controller to support multi-role user authentication passwords.
q. The sound controller to support fault reporting of trouble conditions.
r. The sound controller to feature a nonvolatile memory, capable of storing all system settings in the case of power disconnect.
s. The controller to be CE marked, UL listed, and RoHS compliant.
t. The controller to be TAA compliant and GSA eligible.
u. The controller to be covered by a manufacturer five-year warranty.

2. System Specific Characteristics:
   a. Networked sound masking systems using direct field (downward firing) high impedance emitter distribution.
      1) The sound controller to provide a minimum of four noncorrelated masking signal outputs per-zone.
      2) For passive direct field emitter solutions, the masking controller to support a maximum of 60 emitters on each of two runs for each masking zone with a maximum cumulative cable distance of 1000 ft. Where this distance is exceeded, some emitters to be broken off into a separate run on that zone.
      3) For active direct field emitter solutions, the masking controller to support a maximum of 50 emitters on each of two runs. Each run to be further divided by a power insertion device that injects DC power in each emitter line and has two outputs to power up to one half the number of emitters allowed in a run 25. The maximum cumulative cable distance from the power inserter to the last emitter in each of the two legs of the run to be 400 ft. Where this distance is exceeded, some emitters to be broken off into a separate run on that zone.
      4) The sound controller to provide a factory default sound masking spectrum as defined in this specification.
      5) The sound controller to include factory-set equalization for each loudspeaker output, with no in-field loudspeaker equalization normally necessary.
      6) The sound controller to include a UL/CUL/CE listed, 120-240VAC 50/60 Hz power supply.
      7) A wall mount bracket to be included with the masking controller.
   b. Networked sound masking systems using direct field (downward firing) individually addressable emitter distribution.
      1) The sound controller to provide a minimum of eight noncorrelated masking signal outputs per controller. Each output to be rated at 4Ω and to be designed to power one direct field masking loudspeaker.
      2) The masking controller to be rated for UL 2043 and be designed for installation within a plenum ceiling space.
      3) The masking controller to be powered via standard PoE+ power injector or network switch.

4) The masking controller to support a maximum of eight loudspeakers per controller.
5) The sound controller to provide a factory default sound masking spectrum as defined in this specification.
6) The sound controller to include factory-set equalization for each loudspeaker zone, with no in-field loudspeaker equalization normally necessary.
7) A ceiling grid mounting bracket to be included with the masking controller.

c. Networked sound masking systems using direct field (downward firing) 70-volt loudspeaker distribution.
1) The sound controller to provide a minimum of eight noncorrelated masking signal outputs per controller.
2) The masking controller to support a maximum of eight masking zones per controller.
3) Each masking zone output to be analog line level designed to drive a 70-volt amplifier. The number of loudspeakers supported by a single controller to be determined by the capabilities of the 70-volt amplifier(s) that are chosen.
4) The sound controller to include a UL/CUL/CE listed, 120-240VAC 50/60 Hz power supply.
5) A rack-mount bracket to be included with the masking controller.

d. Networked sound masking systems using indirect field (above ceiling) individually addressable loudspeaker distribution.
1) The sound controller to provide a minimum of eight noncorrelated masking signal outputs per controller. Each output to be rated at 4Ω and be designed to power up to eight indirect field masking loudspeakers.
2) The masking controller to be rated for UL 2043 and be designed for installation within a plenum ceiling space.
3) The masking controller to be powered via standard PoE+ power injector or network switch.
4) The masking controller to support a maximum of 16 loudspeakers per controller.
5) A ceiling grid mounting bracket to be included with the masking controller.

e. Networked sound masking systems using indirect field (above ceiling) 70-volt loudspeaker distribution.
1) The sound controller to provide a minimum of eight noncorrelated masking signal outputs per controller.
2) The masking controller to support a maximum of eight masking zones per controller.
3) Each masking zone output to be analog line level designed to drive a 70-volt amplifier. The number of loudspeakers supported by a single controller to be determined by the capabilities of the 70-volt amplifier(s) that are chosen.
4) The sound controller to include a UL/CUL/CE listed, 120-240VAC 50/60 Hz power supply.
5) A rack-mount bracket to be included with the masking controller.

2.3 EMITTER AND LOUDSPEAKER TYPES

A. 1.25 inches passive emitter, direct field, daisy chainable, in-ceiling or surface mount supporting masking only.
   1. The emitter to be designed for direct field operation, radiating directly into the occupied space.
   2. The emitter driver to be a nominal 1.25 inches diameter with an overall housing diameter of 3.25 inches.
   3. The emitter to be purpose built to interface with its associated controller and cannot be used with any other controlling device.
   4. The nominal frequency response of the emitter to be 125Hz to 8,000Hz.
   5. The nominal dispersion of the emitter to be at least 170 deg F below 4.2 kHz.
   6. The emitter housing to be capable of mounting directly into acoustic ceiling tile materials, surface mounted, pendant mounted, structural beam mounted, or hard surface ceiling mounted utilizing optional manufacturer supplied accessories. Provide seismic rated mounting where required by jurisdiction.
   7. The emitters to be spaced evenly between 8 and 12 ft apart as recommended by the product manufacturer based on site conditions and ceiling heights and below finished ceiling obstructions to meet the performance requirements. Refer to "Installation" Article for direct field masking emitters or loudspeakers installation requirements.
   8. The emitter to be capable of producing minimum sound pressure levels and frequency spectrum for emitters and as measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions. Refer to paragraph 3.6.C of this specification for more information on the installation requirements.
   9. The emitter to include DIP switches to provide 3 dB decrements of level for up to 9 dB of level reduction for easy micro-zoning.
   10. The emitter to include internal circuiting to support the routing of four noncorrelated masking channels so that adjacent emitters do not emit the same noise source, minimizing phase effects between emitters.
   11. The emitter and all mounting accessories to be UL 2043 compliant.
   12. The emitter to require a single, multi-conductor, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
   13. The emitter to be available in white (standard) or black finish. An optional emitter cap to be available that can be painted to match a particular ceiling color if required.
   14. The emitter to include a manufacturer-supported five-year warranty.

B. 1.25 inches active emitter, direct field, daisy chainable, in-ceiling or surface mount supporting masking, paging, and background music.
   1. The emitter to be designed for direct field operation, radiating directly into the occupied space.
   2. The emitter driver to be a nominal 1.25 inches diameter with an overall housing diameter of 3.25 inches.
   3. The emitter to be purpose built to interface with its associated controller and cannot be used with any other controlling device.
   4. The nominal frequency response of the emitter to be 105 Hz to 12 kHz.
   5. The nominal dispersion of the emitter to be at least 170 deg F below 4.2 kHz.

6. The emitter housing to be capable of mounting directly into acoustic ceiling tile materials, surface mounted, pendant mounted, structural beam mounted, or hard surface ceiling mounted utilizing optional manufacturer supplied accessories. Provide seismic rated mounting where required by jurisdiction.
7. The emitters to be spaced evenly between 8 and 12 ft apart as recommended by the product manufacturer based on site conditions and ceiling heights and below finished ceiling obstructions to meet the performance requirements. Refer to "Installation" Article for emitter installations.
8. The emitter to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for 1.25 inches emitters measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
9. The emitter to include DIP switches to provide 1.5 dB decrements of level for up to 4.5 dB of level reduction for easy micro-zoning.
10. The emitter to include internal circuiting to support the routing of four noncorrelated masking channels so that adjacent emitters do not emit the same noise source, minimizing phase effects between emitters.
11. The emitter and all mounting accessories to be UL 2043 compliant.
12. The emitter to require a single, multi-conductor, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
13. The emitter to be available in white or black finish. The emitter is not paintable.
14. The emitter to include a manufacturer-supported five-year warranty.

C. 1.25 inches emitter, direct field, individually controlled, in-ceiling or surface mount supporting masking, paging, and background music.
1. The emitter to be designed for direct field operation, radiating directly into the occupied space.
2. The emitter driver to be a nominal 1.25 inches diameter with an overall housing diameter of 3.25 inches.
3. The emitter to be purpose built to interface with its associated controller and cannot be used with any other controlling device.
4. The nominal frequency response of the emitter to be 125 Hz to 12 kHz.
5. The nominal dispersion of the emitter to be at least 170 deg F below 4.2 kHz.
6. The emitter housing to be capable of mounting directly into acoustic ceiling tile materials, surface mounted, pendant mounted, structural beam mounted, or hard surface ceiling mounted utilizing optional manufacturer-supplied accessories. Provide seismic rated mounting where required by jurisdiction.
7. The emitters to be spaced evenly between 8 and 12 ft apart as recommended by the product manufacturer based on site conditions and ceiling heights and below finished ceiling obstructions to meet the performance requirements. Refer to "Installation" Article for emitter installations.
8. The emitter to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for 1.25 inches emitters measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
9. The emitter and all mounting accessories to be UL 2043 compliant.
10. The emitter to require a single, two-conductor 18 gauge unshielded, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.

11. The emitter to be available in white or black finish. The emitter is not paintable.
12. The emitter to include a manufacturer-supported five-year warranty.

D. 3 inches driver, 70-volt, direct field surface mount loudspeaker supporting masking, paging, and background music.
1. The loudspeaker to be direct field, radiating directly into the occupied space.
2. The loudspeaker driver to be full range with a nominal 3 inches diameter.
3. The loudspeaker to be optimized to interface with the associated controller and to not be used with any other controlling device.
4. The loudspeaker to be capable of surface mounting via the included U-bracket. Pendant mounting can be attained by utilizing threaded rod attached to the U-bracket. Provide an additional safety-rated cable where required by code.
5. The loudspeakers to be spaced evenly between 6 and 10 ft apart as recommended by the product manufacturer based on site conditions and ceiling heights and below finished ceiling obstructions to meet the performance requirements. Refer to "Installation" Article for direct field loudspeaker installations.
6. The loudspeaker to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for drivers measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
7. The loudspeaker to require a single, two-conductor 18 gauge or greater unshielded, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
8. The loudspeaker to be available in white or black finish. The loudspeakers are not paintable.
9. The loudspeaker to include a manufacturer-supported five-year warranty.

E. 5.25 inches driver, 8Ω, indirect field (above ceiling) loudspeaker for masking.
1. The loudspeaker to be mounted above a finished acoustic ceiling tile ceiling, radiating into the plenum space. The plenum space to be at least 18 inches deep from finished ceiling to deck.
2. The loudspeaker driver to be full range with a nominal 5.25 inches in diameter.
3. The loudspeaker enclosure to be ported and formed from a seamless 1 mm cold rolled steel plate material with a powder coated finish. The enclosure to measure 8.5 inches in diameter by 5 inches high. The enclosure to be internally acoustically dampened.
4. The loudspeaker impedance to be a nominal 8Ω.
5. The loudspeaker frequency response to be a nominal 125 Hz to 10 kHz.
6. The loudspeaker sensitivity to be a nominal 91.9 dB 1W/1M.
7. The loudspeaker to be optimized to interface with the associated controller and to not be used with any other controlling device.
8. The loudspeaker to include a four-point suspension system with hanging chain for ease of installation and leveling.
9. The loudspeakers to be spaced as recommended by the product manufacturer based on plenum depth and type of acoustic ceiling tile. Final spacing to meet the performance requirements. Refer to "Installation" Article for indirect field loudspeaker installations.

10. The loudspeaker to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for indirect field loudspeaker installations and as measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
11. The loudspeaker and all mounting accessories to be UL 2043 listed as appropriate for use in the plenum spaces where it will be mounted.
12. The loudspeaker to require a single, two-conductor 18 gauge unshielded, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
13. The loudspeaker to be available in white or black finish.
14. The loudspeaker to include a manufacturer-supported five-year warranty.

F. 5.25 inches driver, 70-volt, indirect field (above ceiling) loudspeaker for masking.
1. The loudspeaker to be mounted above a finished acoustic ceiling tile ceiling, radiating into the plenum space. The plenum space to be at least 18 inches deep from finished ceiling to deck.
2. The loudspeaker driver to be full range with a nominal 5.25 inches in diameter.
3. The loudspeaker enclosure to be ported and formed from a seamless 1 mm cold rolled steel plate material with a powder coated finish. The enclosure to measure 8.25 inches in diameter by 5 inches high. The enclosure to be internally acoustically dampened.
4. The loudspeaker to include an internal transformer with 1/8W, 1/4W, 1/2W, 1W, 2W, and 4W taps at 70 volts and an external wattage selector to choose the preferred wattage.
5. The loudspeaker frequency response to be a nominal 125 Hz to 10 kHz.
6. The loudspeaker sensitivity to be a nominal 91.9 dB 1W/1M.
7. The loudspeaker to be optimized to interface with the associated controller and to not be used with any other controlling device.
8. The loudspeaker to include a four-point suspension system with hanging chain for ease of installation and leveling.
9. The loudspeakers to be spaced as recommended by the product manufacturer based on plenum depth and type of acoustic ceiling tile. Final spacing to meet the performance requirements. Refer to "Installation" Article for indirect field loudspeaker installations.
10. The loudspeaker to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for indirect field loudspeaker installations and as measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
11. The loudspeaker and all mounting accessories to be UL 2043 listed as appropriate for use in the plenum spaces where it will be mounted.
12. The loudspeaker to require a single, two-conductor 18 gauge or greater unshielded, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
13. The loudspeaker to be available in white or black finish.
14. The loudspeaker to include a manufacturer-supported five-year warranty.

G. Dual 4 inches by 1.5 inches, 8Ω, indirect field (above ceiling) loudspeaker for masking.

1. The loudspeaker to be mounted above a finished acoustic ceiling tile ceiling, radiating into the plenum space. The loudspeaker is designed for use in ceilings where plenum space is less than 18 inches or where the plenum space is severely restricted due to HVAC or other obstructions.
2. The dual opposed loudspeaker drivers each to be full range with a nominal 4 inches by 1.5 inches dimension.
3. The loudspeaker enclosure to be formed from a 1 mm cold rolled steel plate material with a powder coated finish. The enclosure dimensions to be a nominal 5.25 inches by 6.25 inches by 1.8 inches high. The enclosure to include tuned ports.
4. The loudspeaker impedance to be a nominal 4Ω.
5. The loudspeaker frequency response to be a nominal 160 Hz to 6.3 kHz.
6. The loudspeaker sensitivity to be a nominal 80.7 dB 1W/1M.
7. The loudspeaker is optimized to interface with the associated controller and to not be used with any other controlling device.
8. The loudspeaker to accommodate an optional ceiling tile bridge for ceiling mounting.
9. The loudspeakers to be spaced as recommended by the product manufacturer based on plenum depth and type of acoustic ceiling tile. Final spacing to meet the performance requirements. Refer to "Installation" Article for indirect field loudspeaker installations.
10. The loudspeaker to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for indirect field loudspeaker installations and as measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
11. The loudspeaker and all mounting accessories to be rated to UL 2043 and CSA C22.2 No. 205-12 as appropriate for use in the spaces where it will be mounted.
12. The loudspeaker to require a single, two-conductor 18 gauge unshielded, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
13. The loudspeaker to be available in white finish.
14. The loudspeaker to include a manufacturer-supported five-year warranty.
15. Retain paragraph below if the Networked Sound Masking Systems using indirect field (above ceiling) 70-volt loudspeaker distribution for plenum spaces under 18 inches deep are chosen.

H. Dual 4 inches by 1.5 inches driver, 70-volt, indirect field (above ceiling) loudspeaker for masking.
1. The loudspeaker to be mounted above a finished acoustic ceiling tile ceiling, radiating into the plenum space. The loudspeaker is designed for use in ceilings where plenum space is less than 18 inches or where the plenum space is severely restricted due to HVAC or other obstructions.
2. The dual opposed loudspeaker drivers each to be full range with a nominal 4 inches by 1.5 inches dimension.
3. The loudspeaker enclosure to be formed from a 1 mm cold rolled steel plate material with a powder coated finish. The enclosure dimensions to be a nominal 5.25 inches by 6.25 inches by 1.8 inches high. The enclosure to include tuned ports.
4. The loudspeaker to include an internal transformer with 1/8W, 1/4W, 1/2W, 1W, 2W, and 4W taps at 70-volts and an external wattage selector to choose the preferred wattage.
5. The loudspeaker frequency response to be a nominal 160 Hz to 6.3 kHz.

6. The loudspeaker sensitivity to be a nominal 80.7 dB 1W/1M.
7. The loudspeaker is optimized to interface with the associated controller and to not be used with any other controlling device.
8. The loudspeaker to accommodate an optional ceiling tile bridge for ceiling mounting.
9. The loudspeakers to be spaced as recommended by the product manufacturer based on plenum depth and type of acoustic ceiling tile. Final spacing to meet the performance requirements. Refer to "Installation" Article for indirect field loudspeaker installations.
10. The loudspeaker to be capable of producing minimum sound pressure levels and frequency spectrum. Refer to paragraph 3.6.C of this specification for indirect field loudspeaker installations and as measured at an above finished floor height of 4 ft regardless of ceiling type, ceiling height, or presence of obstructions.
11. The loudspeaker and all mounting accessories to be rated to UL 2043 and CSA C22.2 No. 205-12 as appropriate for use in the spaces where it will be mounted.
12. The loudspeaker to require a single, two-conductor 18 gauge or greater unshielded, low-voltage cable meeting NEC Class 2 requirements for low-voltage distribution. The cabling to be rated for use in plenum spaces.
13. The loudspeaker to be available in white finish.
14. The loudspeaker to include a manufacturer supported five-year warranty.

2.4 NETWORK SWITCH

A. Network switches are by Division 272100.

2.5 AMPLIFIER

A. The amplifier to be rated to support 70-volt speakers.

B. Individual amplifier channels to be required for each zone where masking equalization needs adjustment due to ceiling material variations or structural variations above or below the ceiling.

C. Unless specifically stated in the amplifier manufacturer specifications for masking systems, each amplifier channel to be loaded to no more than 42 percent of their rated RMS power.

D. Level controls to be located on the back of the amplifier. No level controls to be allowed on the front of the amplifier.

E. Input impedance to be 8kΩ or greater.

F. Input sensitivity to be +4 dBu (1.23 Vrms).

G. Maximum input level per channel to be +24 dBu.

H. THD+N (1 kHz, 1dB below clip) to be less than 0.008 percent.

I. Channel separation at 1 kHz to be greater than 75 dB.

J. Input gain for 70-volt operation to be 35.2 dB.

K. Power output per channel to be at least 75 watts, all channels driven.

L. The amplifier to include a built-in limiter for each output.

M. The amplifier to include a switchable high pass filter rated at 70 Hz, 12 dB/octave for each channel.

N. The amplifier to include front panel LEDs to indicate:

1. Temperature status.
2. Limiter status.
3. Signal status.
4. Power status.

O. Provide the necessary quantity of amplifiers/amplifier-channels to correspond with the Project zoning/sound-masking-generator requirements.

P. The amplifier to be listed to conform to UL 62368-1 and CSA C22.2 No. 62368-1.

Q. The amplifier to include a manufacturer-supported five-year warranty.

2.6 SOFTWARE AND CONTROL

A. The sound masking system to be capable of software control via a TCP/IP local area network connection to the Owner's local area network (LAN Infrastructure). Communication to be via industry standard Ethernet protocols. No communication via serial or proprietary bus architectures to be acceptable in this standard.

B. The integrator to coordinate connection to local area network with Owner's network administrator to include IP Addressing, MAC address(s), switch port assignments, 802.1X and certificate configuration and multirole user authentication passwords.

C. The software interface to consist of one or more of the following types:
1. Client Based Configuration/Control software utilizing Windows 10 or higher.
2. Internal web server using browser client.

D. Software control of the sound masking system to include password-protected adjustment and configuration of the following minimum features:
1. Ability to import multiple floor plans to facilitate control of masking zones.
2. Choice of masking controller(s) in the system. The system may include multiple controller types.
3. Choice of emitters or speakers connected to each controller.
4. Pre-optimization of emitter or speaker equalization when applicable for direct field systems.
5. Muting/unmuting per zone.
6. Sound masking level control on a per-zone basis.
7. Background music and paging audio input level control.
8. Choice of audio distribution to controller(s) via 802.1X or Dante©.
9. Routing of up to eight audio sources via a network connection to one or more zones.
10. Equalization adjustment on a per-output basis.
11. Emergency mute and push to talk for paging.
12. Zone naming on a per-output basis.
13. Time of day scheduling on a per-zone basis.
14. Network / clock management.
15. Audio routing of external network audio sources.
16. Error notification / monitoring.

E. The hardware interface to be capable of basic level adjustment on a per-output basis using the front panel menu screen that allows, at minimum, operation of both sound masking and audio input levels.

F. A third-party API to be published by the sound masking product manufacturer using the RESTful API syntax to allow monitoring of the masking system by building wide / room control system providers.

2.7 PERIPHERALS

A. Fire Alarm Control Panel Input:
   1. The system controller to accept a contact closure from a Fire Alarm Control Panel (FACP).
   2. The contact closure to be configured in the system controller to mute all masking, background music, and paging audio in the masking system.
   3. The controller to communicate with other masking system controllers on the network to also mute their audio when a contact closure is sensed.
   4. The systems to automatically be restored to normal operation when the contact closure is removed.

2.8 CABLE ASSEMBLIES

A. All cable assemblies to consist of the proper number of conductors, wire gauge, and type, as approved by the system manufacturer based on the system design.
   1. Cabling for 1.25 inches diameter emitters to be rated either Category 3, Category 5e, or Category 6. Cables to be terminated to TIA568A or TIA568B standards as a "straight-thru" cable.
   2. Cabling for 3 inches diameter or larger speakers to be a jacketed UTP stranded 18 or 16 AWG cable.
   3. Cabling for 70-volt speaker systems to be a jacketed UTP stranded 18 or 16 AWG cable.
   4. Cabling for emitter system power supplies to be a jacketed UTP stranded 14 AWG cable.
   5. Ethernet cabling to be UTP Category 5e, Category 6, or Category 7 rated. Cables to be terminated to TIA568A or TIA568B standards. Each Ethernet cable shall be verified to 10/100 MB/sec standards.
   6. Line Level analog audio cabling to be a jacketed two-conductor 22 AWG stranded, twisted pair shielded cable designed for analog audio signals.

B. Cabling flammability rating to meet or exceed the installation conditions as required by NFPA/NEC/CSA or local codes/ jurisdiction as follows;
   1. Type CM - General Purpose for Commercial Installation. Meets UL 1581 requirements for smoke and flammability testing.
   2. Type CMR/FT4 - Commercial Installation for vertical risers. Meets UL 1666 requirements for smoke and flammability testing.
   3. Type CMP/FT6 - Commercial Installation for plenum airspaces. Meets UL 910 requirements for smoke and flammability testing.

C. Terminations to be completed utilizing the appropriate connector type, method, and tooling as recommended by the product manufacturer.

D. All cabling to be plenum rated when located in a plenum space.

2.9 LABELS

A. Except where otherwise specified, label each item of control equipment as shown on Drawings.

B. Identify all wires and cables at every connection point to controllers with reference number keyed to the as-built wiring diagrams.

C. Room numbers appear on the contract documents for reference only. All labels shall reflect the Owner's final room designations.

D. Cable Markers:
   1. High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap to be used for labeling cabling.

2.10 SAFETY LISTINGS

A. Products and system to comply with all applicable local, regional, and national safety codes.

B. All electronics to be UL Listed or listed by an equivalent body such as Intertek ETL. Outside the USA, the electronics shall be certified by an equivalent certification body to meet local and/or national safety standards.

C. A ceiling device seismic support system to be installed in a manner certified by the manufacturer. Alternate seismic support system(s) must be approved by authorities having jurisdiction and based on local code requirements.

D. The masking control processor to have the capability to mute or otherwise disable the sound masking signal and any line-level audio input(s) of the entire sound masking system using a dry contact closure from a third-party source such as a fire alarm control panel to one of the masking controllers.

E. The sound masking system is not a primary means of emergency voice evacuation or ECS. For this reason, UL 2572 compliance is not required under this specification.

2.11 ENVIRONMENTAL CERTIFICATION

A. Sound masking system to be Green Spec Listed.

B. Sound masking system to be LEED compliant when Project requirements dictate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation, verify the site is suitable for system installation.

B. Verify all locations where system components are to be installed are free of conflicts with other trades prior to installation.

C. Verify that colors chosen (where applicable) have been coordinated with the Architect, building manager, and/or building owner.

D. Verify that site building conditions match the system design plans including ceiling finishes, wall locations, and obstructions. Immediately notify the project manager of any discrepancies prior to the commencement of work.

E. Ensure system power requirements, network connectivity, and any other third-party infrastructure requirements for the system have been provided and installed prior to installation.

3.2 DELIVERY, STORAGE AND HANDLING

A. Protect all system components from moisture, dust, and damage during shipping, storage, and handling.

B. Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.

C. Inspect all system components upon receipt and upon unpacking.

3.3 INSTALLATION

A. General:
1. Comply with all applicable electrical and other safety codes.
2. Install the sound masking system in compliance with manufacturer's recommendations and published documentation.
3. Utilize competent workers to install all equipment at locations shown on the drawings in strict accordance with approved shop drawings. Record all necessary changes to the system design in cases where different from the submittal documents and submit changes for approval prior to implementing the changes.
4. Ensure that all equipment will be firmly held in place, including emitters or speakers, enclosures, amplifiers, processors, cables, etc. Fastenings and supports will be adequate to support their loads with a safety factor of at least five unless otherwise stated.
5. Ensure that all system components will be mounted in a level and plumb fashion utilizing the dimensions indicated on the associated drawings.
6. Mount user-controllable devices at a location and height that allows for normal adjustment and operation.
7. Locate all electronics to be conveniently accessible for service.
8. Ensure that all equipment located in the ceiling plenum will be UL 2043 rated for air handling environments.

B. Ceiling Mounted Masking Emitters or Loudspeaker:
1. Locate masking emitter or loudspeaker assemblies as indicated on Project Drawings and as required to meet the spatial uniformity requirements of this specification.
2. Ensure that design approval from the sound masking manufacturer is acquired for any direct field masking emitters or loudspeakers scheduled to be installed greater than 20 ft above the finished floor prior to installation.
3. Ensure that design approval from the sound masking manufacturer is acquired for any indirect field masking loudspeakers scheduled to be installed greater than 30 ft above the finished floor prior to installation.
4. Ensure that the emitter or speaker coverage pattern is not obstructed by building systems or structures that may impede performance of the sound masking system.
5. Ensure that minimum distance between the top of an emitter or loudspeaker and the structure or obstacles is maintained to allow adequate clearance of cabling and connectors.
6. Ensure that the masking emitters and loudspeakers are installed using manufacturer-supplied accessories when mounted in other substrates, ceiling types, and/or building structures. Sound masking emitter and speaker assemblies will be mounted to structure in an approved method as required by local codes and jurisdiction and indicated by the Project submittals.
7. Follow manufacturer recommendations for individual emitter or loudspeaker level controls/taps. Adjust as necessary.

C. Cabling:
1. Install all cabling in a professional, skillful manner with adequate service loops where applicable. Cabling will be dressed in a neat and consistent fashion using appropriate methods and materials.
2. Test all field-fabricated and manufacturer-supplied cables, before installation, for open circuits, shorts, crossed pairs, reversed pairs, split pairs, and proper pin-out.
3. Refer to manufacturer recommendations as to maximum cabling distances and types to support control processor unit(s), controls, and emitters or loudspeakers. Manufacturer's cable distance limitations and quantity of devices per cable run will never exceed manufacturer guidelines.
4. Coordinate cabling pathways to prevent conflict with other building systems. Care will be taken to minimize and eliminate all RFI and EMI interference sources.
5. Maintain appropriate separation between dissimilar signal types, voltages, and electrical devices.
6. Install and support cabling in a manner and frequency utilizing approved methods and materials as required by the local authority having jurisdiction.
7. Install cabling in metallic rigid or flex conduit only as indicated on the associated Project drawings/specification and using manufacturer-approved accessories.
8. Support all cabling from structure. Cabling will not contact ceiling tiles or inhibit their removal for access to the plenum.

3.4 SITE QUALITY CONTROL

A. Ensure that emitter and/or loudspeaker spacing is correct, consistent, and follows design guidelines set forth by the product manufacturer.

B. Securely terminate all cables.

3.5 SYSTEM STARTUP

A. Coordinate with building network administrator to provide an Ethernet connection to the building LAN where required.

B. Perform the entire product manufacturer's recommended testing and startup procedure as outlined in the manufacturer's product manual(s).

C. Ensure functional operation of all ancillary devices to include front panel controls, audio inputs, contact closures, wall controls, software control, and third-party controllers. Test each setting and confirm expected results from actions taken. Correct all deficiencies in operation.

D. Perform system startup at a time when each zone/space is completely vacant and free of any noise contamination.

3.6 SYSTEM TESTS AND ADJUSTMENTS

A. Qualifications of Testing Party:
1. Testing, calibration, and setup will be performed by a qualified manufacturer's employee or an authorized dealer or designer who has been trained by the manufacturer.

B. Prior to Test and Adjustment: Ensure the site conditions are suitable for adjustment of the sound masking system. Adjustment can only be made when the following site conditions exist:

1. All ceiling assemblies are currently installed and completed.
2. All interior furnishings are assembled and in place.
3. Mechanical systems have been previously optimized to final operational conditions and are active in areas served by sound masking signals.
4. No occupants are present at the time of adjustment.
5. External noise sources (e.g. construction activities) are not present during testing.
6. Final testing will be scheduled at least 30 days in advance of owner occupancy.

C. Initial Test and Adjustments: Perform and record results of the following tests:
1. Masking Emitter/Loudspeaker Operation: Near field output of each masking emitter or loudspeaker will match the zone average within plus or minus 2.0 dB. Listen directly below each installed emitter or loudspeaker to confirm it is operating. For any emitter or loudspeakers found to be inoperative, or possibly operating at an incorrect level, use a calibrated sound level meter set to A-weighting and slow response to check the output. Place the microphone so to contact each grille and measure the variation between a minimum of two adjacent emitters or loudspeakers of the same zone.
2. Replace any defective emitters or loudspeakers or cabling, or otherwise correct cause for any emitters or loudspeakers found to be operating outside the range stated.
3. Buzzes, Rattles, and Distortion: With system operating at maximum level, listen for any buzzes, rattles, and objectionable distortion in all areas covered. Correct all causes of these defects.

D. Final Test and Adjustment: Perform and record the results of the following tests:
1. Control Settings: Adjust all masking spectrum levels and audio level controls for initial operation using manufacturer-recommended procedures. Document setting for each user control.
2. Adjustment of Sound Masking Levels: With the masking system active, measure the A-weighted sound pressure level of each zone independently. Use an ANSI S1.4 approved and calibrated Type 1 or Type 2 sound level meter and/or calibrated real-time acoustic analyzer with one-third octave filters per ANSI S1.11. Perform all SPL measurements at a typical seated height of 4 ft above finish floor. Adjust the sound masking in each zone to correspond with the A-weighted average levels specified and the manufacturer's frequency spectrum. Manufacturer's frequency spectrum shall be based on the Bradely, NRCC-46274 report. Document, at minimum, one measurement per 500 sq ft in open offices, one measurement in 50 percent of private offices, and one measurement in 50 percent of all other spaces where sound masking is present. All documented measurements will meet the maximum level variation column criteria of the drawings. Correct any sound masking system deficiencies such as emitter or loudspeaker placement or loudspeaker tap settings to meet this performance criteria.

E. Proof of Performance Testing by a Qualified Acoustician: The Contractor will employ the services of a qualified acoustician at no additional cost to the Owner, documenting to the Owner's Representative in written form that the system is fully operable and is installed in compliance with the terms of the performance specifications hereunder.

1. Test the system to demonstrate that the Privacy Index (PI) equal to >75% (Normal Privacy) or better is met between representative workstations separated by felt privacy dividers. For this test, select adjacent workstation pairs without direct line of sight or significant sound reflecting ceiling or wall elements between, and with a ceiling material rated at NRC of 0.85 or higher. Tests will be in accordance with ASTM E1130 except that the octave band calculation method of ANSI S3.5 may be used. Lower levels of PI are acceptable only if the ceiling or partition requirements described herein before are not met. Document the results of this test.
2. Test the system in each open plan area zone served to demonstrate that the design goal for spatial uniformity is met. Tests will be carried out per ASTM E1573 as measured in the 2,000 Hz octave band. At each location, the average sound pressure levels will be measured over an interval of at least four seconds at four positions at 90-degree intervals around a circle of 1 ft radius centered on the location. The arithmetic mean sound pressure level will be calculated from the four measured values. For at least 75 percent of the test locations, the arithmetic mean sound pressure level in the 2,000 Hz octave band will not vary by more than +/-1 dB from the average of the arithmetic mean sound pressure levels measured at all locations. Document the results of this test.
3. Test the system to demonstrate that the Speech Privacy Class (SPC) is at least 55 (Standard Speech Privacy) between representative private (enclosed) offices served by the system. For this test, select adjacent offices with closed doors free of air gaps. Tests will be in accordance with ASTM E2638-10. Test 10 percent of all similar sized offices and meeting spaces utilizing the same basic construction methods. Lower levels of SPC are acceptable if the common walls between the offices are composed of assemblies <=STC 40 and which do not extend to the deck above or in cases where the common wall <=STC 40, does not extend to the deck, and the ceiling attenuation class of the ceiling material is less than 45 (<=CAC 45). If the SPC achieved is lower than 75 due to architectural factors, bring this to the attention of the Owner or General Contractor. Document the results of this test.
4. The sound masking contractor will make all necessary modifications to the system design, integration, and/or settings, as specified by the System Designer, to achieve the performance testing goals contained herein at no additional expense to the Owner. Designer, to achieve the performance testing goals contained herein at no additional expense to the Owner.

3.7 CLEANING AND WASTE MANAGEMENT

A. Remove empty packaging and other material waste.

B. Clean all debris created by installation of components.

C. Clean system components where required.

3.8 FINAL CLOSEOUT AND AS BUILT DOCUMENTATION

A. Document, prepare, and submit all final control processor settings, emitter or loudspeaker zone maps, loudspeaker tap settings, one line diagrams, operational instruction, and testing results in PDF format. Submit three copies to the system designer, the project manager and, if required, the Owner's representative for final review and acceptance.

B. Indicate the location of each sound pressure level measurement, privacy index measurement, and spatial uniformity measurement referenced within the final documents on the zone map.

C. In cases where the sound masking system utilizes configuration software for adjustment and operation, provide a copy on media with each documentation set utilizing the same software version as currently installed and operating. The Contractor provides all configuration files created by the configuration software on the same media.

D. With 30-day advance notice, train Owner's designated representative on sound masking system maintenance and proper operation.
   1. Provide user instruction on operation.
   2. Discuss potential for misadjustment of sound masking levels and deterioration of both comfort and speech privacy performance.
   3. Demonstrate all software features, controls, and configuration.

3.9 TRAINING

A. Contractor shall provide a qualified individual to provide a minimum of eight (8) hours of instruction to the Owner regarding the design, features and proper operation of the systems.

3.10 REFERENCE DOCUMENTS

A. System Design Schematic: Schematic of the system design on a floor plan showing the zoning and dB level requirements per zone type.

B. Project Drawing Sheet(s): See sound masking sheets in T-series drawings.
   1. Reference dB levels in sheet general notes per zone type.

END OF SECTION

SECTION 275123 - EMERGENCY HELP POINTS AND CALL BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section include:
1. 1. Freestanding pedestals
2. 2. Overhead camera mount
3. 3. Speakerphone
4. 4. 360-audio paging unit
5. 5. Security Cameras
6. 6. Collum mounted help point
7. 7. Supporting IT equipment
8. 8. Integrations
9. 9. Battery Backup
10. 10. TVSS devices
11. 11. Ancillary devices and interfaces

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.

B. This section is inclusive of Division 08 Door Hardware specification and Architectural door schedule.

C. Section 014000 - "Quality Requirements"

D. Section 260533 "Raceways and Boxes for Electrical Systems."

E. This section is inclusive of all Division 27 Communications specification sections.

F. This section is inclusive of all Division 28 sections.

G. Section 078413 "Penetration Firestopping."

H. Section 142000 Vertical Transportation specification

I. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

J. Appendix - System Integration Matrix

K. Owner Security Standards:
1. FGI Guidelines for the Design and Construction of Hospitals (2022)
2. FGI Guidelines for the Design and Construction of Outpatient Facilities (2022)
3. IAHSS Security Design Guidelines for Healthcare Facilities 3rd Edition
4. IAHSS Healthcare Security Industry Guidelines 13th Edition
5. The Joint Commission Planning, Design, and Construction of Health Care Facilities 4th Edition
6. Refer to owner security standards, as applicable to the Project.

L. Division 28 and Professional Services
1. Each bidder shall review the professional services scope of work document, associated costs, and all other relevant sections of this specification that require professional services. This review is a mandatory component of the bid response. To ensure compliance, each bid must include a completed and signed Professional Services Compliance Checklist, attached to this bid document.

1.3 Definitions

A. Abbreviations and Acronyms - Division 01 will supersede any conflicts.

1. ASTM: American Society for Testing and Materials
2. CDMA: Code Division Multiple Access, a network technology that makes it possible for phone calls to be transmitted via radio signal.
3. CE: Conformité Européenne (European Conformity)
4. CSA: Canadian Standards Association
5. DHCP: Dynamic Host Configuration Protocol; used on IP networks where the server dynamically assigns an IP address and other network configuration parameters to each device.
6. DID: Direct Inward Dialing; a service offered by telephone companies to subscribers who
7. operate a PBX system.
8. DSP: Digital Signal Processing; performs a variety of operations, applying various
9. algorithms to produce a signal that's higher quality than the original.
10. DTMF: Dual-Tone Multi-Frequency; the signal generated when telephone keys are pressed. Uses voice-frequency band over telephone lines between equipment and other communication devices and switching centers.
11. FXO/FXS: Ports used to connect analog phones. FXO (Foreign Exchange Office) is the port that receives the analog line; FXS (Foreign Exchange Subscriber) delivers the analog line to the subscriber, aka the "wall jack."
12. GSM: Global System for Mobile communications, a standard used to describe the protocols for digital cellular networks to transmit calls.
13. IAX: Inter-Asterisk eXchange; a communications protocol native to Asterisk PBX software and used for transporting VoIP sessions between servers and terminal devices.
14. **ISO**: International Organization for Standardization
15. ISP: Internet Service Provider; an organization that provides services for accessing the Internet.
16. LAN/WAN: Local Area Network; a group of devices connected together, frequently within
17. the same building or campus. Wide Area Network connects multiple LANs.
18. **NEC**: National Electrical Code
19. PBX: Private Branch Exchange; a private telephone network used by a company or organization.
20. PSTN: Public Switched Telephone Network; the aggregate of circuit-switched networks that
21. are operated by local, regional or national providers.
22. SIP: Session Initiation Protocol; used for initiating, maintaining and terminating real-time
23. sessions for voice, video and messaging applications.
24. SNMP: Simple Network Management Protocol; an Internet standard for collecting and organizing information about managed devices on IP networks and modifying that information to change behavior.
25. T1 PRI: Primary Rate Interface (PRI); a telecommunications standard used on
26. an Integrated Services Digital Network (ISDN) for carrying voice and data transmissions. Based on T-carrier (T1) transmission in the U.S. and Canada.

27. TCP: Transmission Control Protocol; used to interconnect network devices on the Internet.
28. TLS: Transport Layer Security; a protocol designed to improve security over a network.
29. Trunk: Used to provide network access to clients by sharing a set of lines or frequencies instead of providing them individually.
30. UDP: User Datagram Protocol; primarily used for establishing low-latency and loss-
31. tolerating connections between applications on the internet.

B. Descriptions:
1. Discrete camera: is a type of camera that is designed to be unobtrusive and blend into its surroundings.
2. Help Point®: A vandal-resistant, multi-functional, freestanding pedestal communication device constructed of carbon steel. It includes a high-quality, hands-free communication device, a high-intensity faceplate light, a powerful combination blue beacon/strobe light, and an area light that serves to easily identify it from a distance.
3. PTZ (Pan-Tilt-Zoom): A type of camera that can be remotely controlled to pan (move horizontally), tilt (move vertically), and zoom in and out.
4. PCB (Printed Circuit Board): A board used in electronics to mount and connect various electronic components.
5. TVSS (Transient Voltage Surge Suppression): A device used to protect electrical equipment from voltage spikes.
6. FGI (Facility Guidelines Institute): An organization that provides guidelines for the design and construction of healthcare facilities.
7. IAHSS (International Association for Healthcare Security and Safety): An organization that provides security design guidelines for healthcare facilities.
8. API (Application Programming Interface): A set of clearly defined methods of communication between various software components.
9. PoE (Power over Ethernet): A technology that allows electrical power to be transmitted over Ethernet cables along with data.
10. SLA (Service Level Agreement): A contract between a service provider and a customer that specifies the level of service expected during the term of the agreement.
11. AGM (Absorbent Glass Mat): A type of battery that uses a glass mat to absorb the electrolyte, making it spill-proof and maintenance-free
12. Manufacture's Professional Services: Services offered by the manufacturer of the video management system designed to ensure the effective deployment and operation of the installed solution. These often include:
    a. System Design and Planning
    b. Installation and configuration
    c. Testing and support
    d. Integration Services
13. Perpetual license: A software licensing model where a user pays a one-time fee to use a specific version of the software indefinitely. Unlike subscription models, it does not require ongoing recurring payments. While the user owns the software version.

14. Integrations: refers to the process of combining different systems or components to work together as a unified system.

C. ACTION SUBMITTALS
1. Product Data: Complete product data and technical specification data sheets that include manufacturer's data for all material and equipment..
2. Shop Drawings: Shop Drawings and Schematics: Shall depict the VMS in final proposed "as built" configuration. The following must be provided:
   a. Device floor plans,
   b. Connection diagrams for interfacing equipment.
   c. One-line diagrams
   d. Network interfaces
   e. Block diagrams,
   f. Riser diagrams,
   g. Typical device installation details,
   h. List of connected equipment.
   i. Locations for all major equipment components to be installed under this specification.
3. Sustainable Design Submittals, as applicable to Project.
4. Test Reports: Submit the following reports directly to Project Manager from Manufacturer's Quality Control Inspector, with copy to Contractor. Prepare reports in conformance with Section 014000 - Quality Requirements:
   a. Testing plan.
   b. Pre-test.
   c. Acceptance test.

D. INFORMATIONAL SUBMITTALS
1. Qualification Data:
   a. Installer certification from video management system manufacturer.
   b. Manufacturer certifications for technicians and installation supervisor.
   c. Manufacturer certification for API interface software, as applicable.

E. Field quality-control reports.

F. CLOSEOUT SUBMITTALS
1. Closeout Documentation:
   a. Operation and Maintenance Data: Include data for each type product, including features, testing plan and operating sequences, both automatic and manual. Include user's software data and recommendations for spare parts to be stocked at the site. Provide names, addresses, and telephone numbers of service organizations that stock repair parts for the system.
   b. Project Record Documents: Record actual locations of equipment and devices, and routing of alarm wiring.
   c. Licensing
   d. Software
   e. Hardware
   f. Firmware
   g. Operational/ User
   h. Administrative
2. Completed Readiness Checklist.
3. Final Test Result Report.

4. As-Built Drawings.
5. Operation and Maintenance Manuals (O&Ms).
6. Warranty Information.

1.4 QUAILITY ASSURANCE

A. Installer/Contractor Qualifications:
   1. Installer must be a factory authorized and certified installer of the security equipment supplied in this project and shall have been regularly engaged in the installation of the type of security equipment, hardware, and software. The contractor shall be factory trained on the VMS and associated products they propose and shall submit with their proposal a certificate from the manufacture indicating their satisfactory completion of training for the VMS proposed.
   2. Installer must have certified technicians and project supervisor certified by the video management system manufacturer to install the provided system.
   3. Minimum 5 years' experience of satisfactory performance on projects of similar size and scope. Provide owner with references upon request. Prime system manufacturers and manufacturers of major system components are required to qualify separately.
   4. Installers shall be licensed where required by the state or county.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Do not deliver or install equipment until HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.6 COORDINATION

A. Coordinate security conduit pathway requirements with EC and GC prior to rough-in work.

B. Coordinate telecom data cabling requirements with Division 27 structured cabling contractor.

C. Coordinate security installation and commissioning requirements with owner security personnel.

D. Coordinate security equipment networking requirements with owner IT personnel.
   1. Equipment and devices will communicate over owner LAN, via owner provided PoE switches.
   2. Assemble and maintain an IP security device schedule, itemizing data port quantities, locations, and other networking requirements, for coordination with owner IT during installation.

E. Coordinate VMS devices with help point supplier.

F. Coordinate video intercom recording with help point supplier.

G. Coordinate pharmacy device installation, workstation, recorder replacement, and camera field of views with GC, electrician and owner's representative.

1.7 WARRANTY

A. Warranty Period: Provide one (1) year warranty from date of Substantial Completion on all parts and installation.

B. Special Warranty: Provide minimum three (3) year manufacturer warranty on all supplied cameras, servers and recorders.

C. The help point assembly to include all compoents decribed above shall be warrantied against any defects in material and workmanship, under normal use, for a period of 2 years from date of installation. If system is found by manufacturer to be defective within the warranty period, manufacturer shall repair and/or replace any defective parts, provided the equipment is returned to manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer shall have regularly produced, as one of the manufacturer's principal products, an ACAMS similar to that specified for this project for at least ten (10) years.

B. Proposed product substitutions must conform to the functional requirements of this specifications document. System architectural differences are acceptable as long as functional requirements are met under the alternate architecture. Windows 32-bit applications may not be substituted for 64-bit applications.

C. Help Point System, Basis-of-Design Product: Code Blue Corporation or equal. 800-205-7186, 259 Hedcor Street, Holland, Michigan 49423. www.codeblue.com.

D. Security Cameras, Basis-of-Design Product: Subject to compliance with requirements, available manufactures offering products that me be incorporated into the work include:
1. Reference Division 282300 for video surveillance camera basis of design.

2.2 SYSTEM DESCRIPTION

A. The unit shall be a vandal-resistant communications device that is a multi-functional, freestanding pedestal constructed of carbon steel, model CB 1-s from Code Blue Corporation, or equal. It shall include a high quality, hands-free communications device illuminated by a high intensity faceplate light, a powerful combination blue beacon/strobe light and an area light that serve to easily identify it from a distance. See options below for add-ons.

B. The overhead camera mount is designed to allow the mounting of a multi-sensor camera with an integrated PTZ directly above the pedestal and link the phone activation to the camera operation, model Overhead Camera Mount from Code Blue Corporation.

C. The LS1000 speakerphone unit shall be a vandal-resistant, communications device, model LS1000 from Code Blue Corporation, no substitutions. It shall have a real time, non-open source, proprietary operating system. It shall have a single enclosure comprised of all electronics with a fixed IP color camera*, serviceable speaker, microphone, button, and PCB components.

D. 360-Audio Paging unit shall be powerful 360-degree, six-speaker Audio Paging System located at the top of Freestanding pedestal (CB1) model Help Points® from Code Blue Corporation, or equal.

2.3 CONSTRUCTION

A. Freestanding pedestal
   1. The unit shall be a cylinder constructed of ASTM A500 seamless carbon steel structural tube, 12.75" outside diameter x 0.135" thick wall, at a height of 108" and weigh approximately 210 lbs.
   2. The unit shall have an internal anchor base plate that is MIG welded 2" above the base and fabricated with a minimum of 0.50" thick A-36 grade steel plate. It shall have a 5" diameter center hole for electrical conduit access. The base plate shall have four oblong holes on an 8" circular bolt pattern for attachment.
   3. One access door measuring 14.00" H x 9.54" W will be placed 13.00" from the bottom of the base to provide access for mounting to the anchor bolts and connectivity to electrical facilities. The opening shall have a cover plate, which mounts flush and is the same steel and radius as the unit. The cover plate shall fit into the opening and have a weather-resistant gasket. The cover plate shall be held in place by two ¼-20 x 1" countersunk proprietary fasteners.
   4. Tamper resistant proprietary fasteners manufactured for Code Blue Corporation shall be used. It shall not be possible to acquire the custom-designed bit from any other source.
   5. Three area light openings 10" high and 10.72" wide, with the bottom of the openings approximately 14" from the top.
      a. A heavy cylindrical lens made of clear UV-rated polycarbonate shall be mechanically and chemically fastened to the interior. The lens shall be fully sealed and treated to prevent damage from ultra-violet radiation, aging, cracking, yellowing or breaking.
      b. A recessed opening shall be cut at a point beginning 36.6" above the bottom of the unit. The opening shall be 15.1" tall at the forward edge and 12.8" tall at the rear edge, creating a 25-degree angle from the horizontal and an arc of 160 degrees in the face.
         1) The opening shall be enclosed by a 7 gauge steel plate with a single opening for a communication device.
         2) The enclosure shall be capable of using interchangeable faceplates: single button, two button or two button with keypad
   6. Overhead camera mount
      a. The unit consists of three main components: camera mount pipe, mounting ring, and retaining ring. The overall height is 63.20" from the bottom of the retaining ring to the top of the camera mount pipe.
      b. The camera mount pipe is constructed from 1.50" Schedule 40 pipe. The mount pipe is bent 90degrees where it attaches to the mounting ring and 180 degrees on the opposite end where the camera attaches. A 1.50" NPT thread is provided for attachment of the camera unit.
      c. The mounting ring is constructed from 12.75" outside diameter x.25" thick ASTM A500 seamless carbon steel structural tube. The mounting ring is 4" tall with a hole that allows the camera mount pipe to be welded on the inside and outside of the intersection.

d. The retaining ring is constructed from 12" outside diameter x .25" thick ASTM A500 seamless carbon steel structural tube. The retaining ring is 2.50" tall and protrudes from the mounting ring 1.50". The ring contains three ½-13 nuts for mounting hardware.
e. A multisensor camera with an integrated PTZ shall be mounted on the 1.50" Schedule 40 pipe.

7. Speakerphone LS1000
   a. The speakerphone shall measure 8.5" W x 11.75" H x 2.56" D with six screw holes and weigh approximately 4.93 lbs.
   b. The Faceplate shall be constructed of 0.104" thick stainless steel with custom-designed, vandal-resistant camera, microphone and speaker openings.
   c. An 8.5" W x 11.75" H x 0.96" D rubber gasket shall be on the back of the faceplate.
   d. A stainless steel screen shall be mounted between the faceplate and speaker for additional vandal resistance and weatherproofing.
   e. A 3.5" weatherproof speaker and optional keypad shall be mounted via .50" stainless steel studs, locking washers and lock nuts.
   f. A discrete 1080P camera standard sensor unit shall be mounted with an aluminum recessed threaded mount.
   g. Piezoelectric buttons that are self-monitoring and contain no mechanical parts shall be mounted in a cast aluminum bezel via locking nut and rubber washer.
   h. Button bezels shall be made of cast aluminum and mounted via stainless steel studs, locking washers and lock nuts.
      1) Manufacture's optional ADA Compliant Tactile and fully customizable bezel designs made of acrylic and aluminum shall be ordered as part of assembly.
   i. One .42" red LED light and one .42"green LED light will be utilized beneath CALL PLACED and CALL RECEIVED signals.
   j. Aluminum stand offs and locking washers shall be utilized to mount conformal coated electronics. A molded plastic housing shall be secured with aluminum standoffs, locking washers and stainless steel screws. Weatherproof modular connectors shall be utilized for external power, auxiliary, PAS control, communication, audio output connectivity
   k. Self-monitoring and fault reporting for loss of power, PAS amplifier/speakers (if attached), battery voltage and button, speaker, microphone and keypad failure. Built-in scripting language provides advanced button and diagnostic report programming.12. The Fault reporting shall be by SNMP management system or by custom script for placing outgoing calls and message playback.
   l. Operational temperature shall be -40° to +70° Celsius (-40° to +158° Fahrenheit).
   m. The unit shall have three Ethernet ports, one capable of being connected to a PoE network switch.

8. 360-Audio Paging

a. The Audio Paging (AP) assembly sits on top of the CB1. The AP unit shall consist of 6 weatherproof speakers and grilles, a housing capable of attaching the dome top, gasketing to make it weatherproof, and fasteners to attach it to the CB1 and CB5 models.
b. Audio Paging speaker shall be integrated and zoned as part of the paging system specified. See paging drawings for zoning requirements. See security drawings for 360-audio paging locations on pedestals.

2.4 MOUNTING

A. Free Standing Pedestal
1. The unit shall be mounted onto four anchor bolts that are set 0.50" above the concrete. Standard 0.75" x 24" galvanized steel anchor bolts, nuts and washers shall be supplied.
2. The concrete foundation shall measure 24" x 24" minimum and the anchor bolts shall protrude 6" from the foundation.
3. Unit shall include a weather-resistant, vented rubberized gasket mounted into the base to prevent entry of sediment and pests.

2.5 ELECTRICAL

A. All electrical components shall have a modular plug for easy service and replacement, and will be equipped with a fuse for protection from transient voltage conditions.

B. Free Standing Pedestal with lights requires 2.5 ampere at 24V AC.

C. Overhead Camera requires 12VDC 80watts POE.

D. Speakerphone LS1000 requires Power over Ethernet IEEE 802.3af (15.4 maximum wattage) and PoE+ IEEE 802.3at (25.5 maximum wattage).

E. 360° Audio Paging Speakers requires 4 amperes at 12-24VDC

F. Voltage options shall include: 12-24V AC/DC; 120, 240 and 277V AC.

G. The unit shall have Power over Ethernet for connectivity to a VoIP network switch with 802.3af or 802.3at (minimum) capabilities. Requires the LS1000 speaker phone for connectivity to ToolVox or SIP/IAX2 compatible VoIP system.

H. Manufacturer's operational SLA/AGM battery backup shall be installed with up to 16 hours of talk time/standby.

I. Nonvolatile memory ensures programming of IP5000 is retained ruing power loss.

2.6 LIGHTS

A. LED Beacon/Strobe: Located in the dome top assembly with a rating of no less than 270 Lumens/92 candela, it shall have a factory-set flash rate of up to 375 flashes per minute and be programmable. A deep blue UV-rated polycarbonate prismatic refractor shall surround the LED Beacon/Strobe and be used to distribute the light in a horizontal pattern for maximum brightness and visibility.

B. The communication device shall be factory programmed to activate the LED Beacon/Strobe for the duration of a call.

C. The LED Beacon/Strobe shall be 5.10" tall and 5.50" in diameter.

D. Area Light: The LED Area Light shall be protected within the two light openings by a .13" thick UV-rated polycarbonate lens and be used to distribute light in a horizontal and vertical pattern.

E. A reflector disk shall be mounted above to direct light outward and downward.

F. It shall measure 10.72" W x 10" H, with the opening 14" from the top.

G. It shall have a Lumen rating of 852.

H. Faceplate light: LED will direct light onto the communications device and be vandal resistant.

I. The opening shall measure 4.50" W x .50" H.

J. The light shall have a lifetime of 100,000 hours and a rating of 100 Lumens.

2.7 COMMUNICATIONS

A. The unit shall have a speakerphone communication device.

B. LS1000

C. The unit shall be capable of communicating via third party IP wireless and cellular devices, which can be housed within the unit.

D. EIA/TIA, ANSI, CSA and BICSI cabling or similar standards shall be adhered to for proper operation of devices connected to copper or fiber infrastructure.

E. The 360-Audio Paging system shall:

F. Be a cylindrical 360°, six-speaker AP assembly for paging notification capabilities:
   1. Load Resistance minimum 2.0 Ohms
   2. Max Output Power 100 Watts
   3. Distortion 10%
   4. Signal to Noise 102 db
   5. Impedance of 8 Ohms per speaker parallel-series
   6. Frequence Range: 450 Hz to 8000 Hz or similar
   7. Power Capacity: 15Watts or more per speaker
   8. Temperature: Operating Temperature: -40°C to 85°C Ambient Temp Range

G. The amplifier shall have the following additional features:
   1. Synchronized Switching Frequencies for AM Avoidance
   2. Full range 20 to 20kHz Bandwidth Programmed to support voice range.
   3. Remote Disable • Silent Turn-On
   4. Full Protection: Over Current Speaker Short, Over Current Short to Chassis Ground, Over Temperature Protection, Power Supply Under Voltage Lockout and Excessive Clipping
   5. Monitor Outputs: Output Current Monitor, Temperature Monitor and Protect and Power On
   6. Input audio gain adjustment at the amplifier
   7. The unit shall be capable of communicating via third party IP wireless and cellular devices, which can be housed within the unit

2.8 FINISH

A. Freestanding Pedestal
   1. Four-coat paint process, with zinc-rich primer for corrosion resistance and baked-on polyurethane enamel for maximum gloss and shine.
      a. Contractor to include clear coating process offered by the manufacturer for additional environmental protection.
   2. The unit shall be finished with a highly graffitit and UV resistant coating process.

3. Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards: D2794 Direct and Reverse Impact, D523 Gloss @ 60 Degrees, D3359B Cross hatch Adhesion, D1654 Corrosion Creep, D714 Scribe Blisters and D714 Field Blisters.
4. The finish shall be available in 7 standard colors: Safety Blue, Safety Red, Safety Yellow, Gloss White, Gloss Black, Dark Bronze and Bright Silver. Custom colors shall be available. Color and graphics shall be coordinated and approved by owner prior to ordering.
    a. Coordinate black with white lettering color and finishes with architecture.
    b. Minimum coverage thickness of 2.0 mils.

B. Overhead Camera Mount
1. Four-coat paint process, with zinc-rich primer for corrosion resistance and baked-on polyurethane enamel for maximum gloss and shine.
    a. Optional clear coating process offered by the manufacture shall be provided for additional environmental protection
2. The unit shall be finished with a highly graffiti and UV resistant coating process.
3. Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards: D2794 Direct and Reverse Impact, D523 Gloss @ 60 Degrees, D3359B Cross hatch Adhesion, D1654 Corrosion Creep, D714 Scribe Blisters and D714 Field Blisters.
4. The finish shall be available in 7 standard colors: Safety Blue, Safety Red, Safety Yellow, Gloss White, Gloss Black, Dark Bronze and Bright Silver. Custom colors shall be available. Color shall be coordinated and approved by the owner prior to ordering.
5. Minimum coverage thickness of 2.0 mils.

C. LS1000 Speakerphone
1. Faceplate shall have an optional four-coat paint process, with zinc-rich primer for corrosion resistance and baked-on polyurethane enamel for maximum gloss and shine. Coordinate paint with owner prior to ordering.
    a. Optional clear coating process available to provide additional environmental protection shall be applied.

D. 360-Audio Paging
1. Four-coat paint process, with zinc-rich primer for corrosion resistance and baked-on polyurethane enamel for maximum gloss and shine.
    a. Optional clear coating process offered by the manufacture shall be provided for additional environmental protection
2. The unit shall be finished with a highly graffiti and UV resistant coating process.
3. Substrate preparation shall be as required to comply with applicable ASTM impact and adhesion standards: D2794 Direct and Reverse Impact, D523 Gloss @ 60 Degrees, D3359B Cross hatch Adhesion, D1654 Corrosion Creep, D714 Scribe Blisters and D714 Field Blisters.
4. The finish shall be available in 7 standard colors: Safety Blue, Safety Red, Safety Yellow, Gloss White, Gloss Black, Dark Bronze and Bright Silver. Custom colors shall be available. Color shall be coordinated and approved by the owner prior to ordering.
5. Minimum coverage thickness of 2.0 mils.

E. Blue Alert Connect Software

1. BLUE ALERT® CONNECT
    a. Blue Alert® Connect Advanced Paging License supports multicast and scheduled automated paging through the Blue Alert® Connect Platform.
    b. Blue Alert® Connect will support up to 200 simultaneous phone calls and up to 1,000 device licenses.
2. BLUE ALERT® MONITOR
    a. Blue Alert® Monitor is a unique real-time monitoring and reporting application. Schedule and run tests of connected devices to ensure the speakers, buttons and microphones are always working properly.
    b. Blue Alert® Monitor provides a comprehensive set of features for faults, performance, traffic monitoring, and alarm generation making it suitable for monitoring networks of any size.
    c. Blue Alert® Monitor provides a web-based user interface for monitoring and managing your network.
    d. Blue Alert® Monitor supports a RESTful API for integration with other systems.
    e. Blue Alert® Monitor is highly scalable and can be deployed on a variety of platforms.
    f. Blue Alert® Monitor can monitor the status and activity of online and registered Code Blue units using a combination of passive and active SNMP traps. These options, and their severity include:
        1) Action Script Triggered - Normal Severity
        2) Auxiliary Out Toggled - Normal Severity
        3) Call Incoming - Normal Severity
        4) Call Outgoing - Normal Severity
        5) Incoming DTMF Commands - Normal Severity
        6) Account Registration - This has two responses (True and False) If True: Normal Severity. If False Major Severity
        7) Call Failed - Warning Severity
        8) Audio Playback Failed - Warning Severity
        9) Script Failure - Warning Severity
        10) Button Failure - Minor Severity
        11) Battery Power Failure - Minor Severity
        12) High Temperature - Minor Severity
        13) Mic/Speaker Failure - Minor Severity
        14) Cold Strat (Reboot) - Minor Severity
        15) Public Address Failure (if present) - Major Severity
        16) Unit Offline/Unresponsive - Critical Severity
        17) Blue Alert® Monitor traps/incidents can be toggled on or off for reporting.
3. BLUE ALERT® MOTION
    a. Blue Alert® Motion is a cloud-based video platform hosted on Amazon Web Services (AWS) with high availability performance and world leading streaming and storage technologies.
    b. Blue Alert® Motion software offers a secure video-verification & event-based recording solution.
    c. Blue Alert® Motion automatically stores all Help Point® initiated videos in the cloud, making it accessible from anywhere.

d. Blue Alert® Motion provides cloud-based storage for playback (up to 90 days) and download capabilities.
e. Blue Alert® Motion delivers notifications to smartphones or other devices when the platform logs a new recording.
f. Blue Alert® Motion mobile application allows users to access event-based video recordings from anywhere with an internet connection.

4. BLUE ALERT® PORTAL
   a. Blue Alert® Portal is a web-based interface used to access Blue Alert® application status, performance history, call logs, subscription status, and other data related to Blue Alert® software applications.
5. BLUE ALERT® PLATFORM DELIVERY
   a. Blue Alert® software applications are hosted on Code Blue's ToolVox™ XS (server appliance), ToolVox™ XV (VM application), or Nebula (cloud).

F. COMPLIANCE
1. F Freestanding Pedestal
   a. Americans with Disabilities Act (ADA) compliant
   b. UL 62368-1
   c. CSA C22.2 No. 62368-1
   d. NFPA 72 Chapter 24 (2010) compliant
   e. Meets NEMA 3 requirements
2. IP 5000 Intercom
   a. Braille symbols and two highly visible LED indicators for ADA compliance
   b. FCC certified
   c. Compatible with Cico Unified Communications Manager.
   d. Nema 3S or compliant when installed with NEMA compliant enclosure.
   e. 5. UL 60950-22 compliant when installed in a Code Blue Help Point®.
   f. 6. UL 62368-1 compliant when installed in a Code Blue Help Point®.

G. GRAPHICS
1. Engineering grade reflective vinyl for high visibility and legibility.
2. Standard 3.25" tall and 30" long graphics text offerings: Help Point.
3. Standard graphics color offerings: Reflective White.
4. Custom text, length and color options shall be available.
5. Graphics shall be coordinated and approved by the owner prior to ordering

H. OPTIONS
1. Overhead Camera Mount
2. 360° Public Address Speakers
3. Secondary Access Door
4. Second faceplate opening for directory listings, camera or other mounted devices.
5. Active vent solar powered fan for improved air flow.

PART 3 - INSTALLATION

3.1 Installation

A. The help points consisting of the free-standing pedestal (CB1 S), Overhead Camera mount, speakerphone unit, 360-audio paging, and associated cameras shall be mounted in the parking lots as identified in the drawing package during phase 1 area 1 for the temporary parking area, during phase 2 area 1 for the first section of parking lot, and in phase 2 area 2 for the second phase of parking lot construction.

B. The help point consisting of half-height free standing pedistal (CB 9S-) and speakerphone unit with integrated camera shall be mounted in as shown in the drawing with the intercom unit facing the outdoor cafeteria during phase 2 area 1 construction.

C. The on-premises Tool Vox server and associated hardware shall be mounted in the existing operations center during phase 1 area 1 to support the temporary parking lot, creating a complete and usable system during the main hospital construction. Coordinate location with owner. The relocation of the tool vox server from the existing operations center to the new hospital shall be coordinated with the owner.

D. Provide one(1) desk mounted intercom master station to receive calls from help points installed during phase 1 in area 1 to be located in the command center in a location to coordinate with owner.

E. After phase 2 area 2 is completed, the units located in phase 1 area 1 shall be decommissioned and removed, unless otherwise specified by owner.

F. Prior to site acceptance testing all software and firmware shall be upgraded to the latest versions for installed equipment.

3.2 Integrations

A. The help points shall be integrated with the public address system to create an exterior paging system zone.

B. The help points shall be integrated with the Master Intercom units located in the security operations center to allow each master station to answer any emergency call. All five work stations within the new hospital security operations center shall be capable of full system operation of any of the help point systems.

C. The help points shall be integrated with the video management system for the recording of all cameras installed on or within the help points.

D. The help points shall be integrated with the video management system to create a video call-up of all cameras associated with the help points on the security operations center video wall when a call is started. Once the call has ended the video wall will return to its original video display.

E. The help points shall be integrated with the Motorola orchestrate software to create automated functions such as a help point announcement when a facility lockdown occurs.

3.3 Professional Services

A. The manufacturer professional services shall be contracted to support the design, programing, and integration of the help point system.

B. TRAINING

1. Provide up to four(4) one(1) -hour sessions of user/operator training. The two sessions may be similar (to allow additional staff to be trained) or may cover different topics while going into more depth, as determined and requested by owner. Training shall cover the following basic aspects of the system:
    a. Help Point overview to include but not limited to
    b. System operation (high level)
    c. Diagnostics (high level)
    d. Identification of help point station assemblies and sub-assemblies.
    e. System operation and monitoring.
    f. Speaker paging
    g. Questions and answer time

C. Provide up to Two(2) Two(2) hour sessions of administrator/operator training. The two sessions may be similar (to allow additional staff to be trained) or may cover different topics while going in more depth, as determined and requested by the owner. Training shall cover the following basic aspects of the system:
    1. Help Point Server Software configuration and administration.
    2. Help Point Camera configuration and adjustments integration with VMS
    3. Help Point Speaker Paging configuration via Atlas IED system
    4. System operation and monitoring.
    5. End-user maintenance and testing.
    6. Diagnosis features
    7. Disassembly and reassembly of Help Point station
    8. Question and answer time

D. Provide up to one(1) eight-hour session of train-the-trainer. The session may be similar to the user/operator training and the administrator/operator training sessions, as determined and requested by the owner. Training shall cover the aforementioned topics above but will allow the sessions to be recorded by internal IHS staff or their delegates.

E. Training shall be used to provide guidance on installed systems not used to upsell beyond the current capabilities. In the event participants ask questions on features that are not purchased, they should be directed to their leadership for discussion on that topic.

F. Training team shall be comprised of a minimum of four people:
    1. Lead-Trainer: Person who will facilitate training.
    2. Manufacture's professional services representative.
    3. Lead-Installer: person who led the installation of the system.
    4. Role-player: Person who can trigger alarms in the field during training.

G. Training leave-behinds: Training team shall prepare and provide the following before each session to each student and an electronic copy:
    1. Training Agenda
    2. Step-by-step instructions on basic tasks such as viewing recorded video and exporting recorded video

END OF SECTION

SECTION 275223 - NURSE CALL AND CODE BLUE 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. This section specifies the requirements for the installation, configuration and integration of the audiovisual/voice nurse-call system and associated digital clinical workflow software, messaging software and communication devices.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Cabling Diagrams: Single-line block diagrams showing cabling interconnections of all components for this specific equipment. Include cable type for each interconnection.

E. Station Installation Details: For built-in equipment, which is dimensioned and to scale.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

C. Warranty: Sample special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For nurse-call equipment to include in emergency, 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. Lamps: All colors for corridor dome lights and zone lights equal to 20 percent of amount installed.
2. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
3. Printed Circuit Boards: Each kind, equal to 10 percent of amount installed, but no fewer than one unit.
4. Master-Station Privacy Handset: One.
5. System program backup software.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.

C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and applications.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty for batteries applies to materials only, on a prorated basis for specified period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ascom (Telligence 7), no substitutions.

B. Ascom Digistat software suite, no substitutions.

C. Ascom Unite Messaging suite, no substitutions.

2.2 NURSE-CALL SYSTEM REQUIREMENTS (IP ARCHITECTURE)

A. IP Network (Local Area Network)
1. The System shall be IP network-based and incorporate decentralized, distributed intelligence architecture. This intelligent architecture shall be built on an IP (Internet Protocol) network and support using the facilities local area network (LAN) for functions approved by local regulatory bodies.
2. The System shall allow both data and voice to be distributed over a common network infrastructure, which is consistent with the communication industry. Communication devices on the network will utilize standards-based protocols.
3. The system shall support both DHCP and BOOTP protocols for IP address handling.
4. The System shall also provide a means of interoperability with third party wired and wireless network devices within the facility, including PCs, PDA's, mobile phones, databases, pagers, etc.
5. The System shall be capable of Hill-Rom and/or Stryker bed side-rail communication compatibility including visual and audible annunciation of patient safety and fall prevention alarms generated by the bed and of disconnected bed.
6. It shall be possible to configure the System using a modular, flexible GUI application that provides the system administrator with the ability to manage, (add, delete, modify) and diagnose information within the nurse call network. Systems not supporting administrative access remotely shall not be accepted.
7. The System shall not rely on any computer for primary operation. Systems requiring a PC to be connected for UL 1069 operation shall not be accepted.
8. IP Devices shall accept switches or power supply devices (such as PoE+) approved by local authority having jurisdiction.

B. Network
1. IP nurse call systems shall be capable of using the facility's local area network where approved by AHJ (Authority Having Jurisdiction).
2. The IP nurse call system must support the following network standards:

a. 10/100 BaseT networks, supporting auto negotiation.
b. Power over Ethernet (802.3 af and 802.3 at)
1) Network switch PoE requirements/options
a) 802.3 af - maximum of 15.4 watts (older switches) (PoE)
b) 802.3 at - maximum power to 30 watts, with 25.5 watts being the standard amount received by the device (PoE+)
2) Support of UDP for performance with security aspects managed in the application

C. System
1. Supplier shall include all control equipment needed to enable open voice communication for patients within the system.
2. System shall support serial data transmission from medical equipment to pass
3. through to centralized server (requires Digistat).
4. System shall support in-room touch screen station with supported HTML5
5. Browsers.
6. The system shall support integrated, automatic presence of staff via compatible
7. mobile devices (requires Unite).
8. System shall support ID badge readers to manually register presence (requires
9. Unite).
10. Systems shall support multi-touch buttons which allow additional functionality on room devices. Example: a short press can be staff assist, and a long press can be a staff emergency.
11. Redundancy/Safe Mode
a. During system communication failure with the nurse call network, it shall be possible that patient/staff nurse call events are still signaled at the dome light.
b. Dome light shall provide a visual indication of the system in "Safe Mode" on the top segment of the light.
c. Dome light shall display a nurse call event on the bottom lens of the light to indicate that there is an active request in the room while in "safe mode".

2.3 AUDIOVISUAL/VOICE NURSE-CALL SYSTEM (COMPONENTS)

A. Patient Devices
1. Pillow Speaker/Handsets
a. Provide one (1) bedside Pillow Speaker/Handset for each patient location. The Pillow Speaker/Handset shall have a magnetic plug to minimize potential device damage.
b. The Pillow Speaker/Handset shall contain selected options that include the nurse call button, a speaker and microphone (optional), and controls for TV volume and channels in a molded, flame-retardant, ABS housing. The cord shall be 8' in length and have an integrated retaining clip.
c. System shall support patient-initiated actions/events such as room lighting, Pain, Toilet, Water, or SunBlind control buttons.
2. Call Cords & Specialty Devices
a. Provide call cords as required. The call cord shall have a heavy duty, molded magnetic connector, a flexible PVC jacketed cable, and a molded, flame retardant, ABS switch housing. The switch shall be the momentary

contact type. The cord shall be 8' in length, have an integrated retaining clip, and be suitable for ethylene oxide sterilization.

b. Call Cords shall be of a sealed design with a smooth shape and minimal crevices to allow for easy, comprehensive cleaning to assist in keeping infectious contaminants out of the pendant and reduce the potential for cross contamination.

c. The call cord shall provide a call assurance LED indicating to the patient a call has been placed.

d. Provide Breathcall® call cords for use by patients who do not have adequate use of their hands to initiate a call. The Breathcall® cord shall have a heavy duty, molded, ¼ inch connector, a flexible PVC jacketed cable, and a momentary contact switch that is sensitive to air pressure. The cord shall be 9' in length, features an adjustable arm for clamping the call cord onto a headboard or bed frame, and be suitable for use in oxygen atmospheres. Each Breathcall® call cord shall be furnished with twelve (12) replacement straws.

e. Provide air bulb call cords for use by patients who must remain distant from electrical fixtures. The air bulb call cord shall have a heavy duty, molded, combination ¼ inch connector/air pressure sensitive switch. The "cord" shall consist of flexible tubing 8' terminated with an air bulb, have an integrated retaining clip, be suitable for use in oxygen atmospheres, and be suitable for ethylene oxide sterilization.

f. Provide geriatric call cords for use by patients who have minimal use of their hands to initiate a call. The geriatric call cord shall have a heavy duty, molded, ¼" connector, a flexible white PVC jacketed cable with a sensitive, momentary contact reed switch that requires only a gentle squeeze or tap to activate. The cord shall be 8' in length, will have an integrated retaining clip, and be suitable for ethylene oxide sterilization.

g. Provide breakaway pull cords at all locations.

h. In Mental Health and Behavioral Health locations, provide any additional anti-ligature measures as required.

B. Patient/Staff Room Devices

1. Patient Station

a. Patient Station shall be expandable to/from single bed to dual occupancy without hardware change. As a dual patient station, unique bed IDs shall be annunciated with associated events.

b. Patient Station design shall allow for mounting on a two or three gang back box, enabling system options, without increased rough in/back box change requirements.

c. Patient Station shall support Serial Input from Pillow Speakers, enabling options on Pillow Speakers functions.

d. Patient Station shall support integration to Smart Beds (Hill-Rom, Stryker, etc.) for nurse call, entertainment, and room controls in addition to transmitted bed alarm(s).

e. Patient Station shall provide an input from equipped Stryker beds to enable bed alarms to be annunciated within the nurse call system. Bed alarms shall include bed exit, bed height, angle, wheel lock and status of rails.

f. Patient Station shall provide three (3) configurable buttons. Each button shall be capable of two call types via a short press or long/double press activation. At minimum Code Blue, Staff Assist and Staff Emergency buttons shall be provided at each Patient Station location.
g. Single Patient configurations must provide a minimum of four (4) inputs that can be used for Pillow Speaker(s), Call Cord(s), Bed Integration, and analog inputs from medical equipment.
h. Shall support Full-Duplex audio for Pillow Speaker when event is generated from patient device. Intercom response to staff calls will bypass TV audio and shall open two-way duplex audio to the Patient Station.
i. To support infection control measures, the station shall support Cleaning Mode to temporarily disable buttons, and cord disconnects without generating nuisance alarms, to allow the device to be properly sanitized.
j. Patient Stations shall offer basic or advanced maintenance modes of operation. Basic (Easy) mode will utilize dipswitch setting enabling plug and play replacements, while advanced will use serial number programming.
k. System connections shall utilize RJ45 connectors for simplified service.

2. Basic Patient Station for Pre/Post Op and PACU Area
   a. Patient Station design shall allow for mounting on a two or three gang back box enabling system options without increased rough-in/ back box change requirements.
   b. Patient Station shall support integration to Smart Beds (Hill-Rom, Stryker, etc.) for nurse call, in addition to transmitted bed alarm(s).
   c. Patient Station shall provide an input from equipped Stryker beds to enable bed alarms to be annunciated within the nurse call system. Bed alarms shall include bed exit, bed height, angle, wheel lock and status of rails.
   d. Patient Station shall provide three (3) configurable buttons. Each button shall be capable of two call types via a short press or long/double press activation. At minimum Code Blue, Staff Assist and Staff Emergency buttons shall be provided at each patient station location.
   e. Single Patient configurations must provide a minimum of four (4) inputs that can be used for Call Cord(s), Bed Integration, and analog inputs from medical equipment.
   f. Shall support Duplex audio when an event is generated from a patient device. Intercom response to staff calls, will bypass TV audio, and shall open two-way duplex audio to the module.
   g. To support infection control measures, the station shall support Cleaning Mode to temporarily disable buttons and cord disconnects, without generating nuisance alarms, to allow the device to be properly sanitized.
   h. Patient Stations shall offer basic or advanced maintenance modes of operation. Basic (Easy) will utilize dipswitch settings enabling plug and play replacements, while advanced will use serial number programming.
   i. System connections shall utilize RJ45 connectors for simplified service.
3. Staff Assist/Code Blue Station
   a. Patient Station design shall allow for mounting on a two or three gang back box, enabling system options, without increased rough in/back box change requirements.

b. Patient Station shall provide three (3) configurable buttons. Each button shall be capable of two call types via a short press or long/double press activation. At minimum Code Blue, Staff Assist and Staff Emergency buttons shall be provided at each Patient Station location.
c. To support infection control measures, the station shall support Cleaning Mode to temporarily disable buttons, and cord disconnects without generating nuisance alarms, to allow the device to be properly sanitized.
d. System connections shall utilize RJ45 connectors for simplified service.

4. Peripheral Devices
   a. Peripheral Devices are addressable initiating modules that provide patient room call-for-assistance indication to the system. When a Peripheral Device is activated, visual indication of the event, displays on the device for assurance, at the dome light associated with the patient room, and an appropriate alert indication registers on the staff console, as well as on any installed and covering annunciators.
   b. Each room shall be capable of supporting up to sixteen devices. These stations shall be configurable to generate any level of call supported by the system configuration. Examples of Peripheral devices are Lavatory, Shower, Lav-Audio, Staff Emergency, Remote Cancel, Housekeeping, Code Blue, Code Pink, Urgent, Family Call, Staff Normal, Manual Presence, Auxiliary Inputs, Bed-Connect, etc.
   c. Room devices shall offer basic or advanced maintenance modes of operation. Basic (Easy) will utilize a dipswitch setting, while advanced will use serial numbers.
   d. Push button/Pull Cord Stations shall be field configurable for a minimum of three total alerts/events on the single device mounting to a one (1) gang back box.
   e. Call type/priority for each pushbutton or pull cord shall be programmable to annunciate the facility-determined call type.
   f. Devices shall allow customization with buttons and matching re-assurance lights in the field.
   g. The physical device button label shall be field replaceable to match the specified call type/priority. Systems requiring the device to be replaced by a new device to match a new call type/label or require buttons to be purchased from the manufacturer shall not be accepted.
   h. Peripheral device buttons shall be configurable for 'Toggle On / Toggle Off," supporting bed management, patient flow, and other non-clinical type events, as defined by the facility.
   i. Peripheral device buttons shall have multiple functions-short press, long press, and double press-that can activate different alerts or room status.
   j. Peripheral devices shall provide on-board lighting for visibility in dark rooms.
   k. Peripheral devices shall support the reuse of existing category cabling (Cat5/5e/6).
   l. Each Peripheral device button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call.
   m. LED assurance must match the color of the button, for reassurance to staff, that the proper alert/event has been placed.

n. All Peripheral devices shall have the ability to be individually numbered to represent a separate and distinct location, even stations that are on the same Room Bus.
o. Peripheral devices provide a means to be hot swappable and not require system shutdown or removal of power prior to replacement and no additional software programming.
p. Peripheral device pull cords shall be made of a non-contaminant material to reduce the spread of nosocomial infections. Pull cords made of cotton or other absorbent materials will not be accepted.
q. Peripheral devices shall provide a cleaning mode to allow station surfaces to be cleaned without accidentally generating calls. Activating cleaning mode shall temporarily disable front panel buttons for a configurable period.
r. All Peripheral devices must be fully supervised.
s. The Pull Cord shall meet IP44 rating to be splash proof and suitable for use in wet areas such as bathrooms.
t. Lavatory Pull Cords shall support up to eighty newtons of force before breakaway occurs.

5. Lavatory Pull / Lavatory Pull with Audio Station
   a. Shall support a minimum of three unique alert/events on a single device (Assist, Emerg, Cancel, or Supplies for example).
   b. Lavatory station shall have an IP44 rating to withstand environment.
   c. Lavatory Pull Cords shall support up to eighty newtons of force before breakaway occurs.
   d. Lavatory Station with intercom capability shall provide duplex audio and mount to a single gang back box.
6. Bath Station
   a. Shall support a minimum of three unique alert/events on a single device (Assist, Emerg, Cancel, or Supplies for example).
   b. Lavatory station shall have an IP44 rating to withstand environment.
   c. Bath Station Pull Cords shall support up to eighty newtons of force before breakaway occurs.
7. Bedside Module
   a. Bedside module shall be field configurable to support a minimum of three (3) customizable buttons and receptacle for use of Pillow Speaker/Handset, Bed or Call Cord.
   b. Bedside module shall have a magnetic connector with a SafeConnect socket that can be used with all system Pillow Speaker/Handsets and call cords. Call assurance LED shall be supported on both Pillow Speaker and Call Cord.
   c. Bedside module shall be able to activate any call event in the system and system shall provide output for reassurance LED.
8. Customizable Module
   a. Module is wall-mounted with a minimum of three (3) customizable buttons with matching color reassurance used to register staff presence in the room.
   b. Module shall have the option to add Speech Module for intercom functions.
   c. Module shall support audible tones.

9. Speech Module
    a. The system shall be capable of providing stand-alone speech modules connected to the active room bus that can be located at the headwall, in the ceiling, or in any area as needed.
    b. Speech shall support duplex audio for two-way speech between patients and staff.
    c. System shall support multiple speech modules in the same room.
    d. Speech module must contain a microphone and speaker.
    e. Speech Module shall include LED indicating microphone and speaker activity. Speech module shall be able to produce dual tone audible notification.
10. Medical Device Integration
    a. Shall support magnetic safe release plug from validated medical device. Staff shall be able to disconnect devices without generating a cord out error. Unintentional disconnects must provide cord out alert.
    b. Shall support the ability to receive and transmit medical device data via supervised, high-speed RS485 interface to a centralized medical device monitoring system.
    c. Shall have RGB LED and indicate if the device is properly connected.
    d. Shall support connection of medical devices for automatic collection of vital signs and other relevant data (requires Digistat).
    e. Shall support a minimum of eight medical devices connected to a single bed/location.
    f. Shall support visual display via touch screen in patient room indicating successful connection and provide status of connected equipment (requires TelliConnect station).
    g. Shall support automatic identification of device type (Pump, Monitor, etc.) with association of the location/patient without the need for configuration by staff.

C. Staff Devices
1. IP Staff Station (TelliConnect)
    a. The Staff Station (TelliConnect) is an IP device with a color touch screen. Touch screen shall be a minimum of seven inches and support 800 x 480 pixels.
    b. The Staff Station shall accept PoE+ power via a UL 1069 listed switch.
    c. The Staff Station shall have a durable scratch resistant screen (Gorilla glass or equivalent).
    d. The Staff Station touch screen display shall support the ability to scroll, swipe and tap for navigation and user interaction.
    e. The Staff Station shall support a micro-SD card to store basic device configuration for easy maintenance. Systems requiring programming for service replacements shall not be acceptable.
    f. The Staff Station shall support two-step credentialing. Credentialing must also be possible by pin code protection, third party RTLS location data.
    g. The Staff Station shall support a minimum of ten (10) HTML5 web browser buttons per device. HTML5 web browser must provide access to supported tools to enable improved clinical workflow.

h. Staff Station shall support speed dial capabilities to include room-to-room communication from a room/bed list, as well as the ability to call any phone permitted by hospital PBX either by a dial pad or speed dial list. Speed dial list must provide a minimum of twenty-one (21) speed dial touchpoints.
i. Shall support Cleaning Mode to temporarily disable touchscreen input to allow the device to be properly sanitized without accidental activation of applications or alarms.

2. IP Staff Consoles
   a. The Staff Console is a primary point of contact among users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.
   b. As a user interface, the Staff Console alpha-numerically displays incoming call events from stations and connected healthcare equipment and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible signaling functions and facilitates two-way, full-duplex staff/patient and staff/staff communications.
   c. The Staff Console shall provide visual identification of the calling station(s) including:
      1) Room number
      2) Bed identification
      3) Priority or event type
      4) Time of event
      5) Elapsed time (duration)
      6) Staff presence
      7) Pending service tasks associated with the room or bed
   d. The Staff Console shall be IP-based, utilizing power over Ethernet (PoE) and Voice over IP technology.
   e. The Staff Console shall support hot swappable replacement via a micro-SD card and shall not require reprogramming.
   f. Staff Console audible annunciation shall indicate priority level. Incoming calls shall be displayed on the color display in the colors for their associated priority levels.
   g. The Staff Console shall have a 7" capacitive touch backlit color LCD screen.
   h. The Staff Console touch screen display shall support the ability to scroll, swipe and tap for navigation and user interaction.
   i. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad. Devices requiring hardened buttons to provide operation shall not be accepted.
   j. Staff Console display shall provide an adjustable tilt mechanism for viewing clarity.
   k. The Staff Console shall connect to the nurse call LAN/WAN utilizing CAT5/5e/6/7 cable and Power over Ethernet. No separate power supply or wiring shall be used.
   l. The alert list screen on the Staff Console shall allow a minimum of five calls to be visible at one time and provide a simple scrolling function to view additional calls when more than five pending calls are present. Pending calls shall be displayed in priority order regardless of the order in which they are received.

m. The user shall have the ability to adjust the volume of the Staff Console incoming call tones.
n. The Staff Console shall support a "nighttime" mode which will automatically reduce the alert tone volumes when active.
o. The Staff Console shall support hands-free communication or the use of a handset to have better privacy for communication.
p. Facility shall be able to make available or remove selected functions/buttons from the Staff Console screens where selected functions are not to be used and to simplify operation. Functions/buttons that can be removed include Audio Page, Swing/Capture/Share, and volume adjustments.
q. Facility shall be able to make available or password protect selected functions/buttons from the Staff Console where functions are to be restricted to approved users. Functions/buttons that can be restricted include Audio Page, Swing/Capture/Share, Reminder Clear and volume adjustments.
r. The Staff Console shall support the ability to override full-duplex mode to eliminate background noise at the nurse station while communicating with patients in the patient rooms.
s. The Staff Console shall be able to call any other audio device on the same nurse call network with two-way duplex audio.
t. The Staff Console shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a pre-configured interval.
u. The Staff Console shall have the ability to adjust independent talk and listen volume levels via easy-to-use touchscreen controls. These settings shall be adjustable on a bed-by-bed basis. Systems using group or zone-wide audio adjustments shall not be accepted.
v. The Staff Console shall allow a user to create a service task identifying a patient's specific request.
w. A service task shall allow a single selection from three user-specified levels of staff which can be associated with the task.
x. The Staff Console shall provide for up to twenty-one user-specified service request soft keys.
y. The Staff Console shall allow up to three simultaneous services to be selected for a single service task.
z. A service task shall illuminate the dome light with the appropriate level of staff response required (e.g., Red=nurse, Amber=Nurse Assistant, Green=Aide) at the location where the service will be delivered.
aa. A service task shall be able to be created without requiring an audio connection to the location.
bb. The Staff Console shall display service tasks created from mobile devices.
cc. The Staff Console shall display service task status, identifying those that have been accepted by a mobile device.
dd. The staff console shall display a timeout when the user has exceeded a specified time and identify the task as overdue.
ee. The staff console shall display overdue tasks.
ff. The Staff Console shall interact with supplemental (PC) display (requires Unite View).

3. IP Annunciator
    a. IP Annunciator features shall be identical in operation to the Staff Console (Section 6.2) with the exception that it will be wall mounted.
4. The wall-mounted IP Annunciator may include an optional Handset to support private conversations between patients and staff.

D. Corridor Devices
1. Dome Lights
    a. Dome and zone lights provide bright, easy-to-see visual annunciation that speeds response time and increases caregiver efficiency. These devices are typically installed in corridors and outside patient rooms to provide staff with a visual indication as to the origin of a call placed on the system.
    b. Dome lights operate in a similar fashion to annunciator panels or staff consoles: the light color and flash rate indicate the type and priority of the call.
    c. Each Dome Light shall utilize Light Emitting Diodes (LED) for displaying colors. Dome Lights utilizing incandescent bulbs shall not be accepted.
    d. Dome and Zone Lights shall be available in two or four sections.
    e. Dome light shall have a status LED for maintenance purposes.
    f. Dome lights shall have two general purpose inputs.
    g. To maintain aesthetics, reduce obstruction, and limit risk of damage to devices, the maximum size of each Dome Light shall not be greater than five inches in height, nor shall it protrude more than 3.5" from the mounted surface.
    h. Each Dome Light section shall be capable of indicating more than eight facility-selected, configurable colors. Dome Lights requiring more than four sections to provide these colors shall not be acceptable.
    i. To allow for maximum flexibility, the Dome Light shall be configurable via configuration to allow multiple sections of a single light to illuminate and/or flash the same color for higher priority calls.
    j. Dome Lights shall be able to match existing Dome Light schemes via configuration. Systems with dome light schemes that are not able to match existing systems will not be accepted.
    k. Any dome lights requiring the replacement of filter caps or lenses to obtain facility-requested dome light colors for any priority shall not be accepted.
    l. Dome Light should be supervised and provide a diagnostic indication of room status to prevent maintenance personnel from disrupting patients.
    m. Dome Light shall be capable of providing power to location infrared beacon for used for integrated automated staff presence.

E. Control Devices
1. All control devices shall be IP-based, utilizing IP Switches and gateways for connections to room devices. These devices shall make up the Nurse Call LAN/WAN 10/100 Base Ethernet.
2. IP Gateway (Telligence Station Gateway)
    a. IP Gateways shall be IP-based and provide power and data to the Hallway Bus devices.
    b. IP Gateways shall mount in a standard 19" rack to be shared with the facility's IT equipment or shall mount in an independent rack.

c. IP Gateways shall have internal power supplies to support Hallway Bus devices. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment shall not be accepted.
d. IP Gateways shall be solid state, fan-less design for high reliability.
e. IP Gateways shall provide up to two voice paths for voice communications.
f. IP Gateways shall support up to eighty dome lights and passive bus concentrators.

3. IP Room Gateway (IP Dome Light)
   a. IP Room Gateways shall be IP-based and provide power and data to Room Bus devices.
   b. IP Room Gateways shall mount on a backbox outside the room.
   c. IP Room Gateways shall have POE+ as power supply. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment shall not be accepted.
   d. IP Room Gateways shall be solid state, fan-less design for high reliability.
   e. IP Room Gateways shall provide non-blocking speech for voice communication. Per room gateway, four (4) room buses originate. Each room bus shall support one (1) voice speech path which can result in four simultaneous speech connections depending on room configuration/layout.
4. IP Touch Screen
   a. IP Touch screens shall be IP-based and provide power and data to room devices.
   b. The IP touch screen shall have a size of seven inches and color display.
   c. IP Touch screen shall mount on a backbox inside the room.
   d. IP Touch screens shall have POE+ as power supply. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment shall not be accepted.
   e. IP Touch screens shall be solid state, fan-less design for high reliability.
   f. IP Touch screen shall provide speech for voice communications.
5. Passive Bus Concentrator (PBC)
   a. The PBC is the interface between the Hallway Bus and passive peripheral devices. It includes eight individually addressed passive room buses.
   b. PBC shall support up to eight rooms utilizing passive devices.
   c. PBC shall use low power (5.5v) for reduced operating costs.

2.4 INTEGRATIONS

A. Ascom Unite
1. Ascom Unite is a communication platform that links Ascom messaging systems with mission-critical work processes and tasks. A suite of software applications that integrate with medical- and non-medical systems.
   a. A suite of software messaging solutions that integrate with systems to send messages, alarms, and alerts to mobile workers.
   b. Unite is focused on Mission-Critical Communication
   c. Unite is intelligent, providing two-way interactive messaging.
   d. Unite gets the right message to the right person at the right time.
   e. Unite is the core value proposition and differentiator of Ascom.

2. Unite has three components:
   a. Unite Connect - provides connection and integration to different information systems, e.g., nurse call systems, patient monitoring systems, etc.
   b. Unite Core - provides a single, system-wide administrator interface, functionality for enhancing capacity & throughput and internal applications.
   c. Unite Axess - provides distribution of messages and alerts to a variety of wireless devices, pagers, mobile phones, smartphones, and text displays.

B. Unite Connect for Clinical Systems
   1. Unite Connect for Clinical Systems is required for the integration to other systems, and the type of interface needed depends on the type of integration.
   2. Integration types:
      a. Patient Monitoring systems
         1) Enables integration with patient monitoring systems and forwards alert information to designated handsets and other notification devices.
      b. Nurse Call systems
         1) Enables integration with nurse call systems and forwards alert information to designated display devices as well as other staff devices.
      c. Real-Time Location systems (RTLS)
         1) Asset Tracking
            a) Enable automated location identification of critical equipment during staff response events.
            b) Initiate notifications for par level management as required.
         2) Staff Tracking
            a) Enable automated identification of staff presence and precise staff tracking during response events. Integration supports real-time monitoring of caregiver locations and alarm cancelling automation.
         3) Infant Protection
            a) Supports infant protection protocols, enabling real-time location tracking and alerting for infant movement across designated care zones.
      d. Synchronized Clocks
         1) Enables precise timestamping of all alert events and clinical interactions. Integration shall enable unified time references across all devices, facilitating accurate event correlation and reporting.
      e. Patient Education / Entertainment
         1) Integration provides patients with direct access to educational content, entertainment options, and service requests through a unified control interface.
      f. Wireless Communications Device
         1) When a patient initiates a nurse call, the system routes the alert directly to assigned caregivers' device, ensuring instant notification and response coordination.
      g. Paging
         1) Nurse call and paging systems shall be integrated to provide immediate, automated transmission of patient alerts to designated

paging speakers and zones. Upon activation of a nurse call event, the system will route standardized messaging.

h. Security Systems
   1) Nurse call and security systems interface via secure network protocols to enable automated event correlation and response workflows. Upon initiation of a nurse call associated with a security concern (e.g., staff duress), integrated controls trigger real-time alerts to security personnel and activate relevant access control measures, such as door locking or video surveillance. System design supports event logging, audit trails, and compliance with healthcare security standards.

i. Electronic Health Records
   1) Nurse call and electronic health records (EHR) systems interface via secure HL7 messaging to automate bidirectional data exchange. When a nurse call event is initiated, patient identifiers, event timestamps, and response actions are documented in real time within the EHR.

j. Dashboard Monitors
   1) Nurse call events are visually prioritized on centralized dashboard monitors, providing real-time status updates and actionable notifications to clinical staff. System integration ensures that all nurse call alerts, response times, and escalation activities are displayed with time-stamped accuracy for situational awareness.

k. Electronic Health Records (EHR)
   1) Enables access to patient demographics and health information. Forwards EHR related events to designated display devices as well as other staff devices.

l. Custom Connect Interface
   1) Custom Connect enables Ascom sales regions and strategic partners to create integrated solutions, using the Unite Connect platform. It is a toolkit for building integrations to third party systems/products. Custom Connect can only be utilized for integration into non-medical devices.

C. Unite Axess Server
   1. Ascom Unite Axess Server is the communication platform for Ascom applications on smart devices. The solution consists of one or more applications for smart devices and supporting components for the infrastructure. The smart devices communicate with the web server using a Representational State Transfer (REST) interface, and the devices receive information through a number of distinct notification channels. The Unite Axess Server works in combination with the Unite Platform Server (Unite PS) and supports the following Ascom mobile applications:
      a. Unite Axess for Smart Devices
         1) Presents alerts and other messages for users on their smart devices (Android or iOS) so clinicians can securely receive interactive messages about patient events anytime and anywhere.

b. Unite Axess Alerts
   1) Presents alerts and other messages for users on their Android device. Designed for use in non-medical environments, for example industry.
c. Unite Collaborate
   1) An application for quick communication between team members. Facilitates patient-centric communication in care teams. The application exists in two versions: Unite Collaborate App, for Android and iOS smart devices, and Unite Collaborate Web, a desktop version for Windows-based computers.
d. Unite Personal Alarm
   1) Combined with the Ascom Myco 4 device, the Unite Personal Alarm mobile app offers personal security for potentially hazardous environments and lone workers.
e. Unite Task Mobile Application
   1) A customizable task management solution for optimization of workflows in hospitals.
f. Ascom Login
   1) A single sign-on solution for Unite Axess, Unite Collaborate, Unite Personal Alarm, Unite Task, and Digistat Smart Central.

D. Unite Assign
   1. Unite Assign enables staff assignment across multiple healthcare systems like nurse call and patient monitoring. To ensure that the right person gets the right information to his or her phone, hospitals and healthcare clinicians can allocate staff resources across a patient ward or unit on multiple levels, to patients (beds), rooms or to a unit.

E. Activity Logging
   1. Logs of various activities in the Unite system can be stored. For example, activities such as messaging, alarm, location (staff presence), responses and status logs. All activity logs are stored in a database for future analysis. It is possible to view incoming activity logs to see that the system is working properly, to search for specific activity logs, and to trace an activity through the entire system.

F. Unite Analyze (Reporting)
   1. The Unite Analyze application is used for reporting in the Ascom Unite Messaging Suite. The application is installed on a Windows server and is accessed via a web browser. Unite Analyze works in combination with Unite Platform Server (Unite PS) or Unite Log Collector. Unite Analyze can be installed on the same server as the Unite PS software, but can also be installed on another server, which is recommended for large systems. Unite Log Collector is included in the Unite PS software.

G. Unite View
   1. The Unite View application provides an overview of alerts in a unit. The operator will be informed about patients needing help and any alerts coming from equipment for monitoring patients. The application shows the location from where an alert originates, the time, what type of alert it is, and the severity of the alert.

2. The operator has the ability to send messages to staff members assigned to the unit(s).
3. Staff members can be located, provided that Ascom devices with IR zone location or RTLS badges exist in the system.

H. Unite Axess for Smart Devices
1. Unite Axess for Smart Devices is a medical software application that makes it possible for smart devices, based on the iOS and Android platforms, to be used in Ascom professional messaging systems.
2. The smart device app handles and presents alerts using an intuitive graphical user interface.
3. Unite Axess for Smart Devices shall allow patient information and alerts to be delivered to a smart device utilizing robust, standards-based security and message encryption.
4. Software and Hardware Requirements:
   a. Unite A4SD Android: v6.6
   b. Unite A4SD iOS: v6.6
   c. Minimum iPhone supporting iOS version 17 and 18
      iPhone XR, 11 and up.
   d. Minimum supported Android version: 11.0 (10.0 only on Myco 3)

I. Integration Software (3rd Party Integration)
1. Telligence offers software that is compatible with systems capable of receiving TAP 1.8 version messages.
2. Telligence with Tap Bridge: All Telligence and TAP components can be installed on the same computer. If you have a remote database machine, the TAP Server Components must be installed on the database computer.
3. The IMT Configuration application is a web-based application that lets you configure and set up applications that are part of the Legacy Application suite. In particular, the IMT Configuration application lets you set up Team Page Device numbers for select nurse call events that are sent over the TAP Bridge to an intended third-party recipient.
4. The TAP Bridge uses a COM port to connect to third-party middleware systems. Use short-haul modems when the system that you are communicating with via the TAP Bridge is more than fifty feet away.

2.5 ASCOM DIGISTAT SOFTWARE SUITE

A. Digistat Connect
1. MDDS software for acquiring, storing, and transferring patient data from medical devices.
2. Supports alarms, logs, and manual data entry.
3. Vendor-neutral and scalable across departments.

B. Digistat Smart Central
1. Class II medical device for secondary alarm notification.
2. Interfaces with monitors, ventilators, infusion pumps, etc.
3. Provides visual/audio/vibration alerts.

C. Digistat Mobile
1. Android-compatible mobile application (v5.1-15.0).
2. Supports CDSS Configurator Mobile module.
3. Requires compatibility validation per ACDM-585-12771.

D. Digistat Gateway
   1. Android-compatible application (v9.0-15.0).
   2. Requires SIM card with voice/data plan.
   3. Compatibility validation per ACDM-585-13656.

E. Digistat Web
   1. Web-based interface supporting Chrome, Firefox, Edge (latest versions).
   2. Requires browser scaling set to 100%.
   3. Supports cookie-based session management and load balancing.

F. System Requirements
   1. Hardware:
      a. Workstations: Intel i3/i5/i7, 4-32 GB RAM, 60-120 GB storage.
      b. Servers: Windows Server 2016-2025, SQL Server 2016-2025
      c. Minimum iPhone supporting iOS version 17 and 18
         iPhone XR, 11 and up.
      d. Mobile Devices: Mobile Devices: Android 5.1-15.0, minimum 3.5" screen.
   2. Software:
      a. .NET Framework 4.7.2 / 4.8
      b. Adobe Acrobat Reader v24
      c. Net Core Runtime & Hosting Bundle
   3. Network:
      a. TCP/IP protocol, 100 Mbps minimum, 1 Gbps backbone recommended.
      b. Redundancy and routing across subnets.
      c. Firewall and antivirus protection (WithSecure recommended).

2.6 ASCOM MOBILE DEVICES (MYCO)

A. Ascom Myco 4: SH4-AAB#
   1. Smartphone for clinical communication and collaboration.

B. Battery Pack: 660733

C. Charger Base: CB1-U1
   1. Can be used together with any combination of 5 charger modules.

D. Charger Module Handset: CTH-U01

E. Charger Module Handset + Battery: CTH-U02

F. Charger Module Battery: CTB-U01

G. Bidding Quantities - confirm with owner during the submittal process and prior to procurement.
   1. Charger Base - qty 40 (part no. CB1-U1)
   2. Charger module handset+battery - qty 160 (part no. CTH-U02)
   3. Charger module battery - qty 40 (part no. CTB-U01)
   4. Battery pack - qty 320 (part no. 660733)
   5. Myco 4 Handset - qty 160 (part no. Myco 4)

PART 3 - EXECUTION

3.1 NURSE CALL INSTALLATION

A. Install nurse call systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
   1. Contractor shall use hook and loop type fasteners on all nurse call cable. Tie wraps shall not be used.
   2. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
   3. All nurse call cabling shall be home-run, no splicing.

B. Identify all nurse call cables as to field location.
   1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write0on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.

C. After completion, all cables shall be thoroughly tested.
   1. Contractor shall provide all instruments for testing the cables.
   2. Contractor shall demonstrate in the presence of Owner's representative that the nurse call system is complete and operational.
   3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.
   1. Two hard copies shall be provided to Owner detailing the entire nurse call system after installation. Each field position shall be labeled and cross-referenced to the appropriate head end position for ease of troubleshooting.

3.2 DIGISTAT INSTALLATION AND CONFIGURATION

A. Install all components per manufacturer's instructions.

B. Only trained and authorized personnel shall perform installation.

C. Validate compatibility of mobile devices and network infrastructure.

D. Configure system per healthcare organization's alarm policies.

E. Enable Privacy Mode and user permissions per HIPPA/PIPEDA.

F. Implement disaster recovery and backup policies.

3.3 Training

A. Contractor to provide up to 16 hours of end user training and 16 hours of technical training. Coordinate with Owner how this is to be broken up for the various user groups.

3.4 TESTING AND COMMISSIONING

A. Perform acceptance testing on all hardware and software components per manufacturer requirements.

B. Verify alarm transmission, data acquisition, and mobile/web access.

C. Document and resolve any discrepancies.

D. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION

SECTION 275313 - SYNCHRONIZED CLOCK SYSTEM

PART 1 - GENERAL

1.1 Summary

A. Furnish and install a complete new Clock System using the Primex OneVue™ Sync System with IP Ethernet/Power over Ethernet Technology.

B. Furnish and install all system devices, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating Clock System.

C. All bids shall be based on the equipment as specified herein. The model designations are that of Primex. The specifying authority must approve any alternate Clock System.

D. System shall include the following system devices:
   1. Analog Clocks
   2. Digital Clocks
   3. Digital Elapsed Timers

1.2 RELATED SECTIONS

A. Division 26 "Electrical"

B. Division 26 Section "Common Work Results for Electrical"

C. Division 27 - All sections

D. Division 28 - All sections

1.3 REFERENCES

A. System devices specified shall meet or exceed the requirements of the following.
   1. Federal Communications Division (FCC); Part 15 - Code of Federal Regulations.
   2. National Fire Protection Association (NFPA); NFPA 70E-2012, Standard for Electrical safety in the Workplace.
   3. Institute of Electrical and Electronics Engineers (IEEE); IEEE 802.3af-1998, Standard for Information Technology - Telecommunications and Information Exchange Between Systems.

1.4 DEFINITIONS

A. This section provides commonly used terms within this specification.
   1. TSA: Technical Support Agreement
   2. AWS: Amazon Web Services
   3. TLS: Transport Layer Security
   4. HTTPS: Hypertext Transfer Protocol Secure
   5. DHCP: Dynamic Host Configuration Protocol
   6. PoE: Power over Ethernet
   7. IP: Internet Protocol
   8. NTP: Network Time Protocol
   9. UTC: Coordinated Universal Time

1.5 SYSTEM DESCRIPTION

A. General Specifications
   1. System devices shall be managed and monitored from the Manufacturer cloud-based system software, that allows OWNER to remotely manage system device settings and monitor system devices.

2. System shall consist of system clocks enabled with IP Ethernet/PoE technology.
3. System shall provide synchronized time by way of system devices connected to OWNER'S IP Ethernet/PoE network.
4. System shall not require the installation of any onsite system hardware or software, with the exception of the specified system devices.
5. Clocks shall be capable of automatically adjusting for Daylight Saving Time.
6. Clocks shall be fully portable, capable of being relocated at any time.
7. Clocks shall receive UTC time from a Network Time Protocol (NTP) time source; allow up to three NTP time sources for failover purposes.
8. Clocks shall operate with a free-running accuracy of .45 seconds per day, and will continue to operate in the absence of receiving the UTC time from an NTP time source.
9. Analog clocks shall report gross mechanical failures by way of automatically performing a daily midnight hand verification check; which if this check shall fail for three consecutive days, the clock shall report a hand position failure status, resulting in a clock warning state within the system software.

1.6 System software specifications

A. System software shall provide an online device configuration procedure that allows OWNER supplied settings to be installed on system IP network devices prior to shipment from the Manufacturer.

B. System devices shall download settings from the system software over the OWNER'S existing IP network.

C. System shall provide a mobile app that allows the OWNER to add system devices to the system software or edit the devices' assigned network and other primary settings for those devices added to the system software.

D. System software shall log the NTP accuracy of the system devices.

E. System software shall monitor and display the operating status of system devices.

F. System software shall provide an automated reporting method to notify system users of device operating statuses that may warrant corrective action.

G. System software shall allow the OWNER to manage authorized system users, including user access to data and system settings that is based on the role assigned to each system user. Access can be limited to viewing and managing the system, including reports, device settings, system users, and account settings.

H. System software shall maintain and store data for up to a minimum of ten (10) years.

1.7 Encryption and Authentication specifications

A. User software access sessions between the web browser and the system software shall be encrypted by the Hypertext Transfer Protocol Secure (HTTPS) protocol.

B. The network communication of system devices enabled with IP Ethernet/PoE technology shall be secure and encrypted using the Transport Layer Security (TLS) encryption protocol and Hypertext Transfer Protocol Secure (HTTPS) authentication.

1.8 System Administration specifications

A. Software interface shall allow the OWNER'S system admin user(s) to manage the system components, including system device settings, reports, system-wide user password complexity settings and user session timeout setting to align with OWNER information security policies and procedures, manage system users and grant users' access to system data and features, activate and deactivate system users, and view users' login history.

B. System software shall allow each system user to manage their own system profile, including their password and contact settings.

C. System software shall allow system device settings to be user-defined to meet OWNER requirements.

D. System software shall allow devices, that send data to and download data from the system software over an IP network, to be assigned to a DHCP or Non-DHCP primary and an alternate network for failover purposes. Network settings are managed within the system software, allowing remote management to migrate devices from one network to another.

E. System software shall allow user-defined reporting; the system shall store and present historical data in the form of reports. User-defined data shall include the system devices included in a report, the frequency a report is system generated, and a specific range of data included in a report. System reports shall be displayed in the system software electronically within the interface to allow system users to download reports. The system shall allow report data to be restricted based on the role(s) assigned to the system users.

1.9 System devices with IP Ethernet/PoE network communication specifications

A. Network Communication Protocols: Hypertext Transfer Protocol Secure (HTTPS) | IP Addressing: Dynamic Host Configuration Protocol (DHCP and static IP addressing | Data Packet Size: typically less than 5 kilobytes (kB)

B. Network setting data is stored locally in devices shall be encrypted and access to locally stored setting data can be controlled by a system admin user.

C. Manufacturer shall provide standalone configuration software to locally configure a device to meet OWNER security policies if IP network setting data cannot be stored in third-party software or to troubleshoot device network connectivity issues.

1.10 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of the Manufacturer latest model.

B. System devices shall be installed in compliance with local and state authorities having jurisdiction.

C. Electrical Components, Devices, and Accessories: Listed and labeled per NFPA 70 by the qualified testing agency.

D. Regulatory Requirements: System design and installation shall comply with the following: National Electric Code (NEC)
   1. Underwriters Laboratory (UL) standards
   2. Local codes and regulations

1.11 SUBMITTALS

A. Product Data: Submit complete catalog data for each system device and components, describing physical characteristics and method of installation.

B. Shop Drawings: Showing the following. 1. Diagram of the proposed system showing the communication pathway and schedule of individual system device installation locations. 2. Indicate integration with the OWNER'S network. Include a line diagram of network relationships. 3. Show system device power requirements.

C. Samples: Submit one specified system device model(s) for approval. Approved sample(s) shall be tagged and shall be installed at a location directed.

D. Manufacturer Instructions: Submit complete installation, set-up, and maintenance instructions electronically.

E. Information submittal: Manufacturer Sample Warranty.

F. Information submittal: Manufacturer Technical Support Agreement (TSA).

1.12 SUBSTITUTIONS

A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to the bid date.

1.13 QUALITY ASSURANCE

A. A. Manufacturer Qualifications: Manufacturer of wireless and IP Ethernet/PoE connected system with a minimum of ten years record of satisfactory manufacturing and support of systems comparable to the basis of specified system design.

1.14 DELIVERY STORAGE AND HANDLING

A. Deliver all components to the site in the Manufacturer original packaging.

B. Packaging shall contain Manufacturer name and address, product identification number, and other related information.

C. Store equipment in the finished building and in unopened packaging until ready for installation.

1.15 PROJECT SITE CONDITIONS

A. System design is integrated with the OWNER'S existing IP Ethernet/PoE network; limited to system devices equipped with IP network technology.

B. Conductors and Cables: Comply with requirements of Division 27 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling.

C. Signal and Control Circuits: Manufacturer recommended stranded, single conductors, or twisted- pair cables.

D. Data Circuits: Category 5 minimum, twisted-pair cable.

1.16 SOFTWARE MAINTENANCE

A. Contractor shall offer an annual Technical Support Agreement (TSA); agreement shall be inclusive to system software access, phone/email technical support, software maintenance and revisions, and firmware revisions.

B. All system updates, enhancements and maintenance are performed per agreed upon TSA.

PART 2 - PRODUCTS

2.1 SECTION INCLUDES

A. The system and equipment are specified as described in this section.

B. All bids shall be based on the equipment as specified herein. The model designations are that of Primex. The specifying authority must approve an alternate system.

2.2 MANUFACTURER

A. System shall be manufactured by:
   1. Primex, Inc. 965 Wells St, Lake Geneva, WI 53147 | Phone: (262) 729-4858 | info@primexinc.com | www.primexinc.com - or equal.

2.3 SYSTEM SOFTWARE

A. Basis of Design System: NTP Time Server. Contractor to provide, configure, and install NTP Time Server for synchronized clock system and integrate with other systems identified in the specifications and systems integration matrix.

B. System software stores and monitors system device operating conditions.

C. All system devices and system settings are managed from the system software.

2.4 SYSTEM DEVICES & ACCESSORIES

A. Analog Clocks shall meet the following specifications:
   1. Clocks (single-sided) shall be wall-mounted.
   2. Additional colors, finishes, and dial faces are available from Manufacturer.
   3. Clock faces can be customized by Manufacturer to display the organization name or logo as specified.
   4. Clock frames and lenses are of durable thermoplastic.
   5. Clocks shall have a tamper-proof/theft resistant clock-lock mounting slots.
   6. A dual-mount kit is available from the Manufacturer that combines two single clocks to create a dual-sided clock.
   7. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self-correct to the current time.
   8. Battery-operated analog clocks shall have a 5-year nominal battery life.
   9. Installer will furnish clock batteries in accordance with Manufacturer instructions.
   10. Shall have a USB port that can be used to supply power via external supply and allow the clock to operate using a conventional Ethernet connection without PoE.
   11. Analog Clocks
      a. Traditional series PoE
         1) A. Size: 16"
         2) B. Color: Black

B. Digital Clocks shall meet the following specifications:
   1. Clock LED display must include a 12- or 24-hour time display, a PM indicator light, and an alternating time and date display option.
   2. Dual-mount kit is available from the Manufacturer that combines two single clocks to allow for a dual-sided clock.
   3. Power over Ethernet (PoE) models shall have an IEEE 802.3af compliant power supply built into the clock assembly.
   4. Clock shall have a power outage memory backup and maintain the correct time up in its memory for a minimum of 1 hour without power.

5. Clock shall be viewable from 150 ft..
6. Clock shall have highly visible 7-segment LED digits.
7. Clock shall have display dimmer options, including 100%, 75%, 50%, and 25%.
8. Clock enclosure shall be ABS plastic and junction box shall be UL listed (UL 50E 1st Ed; listing number E469550).
9. Digital Clocks
    a. Surface Mount 4" Digits
        1) Number of Digits: 6 Digit
        2) Digit Color: Red
        3) Bracket: 4˚ Slope Bracket, 10' (3m) cord with plug

C. Elapsed Digital Timers shall meet the following specifications:
1. Timer shall also function as a clock or function as a count-down/count-up interval timer when programmed with a three-button wall mount control switch.
2. Timer shall accurately count up or count down up to a maximum of 99 hours, 59 minutes, and 59 seconds.
3. Timer shall include a three-button wall-mountable control switch. This control will be mounted in a single gang electrical box. Control buttons must be washable with water and common disinfectants.
4. Switch control shall connect to the timer with a supplied reversed wire (cross-pinned) telephone cable with an RJ-11 connector. It can be extended up to 100 ft..
5. Timer switch control can be configured to simultaneously activate two connected timers. Timers in the PACU / Pre-Post Area and ORs shall be linked together to allow for the simultaneous activation of connected timers.
6. Timer shall be viewable from up to 150 ft..
7. Timer shall have highly visible 7-segment LED digits.
8. Timer shall have display dimmer options, including 100%, 75%, 50%, and 25%.
9. Timer display shall include a 12 or 24-hour time display, a PM indicator light, and an alternating time and date display option.
10. Timer shall have an audible tone option on the count-up and count-time function with a frequency of 3KHz +/-0.5KHz.
11. Power over Ethernet (PoE) model shall have an IEEE 802.3af compliant power supply built into the clock assembly.
12. Timer shall have a power outage memory backup and maintain correct time up to a minimum of 1 hour without power.
13. Clock enclosure shall be ABS plastic and junction box shall be UL listed (UL 50E 1st Ed; listing number E469550).
14. Elapsed Timers
    a. Surface Mount 4" Digits
        1) Number of Digits: 6 Digit
        2) Digit Color: Red
        3) Bracket: 4˚ Slope Bracket

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions with the Installer present for compliance with requirements and other conditions affecting the performance of the system and system devices.

B. Do not proceed until unsatisfactory conditions have been corrected.

C. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.

3.2 INSTALLATION

A. General: Install system devices in accordance with applicable codes.

B. Install system devices in accordance with Manufacturer written instructions.

C. Provide all system equipment necessary for a complete and operable system.

D. Comply with requirements of Division 27 Sections "Common Work Results for Communications" and "Communications Horizontal Cabling."

E. Cables: Install cables in raceways and cable trays per T-series documentation. Install plenum cable where required.

3.3 INTEGRATIONS

A. Patient Education/Entertainment
   1. Ensure that all time-sensitive actions, such as documentation and content delivery, are accurately time-stamped across platforms.

B. Wireless Communications Device
   1. Ensure the accuracy of time-stamped communications and workflows by ensuring all devices and systems operate on a unified timeline.

C. Other systems with synchronized time requirements:
   1. Security System / Access Control / Video Surveillance / Intrusion
   2. EHR
   3. Building IT / network systems

3.4 FIELD INSPECTION

A. Inspection: Make observations to verify that system devices and components are properly labeled.

B. Prior to final acceptance, inspect each system device and component, adjust as required, and replace parts that are found defective.

C. At the completion of system device installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly and that the system software and all system devices and components are functioning.

3.5 SERVICES

A. Manufacturer system software user guides and system device installation guides shall be provided electronically within system software.

B. Commissioning General: Provide system commissioning in accordance with Manufacturer written recommendations. Perform operational testing to verify compliance with requirements. Adjust as required.

C. Services shall include a specified level of commissioning services.

D. Onsite installation and commissioning service: system training, configuration, validation of device configuration, training on system functionality, verification of device network connections, and device installation.

3.6 CLEANING

A. Prior to final acceptance, clean exposed surfaces of devices, using cleaning methods recommended by Manufacturer.

B. Perform cleanup as work progresses and leave the work area clean at the end of each day.

C. Upon completion, remove surplus materials, rubbish, tools, and equipment.

D. Collect recyclable waste and dispose of or recycle field generated construction waste created during construction or final cleaning.

3.7 DEMONSTRATION

A. Initial Demonstration: provide a demonstration to identified OWNER facility staff that is responsible to maintain the system.

B. Demonstrate maintenance procedures for system devices.

C. Demonstrate the system features, including monitoring and management of system devices.

3.8 PROTECTION

A. Protect finished installation until the final project acceptance.

B. Repair damage to adjacent materials caused by the system installation.

3.9 TESTING

A. All system devices must be tested at their operational installation location under normal operational conditions.

END OF SECTION

SECTION 275316 - PATIENT, INFANT, AND EQUIPMENT RFID TRACKING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the installation, configuration, programming and testing of a Unified Real Time Locating (RTLS) & Patient Safety System (PSS).

B. This performance specification provides the minimum requirements for a supervised enterprise- RTLS-PSS. The RTLS-PSS shall include, but not be limited to all equipment, materials, labor, documentation, and services necessary to furnish and install a complete, operational enterprise wireless RTLS-PSS capable of addressing multiple locating and Protection use cases. The System shall comply in all respects with all pertinent codes, rules, regulations, and laws of the hospital authority and local jurisdiction.

C. Each enterprise RTLS-PSS shall be capable of supporting in excess of 20,000 Tags.

D. The System shall support a single integrated platform for:
1. Staff Locating & Duress Notification
2. Asset Tracking
3. Patient Safety, Protection, & Tracking
4. Hand Hygiene Compliance Monitoring
5. Temperature Monitoring

E. It is intended that upon completion of this work, the Owner be provided with complete information and drawings describing and depicting the entire enterprise RTLS-PSS as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the RTLS-PSS at a future date, and complete documentation of RTLS-PSS certification.

F. Professional Services
1. Each bidder shall review the professional services scope of work document, associated costs, and all other relevant sections of this specification that require professional services. This review is a mandatory component of the bid response. To ensure compliance, each bid must include a completed and signed Professional Services Compliance Checklist, attached to this bid document.

1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract Specification Sections.

B. Product Data: The Owner will provide product data for each component, including detailed manufacturer's specifications.

C. Shop Drawings: The Owner will provide shop drawings detailing the RTLS-PSS including, but not limited to, the following:
1. A single-line block diagram showing cabling interconnection of all components for this specific system.
2. CAD drawing of the floor/floors where the Owner furnished enterprise RTLS will be installed.

D. Construction Drawings: The Contractor will provide construction drawings, detailing system components that must fit, match, and align with provisions made in the "Equipment Supplied" section, and under other Sections of the Specifications or under other contracts, including the following:
   1. Infrared emitting devices
   2. Low frequency devices
   3. Hand Hygiene devices
   4. RF antennas

E. Door controlling devices
   1. Elevator controlling devices
   2. User interface application

F. Wiring Diagrams: The Owner will provide wiring diagrams with wiring details for power, signal, and control systems, which clearly differentiate between manufacturer-installed and field-installed wiring. The Owner will identify terminals to facilitate installation, operation, and maintenance.

G. Field Test Reports: Reports of field tests and observations, including an as-built package of final adjustments certified by Installer.

H. Maintenance Data: The Owner will provide maintenance data for the RTLS-PSS to include in the operation and maintenance manual.

1.3 INTERPRETATION

A. No interpretations of the meaning of the bid documents will be made to any Bidder orally. Each request for such interpretation shall be made to the Engineer in writing.

B. The Engineer will issue interpretations and supplemental instructions to all Bidders in written form.

1.4 MANUFACTURER

A. Acceptable enterprise wireless RTLS-PSS Manufacturers include:
   1. CenTrak or equal

B. All equipment and components shall be the Manufacturer's current model. The Manufacturer's representative shall be responsible for the satisfactory installation of the complete System.

C. The manufacturer's representative shall provide equipment and components, which comply with the requirements of these specifications. Equipment or components, which do not provide the performance and features required by these specifications, are not acceptable, regardless of manufacturer.

D. The Manufacturer of the RTLS-PSS equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. The Manufacturer shall have the financial stability to provide project financing and /or lease options to the Owner if desired.

E. All RTLS-PSS components shall be cataloged products sourced from a single Supplier. All products shall be listed by the Manufacturer for their intended purpose.

F. All connected field electronics shall be both designed and manufactured by the same company, and shall be tested to ensure that a fully functioning System is designed and installed. The enterprise RTLS-PSS shall utilize Ethernet topology, switches, and devices.

1.5 ALTERNATES

A. Strict conformance to this specification is required to ensure that the installed and programmed RTLS-PSS will function as designed, and will accommodate the future requirements and operations of the building Owner. All specified operational features shall be met without exception.

B. The authorized Representative of the Manufacturer of the equipment shall be responsible for the satisfactory installation of the complete RTLS-PSS.

C. All equipment and components shall be installed in strict compliance with the Manufacturer's recommendations.

D. Alternates to the equipment specified will be considered only if all sections of the performance specification are met. Any deviations from RTLS-PSS performance as outlined in this specification will be considered only when the following requirements have been met:

1. A complete description of proposed alternate RTLS-PSS performance methods with three (3) copies of working drawings thereof shall be submitted to the Owner for approval not less than seven (7) calendar days prior to the scheduled date for submission of bids. The Supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed System complies fully with the paragraph, as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed System does not comply with the paragraph as written, and the Supplier feels the proposed System will accomplish the intent of the paragraph, a full description of the function, as well as a full narrative description of how its proposal will meet its intent, shall be provided. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed System does not comply.
2. The acceptability of any alternate proposed RTLS-PSS shall be the sole decision of the Owner or their authorized Representative.

1.6 SEQUENCING AND SCHEDULING

A. The contractor will coordinate with space provided, including wiring paths and maintenance access, at locations listed below:

1. Patient rooms
2. Equipment storage areas
3. Staff work areas
4. Egress / ingress areas
5. Elevator(s)
6. Hallways

PART 2 - PRODUCTS

2.1 GENERAL

A. The enterprise RTLS-PSS shall be network-based and incorporate decentralized, distributed intelligence architecture. The RTLS-PSS shall provide a means of interoperability with 3rd party wired and wireless network devices within the facility, including PCs, PDA's, phones, databases, pagers, etc. The RTLS-PSS shall consist of (include):
   1. Infrared emitting devices
   2. Low frequency devices
   3. Door controlling devices
   4. Elevator controlling devices
   5. RF antennas
   6. Alarm notifying devices i.e sounders, strobes, wall panels
   7. Tags

B. The system shall provide RTLS-PSS system configuration using a GUI application that allows the system administrator the ability to manage, (add, delete, modify) and diagnose information within the RTLS-PSS.

C. RTLS-PSS cable plan shall be of standard Ethernet topology. Systems requiring separate cabling for power will not be accepted.

D. The system architecture will not require external power supplies. Systems requiring power supplies to be installed separately shall not be accepted.

2.2 SYSTEM

A. The system shall provide RTLS-PSS system configuration using a GUI application that allows the system administrator the ability to manage, (add, delete, modify) and diagnose information within the RTLS-PSS.

B. RTLS-PSS cable plan shall be of standard Ethernet topology. Systems requiring separate cabling for power will not be accepted.

C. The system architecture will not require external power supplies. Systems requiring power supplies to be installed separately shall not be accepted.

2.3 INTEGRATIONS

A. The RTLS-PSS shall be capable of integrating with:
   1. All major wireless telephone vendors (e.g. Ascom, SpectraLink, Vocera, Cisco, etc.)
   2. Any brand of pocket paging system.
   3. Wireless middleware providers (e.g. Emergin, Ascom, Unite)
   4. Admission/Discharge/Transfer (ADT) systems, nurse call data and reporting software
   5. Electronic Medical Records providers (e.g. Cerner, Epic, McKesson, Allscripts)
   6. High Acuity OR and ED information systems (e.g. Picis)
   7. Clinical Materials Management Systems (e.g. Four Rivers, St. Croix Systems, Phoenix Data Systems - AIMS)
   8. Patient-to-staff assignments, wandering patient alarm systems, bed exit and/or fall prevention alarm systems, and patient equipment calls
   9. PC monitors, and large screen monitors such as Flat Panel LCD or Plasma display

10. Temperature and Environmental Monitoring applications

B. Synchronized Clocks
   1. Ensure accurate timestamping of asset movements, staff locations, and infant protection events.

C. Patient Education / Entertainment
   1. Patient education and entertainment systems integrate with RTLS staff tracking to automatically detect when clinical personnel enter patient rooms, enabling personalized content delivery and real-time assistance.

D. Wireless Communications Device
   1. Enables staff to receive location-based communications and alerts, allowing for rapid response to patient needs based on real-time staff proximity to help identify the nearest available provider.

E. Security Systems
   1. By linking RTLS data with security infrastructure, facilities will be able to instantly pinpoint the location of staff, assets, and patients during a security event. Infant protection systems interface with RTLS to monitor and alert staff to any unauthorized movement of infants, automatically triggering lockdown protocols and alerting security personnel if thresholds are breached. Similarly, duress alarms integrate with RTLS to transmit the precise location of staff in distress, ensuring rapid, targeted responses from security teams.

F. Dashboard Monitors
   1. Dashboard displays integrated with RTLS offer real-time, centralized views of staff, patient, and asset locations using intuitive interfaces like floor plans and status boards. Additionally, analytics from the system reveal movement patterns and resource utilization, supporting safer, more efficient healthcare operations.

G. Cisco Spaces
   1. Leveraging Cisco Spaces and Cisco BLE enabled wireless access points for location services throughout the entire facility.
   2. RTLS system must integrate natively with Cisco spaces to facilitate approximate locating throughout the entire facility, specifically in non-clinical areas.

2.4 INFRARED EMITTING DEVICES

A. Infrared emitting devices shall be battery powered units placed in patient care areas, equipment storage locations, nursing areas, and hallways, as dictated by use cases.

B. The devices shall be labeled with unique identifiers and shall be easily mounted to all types of ceilings (drop or smooth).

C. Each infrared emitting device shall be supervised via Radio Frequency (Wi-Fi and 900 MHz) by the RTLS-PSS and Over the Air configurable (OTA) to adjust power and other settings to address all types of physical environments.

D. Infrared emitting devices shall not require calibration.

E. The infrared emitting devices shall provide for non line of sight performance that shall generate certainty-based room, bed or bay-level locating.

2.5 ROOM AND HALLWAY MONITORS

A. Room and Hallway Monitors shall have a range of 60' in open spaces and are capable of effectively filling a 20' x 20' space.

B. Standard battery life at typical workflow settings shall be up to 5 years.

C. Extended battery life options shall exceed 10 years.

D. Have the ability to connect to the system via the hospital's Cisco Wi-Fi network, Aruba Wi-Fi network, or a 868 - 900Mhz active UHF network.

2.6 VIRTUAL WALL MONITORS

A. Virtual Walls shall be used as required in areas where bay or bed level locating is required such as semi-private rooms, Emergency Departments, PACU, or any curtained areas.

B. The Virtual Walls shall have the ability to create bays out of open space (such as a ward). Minimum room size shall be 8' x 6' with 1' wall thickness on each side.

C. Standard battery life at typical workflow settings shall exceed 3 years.

D. Have the ability to connect to the system via the hospital's Cisco Wi-Fi network, Aruba Wi-Fi network, or a 868 - 900Mhz active UHF network.

2.7 LOW FREQUENCY DEVICES

A. Low Frequency devices shall be battery powered exciters placed in patient care, equipment storage, and egress / ingress areas.

B. The devices shall be labeled with unique identifiers and shall have the ability to be easily mounted to all types of ceilings or walls (drop or smooth).

C. Each low frequency device shall be supervised via Radio Frequency (Wi-Fi and 900 MHz) by the RTLS-PSS and Over the Air configurable (OTA) to adjust power and other settings, to address all types of physical environments.

D. The Low Frequency devices shall provide for non line of sight performance used to generate certainty-based bed-level or choke point locating.

E. Low Frequency devices shall have configurable ranges.

F. Standard battery life at typical workflow settings shall exceed 2 years.

G. Have the ability to connect to the system via the hospital's Cisco Wi-Fi network, Aruba Wi-Fi network, or a 868 - 900Mhz active UHF network.

2.8 DOOR / ELEVATOR CONROLLERS

A. Door / Elevator Controller shall be able to be installed and concealed above the ceiling and instantly lock all egress / ingress areas as needed.

B. The devices shall be labeled with unique identifiers and their condition actively monitored by the PSS user interface application.

C. Door / Elevator Controllers shall operate independent of the user interface application and maintain perimeter protection in the unlikely event of a server outage.

D. Door / Elevator Controllers shall have local memory and be able to store all events until transmitted to the PSS server application.

E. Door / Elevator Controllers shall be capable of creating at least two (2) configurable LF fields each capable of generation a field up to a 25 foot radius.

F. Door / Elevator Controllers must have no fewer than four (4) onboard dry contact relays for controlling external devices such as mag locks, sounders, and strobes.

2.9 HAND HYGIENE DEVICES

A. Hand Hygiene devices shall be small battery powered exciters placed on dispensers or bottles or over hand washing stations.

B. The devices shall be labeled with unique identifiers and shall have the ability to be easily mounted on all types of dispensers and bottles.

C. Each Hand Hygiene device shall be supervised via Radio Frequency (900 MHz) by the RTLS-PSS and Over the Air configurable (OTA) to adjust power and other settings, to address all types of physical environments.

D. Hand Hygiene devices shall provide for the certainty-based collection of hand hygiene events based upon motion and or proximity.

E. The Hand Hygiene devices shall generate visual notifications of compliance using color coded LEDs.

F. Low frequency devices shall have configurable ranges.

G. Standard battery life at typical workflow settings shall be 2+ years.

2.10 RF ANTENNAS (Stars)

A. Stars are Ethernet devices that shall connect to all hospital networks via the WLAN or Wi-Fi network.

B. Stars shall communicate with infrared emitting devices, low frequency devices and tags, using 900 MHz.

C. Stars shall receive location information from tags, provide supervision, and shall configure both Tags and infrared emitting devices Over the Air (OTA).

D. Stars shall be DHCP devices that can be easily added to the network.

2.11 TAGS/BADGES/TRANSMITTERS

A. Tags shall have an infrared receiver and Wi-Fi and/or 900 MHz transceivers.

B. They shall receive location information from infrared emitting and low frequency devices and send / receive information from the 900 MHz antenna and Wi-Fi network.

C. Each Tag shall have a unique ID printed on a label with a bar code.

D. Tags shall utilize advanced battery management techniques and generate low battery indicators based upon customer specified levels.

E. Tags shall offer motion sensors, over the air upgrades, and bi-directional communication capabilities.

F. The Tags shall have a standard ping rate of 3 seconds, in 900 MHz mode, and shall utilize field replaceable batteries.

G. Tags shall have an adjustable ping rate based on the customer requirements, down to a 1.5 second option.

H. Tags shall have motion sensors reduce the number of transmissions if a tag is not moving, thereby extending the battery life.

I. The tag motion sensor shall be configurable based on the customer requirements.

J. Tags not meeting the requirements above, or that use rechargeable batteries, shall not be accepted.

K. Have the ability to connect to the system via the hospital's Cisco Wi-Fi network, Aruba Wi-Fi network, or a 868 - 900Mhz active UHF network.

2.12 ASSET TAGS

A. Asset Tags shall attach to mobile medical equipment, including small devices which can be easily lost.

B. Asset Tags shall have a standard ping rate of 3 seconds, in 900 MHz mode, and shall utilize field replaceable batteries.

C. Tags shall have an adjustable ping rate based on the customer requirements, down to a 1.5 second option.

D. Standard battery life for the Asset Tag at a 20% activity level with a continuous 3 second ping rate shall be 6+ years.

E. Asset Tags shall offer a detachment detection (tamper) mechanism.

F. Asset Tags shall offer a button that provides an audible click sound when depressed.

2.13 WI-Fi/BLE ASSET TAGS

A. Asset Tag shall support bi-directional communication to the receivers

B. Wi-Fi/BLE Asset Tags shall communicate with a Cisco Wi-Fi network using the Cisco Spaces or Aruba network using the HPE Aruba Networking Analytics and Location Engine, or Juniper network using MIST AI Solutions.

C. Wi-Fi/BLE Asset Tags shall be attached to mobile medical equipment, including small devices that are easily lost.

D. Standard battery life for the Wi-Fi Asset Tag at a 100% continuous 30 second ping rate shall exceed 42 months.

E. Wi-Fi/BLE Asset Tags shall offer detachment detection mechanisms.

F. Wi-Fi/BLE Asset Tags shall offer a button that provides an audible click sound when depressed.

2.14 STAFF BLE TAGS (BADGES)

A. Staff Tag shall support bi-directional communication to the receivers.

B. Staff Tags shall weigh less than 1.4 oz.(38g)

C. Staff Tag dimensions shall be less than 5mm thin, and fit within the footprint of a standard hospital issued ID badge.

D. Staff Tags shall have the ability to be worn in portrait or landscape orientations.

E. Standard battery life for the Staff Tag at a 3 second ping rate shall exceed 12 months.

F. Staff Tags shall offer three configurable with distinguishable tactile feel buttons, and audible alerting capabilities for use with workflow applications.

G. Each button shall support activating an event, such as a staff call, cancelation of an event, or enabling a status change.

H. Staff Tags shall support attachment of a standard ID card (ISO/IEC 7810 ID-1) to the front.

I. The staff Tags shall support battery replacement using a battery pack with 2 screws.

J. The Staff Tags shall support Gen2IR technology with Dual Direction Wide Angle sensing IR as well as Low Frequency (125KHz) Dual Mode.

K. Have the ability to connect to the system via the hospital's Cisco, Aruba or Juniper BLE-Enabled Wi-Fi network or a 868 - 900Mhz active UHF network.

2.15 PATIENT TAGS/TRANSMITTER

A. Patient Tags shall weigh less than .9 oz and shall be designed with a loop to accommodate a standard hospital issued ID band.

B. Standard battery life for the Patient Tag at a 3 second ping rate shall exceed 12 months.

C. Patient Tags shall offer a button which provides an audible click sound when depressed.

D. Patient Tag button press shall support activating an event, such as a patient call, status change or cancelation of an event.

E. Patient Tags shall have an optional tamper mechanism and immediately communicate with the RTLS-PSS if it's removed from the patient.

F. Have the ability to connect to the system via the hospital's Cisco Wi-Fi network or a 868 - 900Mhz active UHF network.

2.16 INTEGRATED STAFF LOCATING

A. The RTLS-PSS shall track the location of staff by two field configurable options:
   1. The first shall display staff presence in an area each time the Tag sees the unique ID of the infrared emitting device. This location shall be displayed on each staff console and graphical audio station on the network. If staff members are not found, asterisks shall be placed next to the staff member's name.
   2. The second method shall display the last known location at the nurse call staff console and graphical audio stations. The time interval since the staff member left the last known location will be displayed on the location screens at the staff console. The audio channel shall be opened up to the last known location if an audio station is present.

2.17 STAFF LOCATING SOFTWARE APPLICATION

A. A web-based Staff Tracking application shall be supplied per Owner specifications.

B. The Staff Tracking application shall track the location of Tags placed on staff to the room or bed / bay level, as specified by the Owner.

C. The location of Tags shall display on an optional graphical map view displaying the various status of devices.

D. Staff tracking application shall operate stand alone or be capable of integration with nurse call systems.

2.18 ASSET TRACKING APPLICATION

A. A web-based Asset Tracking application shall be supplied per Owner specifications.

B. Asset Tracking application shall track the location of Tags placed on assets to the room or bed / bay level, as specified by the Owner.

C. The location of Tags shall display on a graphical map view displaying the various status of devices.

D. Asset status changes shall be visible in real time in the Asset Tracking Application.

E. Asset Tag button presses shall be configurable to enable workflow applications, including asset status change, usage, and activity.

F. Asset Tracking application shall support automated status updates based on the location of the asset.

G. Asset Tracking application shall manage and map up to 26 different asset attributes to use for Owner specific application.

H. The Asset Tracking application shall manage web interface by user, and shall filter what users have the ability to view and/or edit.

I. Asset Tracking application shall support import of device specific images for any asset.

J. Asset Tracking application shall support creation of rules through visual editing system.

K. Asset Tracking application shall allow for instant enable and disable of rules per Owner specification.

L. Asset Tracking application shall support escalation paths for notifications and messages.

M. Asset Tracking application shall allow for reusable notification groups consisting of multiple notification methods.

N. Asset Tracking application shall support tracking responses to work orders, corrective actions, who is responding and resolution time.

O. Asset Tracking application shall support creation of notifications based on location changes.

2.19 PATIENT SAFETY & TRACKING APPLICATION

A. Patient Safety & Tracking application shall be supplied per Owner specifications.

B. The Patient Safety & Tracking application shall track the location of Tags worn by patients, as specified by the Owner.

C. The location of Tags will display on a graphical map view and allow for the generation of events based upon patient location.

D. The Patient Tracking application shall be capable of integration with Electronic Medical Records, Emergency Department, and Operating Room information systems.

E. All events shall be logged by the Patient Safety & Tracking application and detailed customized reports generated.

F. Patient Safety & Tracking application must be capable of immediately displaying all alarm conditions with the following information:
   1. Patient name
   2. Tag number
   3. Alarm location
   4. Patient image
   5. Date
   6. Time
   7. Temperature Monitoring

2.20 HAND HYGIENE COMPLIANCE (HHC) APPLICATION

A. Contractor to provide hand hygiene compliance sensors at all sinks and sanitizer stations in all clinical areas of the buildings including acute care, L&D, ED, imaging, surgery, PACU, etc.

B. A web-based Hand Hygiene compliance application shall be supplied per the Owner specifications.

C. The Hand Hygiene compliance application shall track staff hand hygiene compliance opportunities for individual staff members, as specified by the Owner.

D. The HHC solution shall support existing hospital protocols and procedures.

E. The HHC solution shall provide customized entry and exit rules to support hospital policies.

F. The HHC solution shall allow hospitals to define a hand washing protocol and alert staff members when they are in violation of this protocol.

G. The hand washing protocol shall track the amount of time a staff member has been in a room or location.

H. The Hand Hygiene Compliance application must be capable of measuring compliance by nursing unit, room, room type, staff group, or individual staff.

I. The Hand Hygiene Compliance application shall support unique protocols for different nursing units.

J. The Hand Hygiene Compliance Application shall support unique rules for different locations or room types.

K. The Hand Hygiene Compliance Application shall be able to differentiate between soap or gel/foam/alcohol dispensers for use in supporting rules.

L. The Hand Hygiene Compliance Application shall support an optional alert mechanism to notify caregivers of potential missed opportunities.

M. The location of Tags will display on a graphical map view and allow for the generation of active alerts and notifications, to remind staff members of missed hand hygiene opportunities, which can be sent to Tags, other wireless devices, or the Nurse Call system, within 3 seconds of the event,

N. The Hand Hygiene Compliance application shall provide graphic and tabular displays of real time compliance rates ranging from national benchmarks to the individual staff member level.

O. The Hand Hygiene Compliance Application shall show compliance information for current and previous shifts in graphical user interface.

P. The Hand Hygiene Compliance application shall be capable of generating historical compliance / non-compliance reports by individual staff member, role, group, unit, room or room type.

Q. The Hand Hygiene Compliance application shall not impact the normal requirements for hand washing by staff members. Solutions that require staff change their normal behavior such as alcohol detection solutions shall not be considered.

R. The Hand Hygiene Compliance application shall provide reporting capabilities via a web based user interface.

S. The HHC solution will provide historical data by healthcare worker, role, group, location, room type or unit.

T. The HHC solution will provide a summary of the compliance rate for each location as well as an overall compliance rate.

2.21 MAINTENANCE APPLICATION

A. A web-based Maintenance application shall be supplied per the Owner specifications.

B. The Maintenance application shall store an unlimited amount of historical system information using a cloud-based architecture.

C. The Maintenance application will store and allow for drill down reporting of every interaction between Tags and the Infrared Emitting and Low Frequency devices.

D. The Maintenance application shall provide a dashboard view allowing for users to rapidly determine the health of the system.

E. The Maintenance application shall provide alerts when key system components are approaching low battery status or fail.

F. The Maintenance application shall be capable of generating historical reports.

2.22 REPORTING

A. The solution shall provide a built in report generation and distribution engine.

B. The solution shall provide a minimum of 25 different report templates for various types of RFID, RTLS and sensor systems.

C. The solution shall support creation of customized templates by filtering on locations, item sets and other variables

D. The solution shall utilize the same customizable web interface as the Owner required application.

E. The solution shall support a System Administrator level user to customize report fields, names and information.

F. Reports shall be able to be delivered to an email box as HTML files.

G. Reports shall support specific delivery frequency and times for each report.

H. These parameters will include daily, every other day, weekly, monthly or when new information is available.

I. Reports shall support monitoring options that will send emails or notifications when new information changes or becomes available.

2.23 TAG QUANTITIES FOR BIDDING

Type	BLE Badge	DuraTag	Mini Asset Tag	Micro Asset Tag	Multi-mode Asset Tag
Quantity	200	250	450	760	420

A. Contractor to include pricing and implementation for the above tag counts and quantities. Contractor to verify final counts and locations with Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of equipment shall comply with manufacturer's written instructions.

B. Wiring Method: Wiring shall be installed in compliance with ANSI/TIA-569 Commercial Building Standards Telecom Pathways and Spaces.

C. Terminations: Cabling in back boxes shall be terminated with 8 pin 8 wire RJ45 connectors.

D. Infrared emitting devices: Shall be installed on ceiling per manufacturer recommendations.

3.2 DEMONSTRATION

A. Contractor coordinates a demonstration with the Owner, using the RTLS-PSS in a simulated environment to evaluate the project effectiveness, ensures the system meets requirements.

3.3 ACCEPTANCE

A. Coordinate with Division 01 for Owner acceptance requirements.

3.4 COORDINATION

A. Contractor coordinates, installs, maintains enterprise RTLS-PSS with hospital staff to ensure proper operation.

B. Installation, testing, operation, and maintenance coordinated with hospital facility personnel at time of construction activities.

C. System operated with hospital fire system in good communication and interaction with facility staff.

3.5 WARRANTY AND TRAINING

A. Contractor shall provide 40 hours of training for both clinical and IT staff with a 5-year warranty. 5-year warranty to include 1 year plus years 2-5 broken out separately for Owner to purchase prior to 1 year warranty expiration.

END OF SECTION

SECTION 275319 - DISTRIBUTED ANTENNA STSYTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes products and execution requirements pertaining to Division 27 53 19 systems for internal cellular and antenna systems. System components and support systems are covered under this document.

B. Internal cellular and antenna systems are commonly referred to as a Neutral-Host Distributed Antenna System (DAS) for supporting Wireless Service Providers (WSP)

C. System components include, but are not limited to Network Units, Coverage Units, Fiber Hubs, Fiber Range Extenders, Donor Antennas. Ceiling Omni Antennas, Directional Antennas, Smart Server Antennas, RF and Horizontal Coax Cabling, Category 6/6A Structured Cabling, and Optical Fiber Structured Cabling

D. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities for all internal cellular and antenna system products shall be provided as required to complete the project as shown on floor plans per the design.

E. The DAS shall provide coverage for the WSP's listed below.
   1. AT&T
   2. Verizon
   3. T-Mobile

F. Substitutions: No substituted products shall be installed except with written approval by Owner.

G. The project design and system component installation shall be performed or managed by a Nextivity certified system integrator (SI).

1.2 CONTRACT WORK REQUIREMENTS

A. General:
   1. Provide the following pre-deployment surveys upon award:
      a. Rooftop macro survey of all available brands and operators, to include:
         1) Signal Strength
         2) SiNR
         3) QoS

B. Indoor coverage survey of existing cellular performance of all operators
   1. Furnish all labor, materials, tools, equipment and services for the installation in accordance with general provisions of specifications and the Contract Drawings.
   2. Report percentage of work completed on a monthly basis.
   3. Completely coordinate with work of all other trades.
   4. Provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation, whether or not specifically indicated in the Contract Documents.
   5. Provide all floor penetrations, floor sleeves, conduit raceways, wall penetrations, etc. not shown on the electrical plans but needed for the routing of cabling provided herein.
   6. Provide fire stopping.
   7. Provide labor for installation, testing, and commissioning of system components.

8. Confirm that the site has the necessary space and power to support the DAS as well as RF Sources.

C. Purchasing
1. Provide complete price breakdown of materials and handling fees.

1.3 SUBMITTALS

A. Submittals shall be submitted in one single package. Partial submittals will not be considered.

B. Material lists, schedule of values, lists of subsystem Integrators, and proof of System Integrator (SI) qualifications shall be provided to upon request and shall follow the guidelines as stated in the General Requirements (Division 1 of the specification).

C. C. Performance bonds, payment bonds, and insurance certifications shall be submitted by the System Integrator prior to the execution of the contract.

D. Shop drawings shall be submitted. All communication system shop drawings shall include:
1. Manufacturer's data (specifications, "cut sheets").
2. Wiring diagrams for all installed cabling.
3. Equipment rack/cabinet layouts.
4. Proposed labeling schemes and labeling method.
5. Submit copies of certifications for all technicians and the project manager who will support this project.
6. A list of managers and technicians certified
7. Approved manufacturer classes satisfactorily completed.
8. System Integrator shall submit a test plan with the submittal package that defines the tests required to ensure that the system meets technical, operational, and performance specifications. The test plan must also meet manufacturer's certification requirements.
9. Work shall not proceed without the approval of the submitted items.

E. E. Drawings & Inspection of Site:
1. Communications floor plan drawings are to scale and typically are not dimensioned. The System Integrator shall not scale drawings for equipment placement and clearances. Dimensions given on drawings shall always take precedence over scaled drawings.
2. Any existing wires, utilities, or equipment shown on the drawings are shown for general information and to the best knowledge. The System Integrator shall verify all existing wires, utilities, or equipment.
3. The System Integrator shall verify distances and equipment placements coordinating locations with other trades, construction managers, and general System Integrator prior to installation.
4. The System Integrator shall review all site conditions prior to submitting a bid on this project. Any obvious discrepancies between the site conditions and bidding documents shall be brought to the attention of the design team at the time of bidding so clarification can be made by addendum.
5. Change order requests for additional costs related to the System Integrators' misunderstanding related to the amount of work involved and lack of knowledge related to the site conditions will not be allowed.

6. Convene pre-installation meeting 2 weeks prior to start of installation of horizontal communications cabling. This meeting will review the installation timeline and allow for coordination with additional System Integrators on site.

1.4 QUALITY ASSURANCE

A. Installation Reference Standards (all codes and standards compliance will be to the most current revision available, including applicable addendums): Installation shall comply with the following:
   1. NFPA 70: National Electric Code®, current edition or as specified per local codes and Authority Having Jurisdiction (AHJ).
   2. ANSI/TIA-568.0-D - Generic Communications Cabling for Customer Premises.
   3. ANSI/TIA -568.1-D Commercial Building Telecommunications Cabling Standard. Part 1: General Requirements
   4. ANSI/TIA-568.2-D: Commercial Building Telecommunications Cabling Standard
   5. ANSI/TIA-568.3-D: Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standards
   6. ANSI/TIA-569-D: Commercial Building Standard for Telecommunications Pathways and Spaces
   7. ANSI/TIA-606-B. The Administration Standard for the Telecommunications infrastructure of Commercial Building
   8. ANSI/TIA-607-C. Commercial Building Bonding and Grounding (Earthing) Requirements for Telecommunications
   9. BICSI-TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (Revision 12 or most current revision)

B. Materials:
   1. All materials shall be listed with UL or ETL and shall be marked as such.
   2. Products shall be regularly catalogued items of the manufacturer and shall be supplied as a complete unit in accordance with the manufacturer's standard specifications with any +optional items required for proper installation unless otherwise noted.
   3. Material shall be delivered to the site in the original packing.
   4. Alternates are to be considered based on the bidding requirements and as approved "as equal".
   5. Approved Products: (Basis of Design or equal)
      a. Network Units: Nextivity
      b. Coverage Units: Nextivity
      c. Fiber Hubs: Nextivity
      d. Fiber Range Extenders: Nextivity
      e. Donor Antennas: Nextivity
      f. Ceiling Omni Antennas: Nextivity
      g. Directional Antennas: Nextivity
      h. Smart Server Antennas: Nextivity
      i. Category 6 Cabling: Leviton or Equal
      j. Optical Fiber Cabling: Leviton or Equal
      k. RF Coax: CommScope of Equal
      l. Horizontal Coax Cabling: CommScope or Equal

m.	Accessories: Supplied	Nextivity or System Integrator
n.	Scanner Tool for Site Surveys	Nextivity Compass XR

C. System Integrator Qualifications:

1. The System Integrator shall have experience in the installation and testing of similar systems as specified herein and shall have completed at least two projects of similar size and scope within the last 24 months. The System Integrator shall provide references upon request (including the project name, address, date of implementation, client name, title, telephone number, and project description.)
2. The System Integrator bidding on communication systems specified herein shall be an Nextivity Certified System Integrator. The awarded System Integrator must be able to install, service, and warrant the specified product prior to the time of bid and throughout the duration of the installation; or, the bidding System Integrator shall utilize a sub-System Integrator(s) certified by Nextivity to install, service, and warrant the specified product. The awarded System Integrator must be eligible to support the Nextivity warranty. Manufacturer certifications shall not be project specific and should be valid for any and all projects completed by System Integrator.
3. The System Integrator must meet all training requirements from Nextivity. The System Integrator must be in good standing with a minimum of 30% of the technicians on site and at least one manager current with the required training.
4. The System Integrator is responsible for workmanship and installation practices in accordance with Section 1.4.A Installation Reference Standards.
5. The System Integrator must maintain a state System Integrator's license as required by the state.
6. The System Integrator shall provide copies of certificates for proof of manufacturer's training, manufacturer's certified installer, authorized distributor in the shop drawing submittal ato verify compliance with specification prior to recommendations for awarding bid.

1.5 MAINTENANCE

A. A. All materials used on this project shall be new. Used and refurbished equipment is not permitted. Provide equipment to site in original packaging whenever practical.

B. B. The System Integrator is responsible for scheduling all deliveries and providing proper receipt, handling, and storage of all materials. Protect all equipment from physical damages (dents, scratches, dust, water, paint, chemicals, and temperature extremes) and vandalism, or theft. The System Integrator shall replace any damaged or stolen equipment. The System Integrator is responsible for all equipment until final project acceptance by Owner.

1.6 WARRANTY

A. Nextivity Limited Warranty: warrants each Nextivity Product against defects in materials and workmanship when used in accordance with Nextivity's published guidelines for the Warranty Period.

B. The foregoing Limited Warranty does not apply to (i) damage or loss during shipment for replacement or repair; (ii) Products that have been subjected to accident, abuse, misuse, neglect, shipping or other physical damage, improper installation or operation, improper testing or use contrary to the instructions given by the Nextivity; or (iii) Products that have been repaired, altered, or modified by anyone other than Nextivity.

C. The warranty period is 24 months with an option to extend the warranty coverage in 12-month or 36-mont increments up to a maximum of 60 months from the time of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURES

A. Specified manufacturer: Nextivity or equal

B. Others per section 1.4.B.

2.2 DESCRIPTION - DAS SYSTEM

A. The system shall consist of the following:
   1. The system shall obtain the signal off-air and requires roof mounted antenna/s
   2. Location of antennas will be determined as part of the pre-deployment survey
   3. The donor antenna will connect to the system via coaxial cable
   4. The signal shall be distributed through the 'required improvement area
   5. Options for remote monitoring

B. Intelligent and Dynamic Channelization
   1. The system shall be intelligent and dynamically channelized to ensure:
      a. Each MNO and individual band shall be optimized independently and dynamically to adapt with network changes
      b. Such individual and dynamic optimization shall ensure continuous, optimal and equal coverage performance of each MNO and band
      c. Remove interference associated with traditional repeaters
      d. Dynamically adjust both uplink and downlink independently per band per MNO for optimal performance
      e. Dynamically adjust to the changing outdoor macro parameters to constantly optimize indoor performance independently for each MNO and band
      f. Implement advanced echo cancellation to ensure optimal system and cellular QoS
      g. Such automated and dynamic self-configuration and optimization shall at all times protect the MNO networks from interference and harm

C. Digital Signal Distribution
   1. The selected solution shall provide digital signal distribution throughout the 'required improvement area'. This is important to ensure:
      a. Conformance with the standard Category and fiber cabling infrastructure as defined by the building owner/enterprise
      b. Existing cabling infrastructure can be used, where available
      c. Connection between active components of the solution is lossless and utilizes power-over-Ethernet (PoE)
      d. Existing cable management and cable trays can be used between active components

e. Any existing new infrastructure cabling required to be installed between active components is fast to deploy and gives minimal disruption to the building, the business and its employees
f. Existing communications rooms and IDFs can be used with existing patch panels and cables used to distribute signal and power

D. Remote Monitoring
1. The system shall have remote monitoring to enable the contractor to provide proactive maintenance support:
a. On-premises LAN connection or LTE modem option should be available
b. Remote monitoring should be via an online portal.

E. Live Monitoring, Alerts, and Alarms Monitoring
1. The system shall be monitored live and provide alerts and alarms to contractor's support team. These shall include:
a. Monitoring of NU current status
b. Monitoring of CU current status
c. Monitoring of macro signal status
d. Detailed drill down option to enable remote investigation
e. Trend information over selectable timeframe
f. Reports
g. Undertake remote maintenance activities, e.g., recycling CU power

2.3 MATERIALS / COMPONENTS

A. Network Unit (NU)
1. 1. Neutral-Host active DAS hybrid cellular coverage Network Unit
a. Specifications per Data Sheet
b. Capability to be wall or 19-inch rack mounted
c. Have intelligent operation that adapts to changes in the outdoor macro network to ensure dynamically and consistently optimized indoor coverage performance, as set out in Section 2.2.C
d. RJ45 and fiber ports to support up to 12 Coverage Units/radio units per NU
e. RJ45 management port for live monitoring and maintenance
f. Each MNO shall have a dedicated high performance N-type donor port. This ensures the MNOs are individually and automatically optimized to provide the appropriate gain and to ensure each MNO has equal indoor coverage
g. FCC Part 15, 20, 22, 24, 27, 90, and 96 per DAS design
h. Four donor ports to support AT&T, Verizon, T-Mobile, and Private Networking
i. Connection via ethernet or LTE modem to Nextivity WAVE Platform for remote monitoring
j. Manufacturer: Nextivity part number Q44-1M34CNU

B. Coverage Unit (CU)
1. 1. Neutral-Host active DAS hybrid cellular coverage Coverage Unit
a. Specifications per Data Sheet
b. Power via PoE
c. Connect to the NU via Category cabling to provide lossless RF distribution
d. Have an option for PoE extension to increase distance between devices

e. A high performance 4.3-10 RF antenna port for quality of connection to the passive antenna/s
f. Various mounting options for wall, ceiling, rack
g. FCC Part 15, 20, 22, 24, 27, 90, and 96 per the DAS design
h. Connection to NU via Category 6/6A structured cabling and Power over Ethernet
i. Manufacturer: Nextivity part number Q41-RECU

C. Fiber Hub
1. 1. Neutral-Host active DAS hybrid cellular coverage Expansion Solution
a. Specifications per Data Sheet
b. FCC Part 15 per the DAS design
c. Connection to NU via Category 6/6A structured cabling and Power over Ethernet
d. Manufacturer: Nextivity part number Q40-1234FNU

D. Fiber Range Extender
1. 1. Neutral-Host active DAS hybrid cellular coverage Expansion Solution
a. Specifications per Data Sheet
b. FCC Part 15 per the DAS design
c. Connection between Fiber Extender NU and CU via optical fiber cabling
d. Connection to NU via Category 6/6A structured cabling and Power over Ethernet
e. Manufacturer: Nextivity NU part number Q40-0XNU, Nextivity CU part number Q40-0XCU

E. E. Donnor Antennas
1. LPDA-R
a. Specifications per Data Sheet
b. Electrical Specifications
1) Frequency Range: 617 - 4000 MHz
2) Gain: 12-14 dBi
3) VSWR: $\leq$ 2.0
4) Polarization: Vertical
5) Input Impedance: 50 Ohms
6) Maximum Input Power: 50W
c. Mechanical Specifications
1) Connector: N-Female
2) Mounting: Pole
3) Operating Temperature: -40^{o}C to +65^{o}C
d. Manufacturer: Nextivity part number A62-V44-201
2. Wideband Directional Antenna
a. Specifications per Data Sheet
b. Electrical Specifications
1) Frequency Range: 698 - 960 MHz and 1710 - 2700 MHz
2) Gain: 10 dBi (698-960 MHz) and 11 dBi (1710-2700 MHz)
3) VSWR: $\leq$ 2.0 (698-960 MHz) and $\leq$ 1.5 (1710-2700 MHz)
4) Polarization: Vertical
5) Input Impedance: 50 Ohms
6) Maximum Input Power: 50W
c. Mechanical Specifications

1) Connector: N-Female and SMA Male
2) Mounting: Pole
3) Operating Temperature: -40°C to +65°C

d. Manufacturer: Nextivity part number A32-V32-200 or A32-V32-201

3. Wideband and Directional Panel Antennas
   a. Specifications per Data Sheet
   b. Manufacturer: Nextivity various part numbers per the spec sheets

F. Server Antennas
1. Smart Server Antenna: Low profile omnidirectional for 360° coverage and active monitoring.
   a. Specifications per Data Sheet
   b. Includes Bluetooth Low Energy connectivity
   c. FCC Part 15 per DAS design
   d. Electrical Specifications
2. Frequency Range: 617 - 3980 MHz
3. Average Gain: 2.2 - 3.8 dBi
4. Polarization: Horizontal
5. Input Impedance: 50 Ohms
6. Maximum Input Power: 2W

G. Mechanical Specifications
1. Connector: N-Female
2. Mounting: Hard ceiling mounting place
3. Operating Temperature: 0°C to +40°C

H. Manufacturer: Nextivity part number A91-JV4-C00
1. LP SISO Indoor Omni Antenna
   a. Specifications per Data Sheet
   b. FCC Part 15 per DAS design
   c. Electrical Specifications
2. Frequency Range: 617 - 4000 MHz
3. Average Gain: 3 - 5 dBi
4. Polarization: Linear, Horizontal
5. Input Impedance: 50 Ohms
6. Maximum Input Power: 50W

I. Mechanical Specifications
1. Connector: N-Female
2. Mounting: Hard ceiling mounting place
3. Operating Temperature: -40°C to +60°C

J. Manufacturer: Nextivity part number A11-H43-201
1. Indoor Omni Dome Antenna
   a. Specifications per Data Sheet
   b. FCC Part 15 per DAS design
   c. Electrical Specifications
2. Frequency Range: 698 - 5900 MHz
3. Average Gain: 2 - 5.5 dBi
4. Polarization: Vertical
5. Input Impedance: 50 Ohms
6. Maximum Input Power: 50W

K. Mechanical Specifications
   1. Connector: N-Female
   2. Mounting: Fix with nut
   3. Operating Temperature: -40°C to +60°C

L. Manufacturer: Nextivity part number A11-V43-121 (N-Type) / A11-V43-100 (SMA)
   1. Other Indoor Antennas
      a. Specifications per Data Sheet
      b. Manufacturer: Nextivity

M. Category UTP Cabling
   1. Category 6 UTP Plenum 4-pair Cabling
      a. Specifications per Data Sheet
      b. Cable shall comply with ANSI/TIA-568.2-D Category 6; UL 444.0; ISO/IEC 11801.
      c. Cable shall support network transmission protocols IEEE 802.3: 1000BASE-T; 100BASE-T; ATM 155 Mb/s; CDDI 100 Mb/s.
      d. Electrical performance Third-party (ETL) verified and characterized to 500MHz.
      e. The cable shall be constructed of 23 AWG copper wire insulated with polypropylene. Four pairs cabled to form the basic unit, jacketed with flame-retardant PVC.
      f. Cable shall have Flame Rating of Plenum-NFPA 262, CMP and UL Listed.
      g. The cable shall support up to 100 watts PoE with up to 240 cables in a bundle.
      h. The cable shall support the following PoE standards when installed according to Manufacturers recommendations.
         1) IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
         2) IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts
         3) IEEE 802.3bt (Type 3) Power over Ethernet (PoE++) applications up to 60 watts
         4) IEEE 802.3bt (Type 4) Power over Ethernet (PoE+++) applications up to 90 watts
      i. The Cat 6 UTP cable shall have a nominal outside diameter of 0.225" (5.84 mm)
      j. Cable jacket colors available Blue, Yellow, Dark Grey, Green, White, Violet, Pink, Red, Orange, Black, Brown - Confirm colors with owner prior to ordering.
      k. Cable shall have alpha numeric code printed every 1 meter.
      l. Cable shall be compliant with Manufacturer's performance warranty criteria.

      m. Basis of Design
         1) Manufacturer: Berk-Tek/Leviton LM-1000 Category 6 Plenum Rated Box
         2) Part #s: 10032094 Blue
         3) White
         4) 11091087 Dark Grey

N. Category 6 Patch Cords - Standard Diameter - UL Listed
   1. Patch cords shall be independently tested and verified to meet ANSI/TIA-568.2-D and ISO 11801-1 Category 6 component requirements
   2. Patch cord cable shall be UTP construction, stranded 24 AWG conductors, and a nominal outside diameter of .240" (6.0mm).
   3. The patch cord shall incorporate 8-position modular plugs on both ends with a snag less tab design. Plugs shall be short body style without bend radius boots for limited space applications.
   4. Patch cord plugs shall be industry standard, FCC compliant clear material with 50 micro inches of gold plating.
   5. Patch cords shall meet UL 444 CM rating.
   6. The patch cord shall comply with the following PoE standards
      a. IEEE 802.3at (Type 1) Power over Ethernet (PoE) applications up to 15.4 watts
      b. IEEE 802.3at (Type 2) Power over Ethernet (PoE+) applications up to 30 watts,
      c. IEEE 802.3bt (Type 3) Power over Ethernet (PoE++) applications up to 60 watts
      d. IEEE 802.3bt (Type 4) Power over Ethernet (PoE++) applications up to 90 watts
      e. Cisco Universal Power Over Ethernet (UPOE/UPOE+) applications up to 90 watts
      f. Power over HDBaseT™ (PoH) applications up to 95 watts
      g. The cords shall be available in white, yellow, red, blue, green, violet, orange, grey, and black colors.
      h. The patch cords shall qualify as part of the Manufacturers Product and Systems Performance Warranty when installed as part of a certified system.
      i. Basis of Design
         1) Manufacturer: Leviton Category 6 UTP Patch Cords
         2) Part #: 6D460

O. Fiber-Optic Cable and Connectors:
   1. General Specifications:
      a. Cables shall be single-strand or greater, designed for point-to-point applications as well as mid-span access, and shall provide a high- level of protection for optical fiber installed in interior building environments.
      b. Single-mode optical fibers shall be 8.3 µm and use standard colored tight-buffered construction.
      c. The single-mode optical fiber shall be dispersion-unshifted optical fiber that meets ITU-T G.652c standards.
      d. Cable shall provide optimum performance over entire wavelength range from 1260 to 1625 nanometers.
      e. Fire ratings: Riser, plenum, and/or LSZH
      f. Approved Manufacture: Leviton or equal in accordance with Section 1.4.B.

P. Fiber-Optic Pigtails:
   1. General Specifications:

a. To maintain channel integrity, optical fiber patch cords and pigtails shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots and shall have the same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtails shall be available with the following options as specified or indicated:
b. Termination types: SC-APC
c. Connector/cable configuration: Simplex and duplex
d. Fire ratings: Riser, plenum and/or LSZH
e. Patch cord outside diameters: 1.6 millimeters (0.063 inches) and 3.0 millimeters (0.118 inches)
f. Pigtails: Ruggedized and tight-buffered optical fiber-0.9 millimeters (0.035 inches) outside diameter
g. Lengths: As specified or indicated
h. Approved Manufacturer: Leviton or in accordance with Section 1.4.B.

Q. Air Dielectric, Plenum Rated Cable:
1. Material Characteristics:
a. Jacket: Halogenated, Fire-Retardant
b. Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
c. Inner Conductor Material: Copper-Clad Aluminum Wire
d. Electrical Characteristics:
1) Impedance: 50 ± 2.0 Ω
2) Frequency Band: 1 - 8800 MHz
3) Peak Power Rating: ≥ 40.0 kW
e. Mechanical Characteristics:
1) Diameter Over Jacket: ≤ .627 in
2) Minimum Bending Radius: ≤ 5 in
3) One Time Minimum Bending Radius: ≤ 3 in
4) Attenuation Characteristics shall meet product specifications sheet
f. Approved Manufacturer: CommScope HL4RP-50A, HL4RPV-50A or equivalent, in accordance with Section 1.4.B

R. Foam Dielectric Cable:
1. Material Characteristics:
a. Jacket: Non-halogenated, Fire-Retardant Ployolefin
b. Outer Conductor Material: Corrugated Copper
c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
2. Electrical Characteristics:
a. Impedance: 50 ± 1.0 Ω
b. Frequency Band: 1/2" Nominal: 1 - 8800 MHz, 7/8" Nominal: 1 - 5000 MHz
c. Peak Power Rating: ≥ 40.0 kW
3. Mechanical Characteristics:
a. Diameter Over Jacket: 1/2" Nominal: ≤ .630 in, 7/8" Nominal: ≤ 1.1 in
b. Minimum Bending Radius: 1/2" Nominal: ≤ 5 in, 7/8" Nominal: ≤ 10 in
c. One Time Minimum Bending Radius: 1/2" Nominal: ≤ 2 in, 7/8" Nominal: ≤ 5 in
4. Attenuation Characteristics shall meet the product specification sheet

5. Approved Manufacturer: CommScope LDF4-50e or equivalent, in accordance with Section 1.4.B.

PART 3 - EXECUTION

3.1 INSTALLATION: GENERAL

A. DAS Active and Passive Components
   1. The System Integrator shall design, install, test, and commission in DAS solution including all the active and passive components in accordance with the manufacturer's published installation instructions and training.

B. Open Cable Support installation
   1. This System Integrator shall furnish and install all supports for cables specified in this section.
   2. Ensure complete raceway system is installed prior to cable installation. At no time shall cables be left unsupported
   3. Cable supports shall be spaced randomly, but no further than 5'-0" apart.
   4. Provide all additional cable management products, sleeves or conduit raceways as required to protect exposed cabling and complete the installation of cables in a neat manner.
   5. All floor penetrations shall be at columns, exterior walls or in equipment rooms.
   6. Cables shall be supported at height of the bottom flange of structural beams using a rigid support method (i.e. threaded rod, beam clamps, etc.).
   7. Do not support cables from ductwork, sprinkler piping, water piping, waste piping, conduit, ceiling wire, or other system supports.
   8. Provide independent support system for each low voltage cabling system.

C. Cable Installation
   1. All cables shall be loosely bundled using plenum rated ties or hook and loop fasteners, so as not to deform cable, no greater than 5'-0" on center (at mid-span).
   2. All cables shall be installed in accordance with manufacturers' written bend radius and pulling tensions. General industry guidelines recommend the following bend radius and pulling tensions:
      a. Tensile loading on a single 4-pair copper UTP cable shall not exceed 25 lbs.
      b. Bend radius of a single 4-pair copper unshielded twisted pair cable shall not exceed 4 times the diameter of the cable.
      c. Bend radius of multi-pair copper unshielded twisted pair and optical fiber cable shall not exceed 10 times the diameter of the cable.
   3. All conduits and conduit sleeves shall have bushings or grommets shall be installed prior to the installation of communications cables to avoid damage and abrasions to cable sheathing and insulation. If bushings have are installed by the electrical System Integrator, the communications cabling contract shall furnish and install bushings prior to pulling communications cabling.
   4. Horizontal cable length for 4-pair copper UTP cables shall not exceed 328 feet. Prior to bidding and installation, the contactor shall review the drawings and verify no cable run exceeds 328 feet. Exception of this requirement when using Cat-6A cabling from Leviton where the cable runs may not exceed 492 feet.
   5. Splices are not permitted in any copper cable.

6. Avoid placing copper cables near sources of extreme heat (i.e. boilers, radiators, heat coils).
7. Maintain cable twists for all UTP cables. For terminations cable sheathing shall be stripping back no more than ½" back from termination point for all Category 6 cables.
8. All cables shall be supported by cable tray, cable runway, or J-hooks. When cables leave trays or runways, cables shall be supported by drop-outs or cable support hardware manufactured specifically for the purpose of supporting cables. J-hooks shall be installed a minimum of every 5 feet and cabling shall maintain minimal deflection and strain (less than 12" deflection). Cables shall not be supported from ceiling grid wires. Cables shall not run above iron joists.
9. All cables shall be separated and bundled into like groups by cable sheathing colors.
10. Service loops shall be provided at both ends of installed horizontal and backbone cabling. A 12" service loop shall be installed in the ceiling space near workstation outlets (excessive cable shall not be coiled in outlet boxes). A 10' service loop shall be provided in communication rooms and shall be installed to allow for future equipment rack/cabinet relocations without the need to re-terminate patch panels; the 10' service loop shall be neatly bundled and secured in ceiling space with large D-rings or place in cable trays. Service loops should be created in a figure-8 or staggered oval loops.
11. Any cabling installing in equipment rooms shall be neatly placed in cabling trays, cabling runways, or horizontal and vertical rack/cabinet cable managers. When tray, runways, or cable managers are not specified, cable shall be neatly installed with D-rings. Cables shall always be installed vertically/horizontally or at right angles to structure.
12. Hook and loop fasteners are recommended to secure permanently installed horizontal and backbone cabling; all cable fastening methods installed in plenum ceiling spaces shall be rated for use in plenum spaces. Hook and loop fasteners shall never be secured too tight whereby potentially changing the cable geometry.
13. Separation: Maintain the following distances between cables, other system cables and other building systems:
    a. One (1) foot from fluorescent lights.
    b. Four (4) feet from motors and transformers
    c. Three (3) feet from hot water piping or other mechanical equipment.
    d. One (1) foot from electrical conduits, other systems cables or other electrical equipment.
14. All low voltage cables shall be run parallel or at right angles to building structural
15. framework. Do not run cables diagonally across ceiling space without written
16. authorization by the Architect's Electrical Engineer.
17. Fire seal around all cables running through rated floors and walls. UL Systems should
18. be contained in the submittal and available for review by building inspection.
19. H- straps shall be utilized in the TR and inside TC enclosures for all cable bundling. Tie
20. wraps shall be prohibited in the telecommunication rooms.
21. Leave spare pull string with every outlet installed.

22. All cabling that has been shipped or stored in an environment outside the manufacturer's recommended installation temperature range shall be conditioned per the manufacturer's recommendations immediately prior to installation.
23. All cables installed in underground conduit, conduit under slab on grade, or direct buried must be rated by the manufacturer for wet locations.

3.2 INSTALLATION: COMMUNICATIONS INFRASTRUCTURE

A. Category 6 Horizontal Cables:
   1. Maximum cable lengths to be 328 feet or 492 ft when using Cat-6A cabling, including service loop. Provide all necessary installation materials, tools and equipment to perform insulation displacement type terminations at all communications outlets, patch panels and 110 punch-down blocks. See exception in 3.1.B.5. Support and secure cables at patch panels using rear cable management bracket supplied with panel.

B. Optical Fiber Cable:
   1. All optical fiber installations shall be installed using open-cabling methods. Limit the cable-bending radius to 20 times the cable diameter during installation, and 10 times the diameter after installation. Provide all required tools, materials, consumables, and equipment necessary for cleaning and field termination of optical fiber connectors. Label each end of each cable as to source and destination. Terminate optical fibers in a consistent, consecutive manner at each end.
   2. Optical fiber cable terminations shall utilize enclosures and components in quantities consistent with the required fiber counts at each end of each segment. During field polish optical fiber connector termination, visually inspect all terminations with a 400-power microscope. Follow all of the connector manufacturer's recommendations. Unacceptable flaws in the terminations will include, but not limited to, scratches, full or partial cracks, bubbles, pits, epoxy residual, dirt, dust, oil, moisture, grinding and sanding debris. The acceptable termination will show a connector tip that is free of all imperfections in 100% of the core and 80% of the cladding. All unacceptable connectors shall be inspected after rework.
   3. During installation of optical fiber cable do not allow pulling tension to exceed cable manufacturer's specification for the cable being installed. Only the strength member of the cable shall be subjected to the pulling tension.
   4. All optical fiber connector tips shall be cleaned with proper cleaning tools specifically designed for optical fiber prior to inserting them into matting receptacles or bulkheads.

3.3 CLEANUP

A. The communications System Integrator shall clean up all debris-related communications cabling installation on a regular basis. Protect all equipment from damage during construction. Equipment not protected shall be replaced at the System Integrator's expense.

END OF SECTION

SECTION 280413 - COMMON SUBMITTAL REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes supplementary administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals specific to the work of this Division.

B. Related Requirements:
   1. Division 01 submittal requirements.

C. Manufacturers
   1. Unless otherwise noted, all telecommunications systems have manufacturers listed. The contractor is permitted to propose a substitution for an equivalent product.

D. System Integration Scope
   1. Contractor shall engage a master systems integrator for division 27 and 28 scopes of work. Contractor to include 1 FTE Support on Site for a two-week duration to assist with any training and operations support, starting from occupancy date. This scope of services is separate from and does not include the training and commissioning requirements identified in these specifications.
   2. Contractor to include scope and pricing for a professional quality video recording of the various training sessions referenced throughout and handover to IHS prior to project completion.

E. Warranty
   1. For all products and services included in Division 27 and 28 specifications, Contractor to include 1-year warranty and provide pricing for the same warranty services during years 2-5, broken out by year with pricing valid 1 year from project completion. IHS to advise on years 2-5 warranty procurement prior to the end of the 1-year period after project completion.

1.2 DEFINITIONS

A. Reference Division 01 for project definitions in addition to the below. Division 01 will supersede any conflicts.

B. Contractor: Refers to an entity in direct Contract with the Owner to furnish and/or perform any portion of the Work of the Contract, including but not limited to a Construction Manager.
   1. Contractor shall review and approve Product Submittals prior to forwarding them to the Architect.

C. Product Submittals: In general, Product Submittals show characteristics of the proposed construction in one of the following forms:
   1. Shop Drawings.
   2. Product Data.
   3. Samples.

D. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

E. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

F. Submittal Review Sheet: Specific form required to accompany each submittal. Obtain Submittal Review Sheet from the SmithGroup Project Manager.

1.3 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Requirements specified for submittals are intended to provide efficient handling, while permitting review responsibilities to be carried out.

B. Avoidable Resubmittals: The first two reviews of each specified submittal will be processed without cost to the Contractor. After the second review, the Owner may charge the Contractor for the cost of such additional processing, unless the processing results from approved Change Orders causing revisions to previously approved submittals.

C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
   4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   1. Initial Review: Allow 10 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required.
   2. When a large volume of submittal materials is scheduled, additional review time may be required. Similarly, a particular submittal may require review completion in less than the agreed normal time. Due to variations in submittal volume and processing needs, agreed review time is not intended to apply to extreme conditions.
   3. Resubmittal Review: Allow 10 business days for review of each resubmittal.
   4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 15 business days for initial review of each submittal.

E. Maintain at the Project Site ready access to the latest reviewed Shop Drawings and Product Data, and one set of samples.

1.4 DELEGATED-DESIGN SERVICES

A. Definitions:
   1. Delegated Design: A portion or component of the Work identified by the Contract Documents to be designed by the Contractor, or an entity assigned by the Contractor, to satisfy performance and design criteria specified in the Contract Documents for that portion or component.
   2. Registered Design Professional: Design professional, assigned by the Contractor, who is responsible for providing the delegated design work, and for certifying that the work is in compliance with the specified performance requirements and design criteria. Design professional shall be legally qualified to practice in jurisdiction where Project is located and shall be experienced in providing delegated design services of the kind indicated. Delegated design services are defined as those performed for installation of the system, assembly or product that are similar in material, design, and extent to those indicated for this Project.

B. 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 Architect.

C. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file copies of certificate, 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.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Combine with Submittal Review Sheet before submitting to Architect.

1. Submittal Compliance Form: Allowed in lieu of some product data and sample submittals. See individual specification sections for specific allowable use. By submitting the form, the Contractor certifies that all products specified in the Section are being submitted exactly as indicated, including all options and features indicated, with no substitutions or comparable products. Where a Basis-of-Design manufacturer/product is indicated, along with a list of other manufacturers, the Contractor certifies that only the Basis-of-Design manufacturer/product will be provided and not any other listed manufacturers/products. Where a single manufacturer/product is indicated, even if specified as "available manufacturer" or manufacturer "included but not limited to the following", Contractor certifies that only the indicated single manufacturer/product will be provided.
    a. Obtain a copy of the Submittal Compliance Form from the Architect, fill in the information required and include as a line item on the Submittal Cover Sheet for each applicable Submittal.
    b. Upon receipt, the Architect will complete the form in the space below "Architect Action" and indicate the Action on the Submittal Cover Sheet.

B. Project Closeout and Maintenance Material Submittals: See requirements in Division 01.

C. Be responsible for quantities, weights, and dimensions to be confirmed and correlated at the site; for information that pertains solely to the fabrication processes and to the means, methods, techniques, sequences, and procedures of construction; and for coordination of the work of every trade, supplier, and subcontractor.

D. Be responsible for each submittal to be in conformance with information given and the design intent expressed in the Contract Documents.

E. Provide with each submittal specific written notice of any variation from the requirements of the Contract Documents by causing a specific notation to be made on the Submittal Review Sheet and Submittal Transmittal.

3.2 ARCHITECT'S AND GENERAL CONTRACTOR'S ACTION

A. General: Architect will not review submittals that do not include the Submittal Review Sheet.

B. Action Submittals: Architect's staff and consultants will review the submittal, and mark the Submittal Review Sheet with an action code. The code meanings are described below.

C. Additional codes may be provided within comments or as an electronic submittal review stamp and shall be used in help indicating return of partial submittals.

D. The Final Review Code on the Submittal Review Sheet prevails and governs the action of the overall submittal.

E. Review Code meanings are as follows:
1. Action Codes Permitting Use:
    a. When an action code permitting use is assigned to a submittal, it does not authorize work that does not comply with the requirements of the Contract Documents. Acceptance of the Work will depend on compliance.

b. Code AP - Approved: The Work covered by the submittal item may proceed, provided it complies with Contract Document requirements.
c. Code AN - Approved as Noted: The Work covered by the submittal item may proceed, provided it complies with the Architect's notations and Contract Document requirements.
d. Code AN-R - Approved as Noted - Resubmit: Do not deliver or install the related work until the resubmittal has received Code AP or AN. However, fabrication and other off-site work covered by the submittal item may proceed, at the Contractor's risk, provided it complies with the Architect's notations and Contract Document requirements.

2. Action Code Prohibiting Use:
a. Action Code REJ - Not Approved: The Work covered by the submittal item, including purchasing, fabrication, delivery, and other activity, shall not proceed. Revise the submittal item or prepare a new item in accordance with the Architect's notations. Resubmit the corrected or new item without delay; do not permit submittal items marked "Not Approved" to be used. Work incorporating such items will be rejected.

3. Action Code for Items Not Required:
a. Action Code X - Not Requested by Contract Documents: The submittal item is not called for by the Contract Documents and is being returned unreviewed by the Architect except to the extent necessary to determine its status.

F. Informational Submittals: For Architect's information only. Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
1. Action Code for Information Only:
a. Action Code INF - Information Only - Received: The submittal item is not called for a return with a reviewed action code by the Contract Documents and is being returned un-reviewed by the Architect except to the extent necessary to determine its status.

G. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

H. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.

I. Architect will discard submittals received from sources other than the Contractor.

J. Submittals not required by the Contract Documents may be returned by the Architect without action.
1. Do not submit Material Safety Data Sheets. They will be returned without review.

3.3 SUBMITTAL TRANSMITTAL REQUIREMENTS

A. Submittal Transmittal shall be a PDF file in electronic format. It is recommended, to expedite the submittal review, the electronic form be emailed for review to the Architect as early as possible.
1. Submittal Numbering: See below.
2. Contact Information: Full Name, Phone Number and Email Address.

B. Submittal Definition

1. Each submittal consists of items from only ONE Specifications section.
2. Complete Submittal: If ALL the items required by the Specifications section are listed on one Submittal Form (including continuation sheet), it is a complete submittal.
3. Partial Submittals: If it is necessary to divide the required items of a given Specifications section into two or more submittals to meet schedule or handling requirements, the separate submittals are partial submittals. All partial submittals have the same submittal number, and are differentiated by sequential P-numbers (see below).
4. All items in each submittal, whether complete or partial, will be processed together: Individual items will not be 'broken out' for special handling. Arrange submittals accordingly.

C. Submittal Numbering
1. Number submittals as described below to assist tracking.
2. Number each submittal in the format nnnnnn-nn.
   a. The 6-digit number is the number of the section that requires the submittal. For example, 044200.
   b. The 2-digit number is based on the numerical sequence of submittals from that section. In other words, for each section, the first submittal is 01, the second is 02, and so on. The 2-digit number does not change for partial or re-submittals, so that the submittal can be tracked.
   c. P-Number for Partial Submittals: Number each partial submittal in the pee space, beginning with P1, and increasing by one for each partial submittal of that submittal. If the submittal is a complete submittal, leave the P space blank.
   d. R-Number for Re-submittals: Number each re-submittal in the arr space, beginning with R1, and increasing by one for each re-submittal of that submittal. Do not include an R-Number for the initial submittal.
   e. Examples:
      1) Initial Complete Submittal: 044200-01. First Re-Submittal: 044200-01-R1.
      2) Initial Partial Submittal: 044200-01-P1. Second Partial Submittal: 0044200-01-P2. First Re-submittal of Second Partial Submittal: 044200-R1-P2.

3.4 SUBMITTAL REVIEW SHEET REQUIREMENTS

A. Provide Submittal Review Sheet in PDF format. Submit as the page after the Submittal Transmittal.

B. When attached, the Submittal Review Sheet shall not obscure information contained in the submittal.

C. Do not edit any of the information contained within the Submittal Review Sheet except as follows:
1. Submittal Number: See Submittal Numbering in Submittal Transmittal Requirements paragraph.

D. The Contractor shall submit the PDF file in a manner that will allow editing of the Submittal Review Sheet fields by SmithGroup and its consultants.

END OF SECTION

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Low-voltage control cabling
2. Control-circuit conductors
3. RS-232 cabling
4. RS-485 cabling
5. Optical fiber cabling
6. Fire alarm wire and cable
7. Identification products

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.

B. This section is inclusive of all Division 28 sections.

C. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

D. Section 271500 "Communications Horizontal Cabling" for horizontal Category data cabling, fiber optic cabling, and coaxial cabling to support Division 28 Electronic Safety and Security Systems.

1.3 DEFINITIONS

A. Reference Division 01 for project definitions in addition to the below. Division 01 will supersede any conflicts.

B. BICSI: Building Industry Consulting Service International.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. Low-Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

F. Open Cabling: Passing cabling through open space, ie between studs of wall cavity.

G. TDMM: BICSI Telecommunications Distribution Methods Manual.

H. UTP: Unscreened (unshielded) twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

1.5 INFORMATIONAL SUBMITTALS

A. Operation and Maintenance Manuals (O&Ms).

B. Warranty Information.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Comply with requirements of Section 271500 "Communications Horizontal Cabling" for testing and certification or horizontal Category twisted pair cabling and fiber optic cabling.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.
   2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide low-voltage cabling for all Electronic Safety and Security Systems included in the Project.

B. Provide low-voltage cabling for each electronic safety and security component and application, as recommended by and in compliance with the respective system manufacturer.

C. 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.

D. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

E. For all installation applications of Project, provide cabling rated for the environment in which it is installed.

F. Security cable colors:
   1. Security cabling shall be yellow.
   2. Prior to procuring equipment, confirm all cable colors with owner.

G. Telecommunications Pathways and Spaces: Comply with TIA-569-E.

H. Grounding: Comply with TIA-607-D.

2.2 RS-232 CABLE

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. Belden
   2. West Penn Wire
   3. General Cable
   4. Windy City Wire
   5. Southwire

B. Cable Standards:
   1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
   2. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   3. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
   4. Flame Resistance: CM/CMG comply with UL 1581; CMP comply with NFPA 262.
   5. Rating Type: Comply with NFPA 70 for each installation application.

2.3 RS-485 CABLE

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. Belden
   2. West Penn Wire
   3. General Cable
   4. Windy City Wire
   5. Southwire

B. Cable Standards:
   1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
   2. Unshielded.
   3. Flame Resistance: CM/CMG comply with UL 1581; CMP comply with NFPA 262.
   4. Rating Type: Comply with NFPA 70 for each installation application.

2.4 LOW-VOLTAGE CONTROL AND POWER CABLES

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. Belden
   2. West Penn Wire
   3. Paige Datacom
   4. General Cable
   5. Windy City Wire
   6. Southwire

B. Cable Standards:
   1. Provide all necessary low-voltage control cabling, as recommended by system manufacturer.
   2. Provide all necessary low-voltage power cabling, as recommended by system manufacturer.

3. Flame Resistance: CM/CMG comply with UL 1581; CMP comply with NFPA 262.
4. Rating Type: Comply with NFPA 70 for each installation application.

2.5 LOW-VOLTAGE SECURITY ACCESS CONTROL COMPOSITE CABLES

A. Provide Access Control Composite Cable for each access controlled door, unless otherwise indicated on Drawings. Composite cable includes individual cables for: Access device, lock, door status, request-to-exit.

B. Reference Section 281300 "Access Control" for access device (reader) communication protocol requirement of Open Supervised Device Protocol (OSDP).

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. Belden
2. West Penn Wire
3. Paige Datacom
4. General Cable
5. Windy City Wire
6. Southwire

D. OSDP Access Control Composite Reader Cable (banana type):
1. OSDP composite cable as recommended by access control system manufacturer.
2. OSDP reader cable supports RS-485 as the underlying communication protocol.
3. Flame Resistance: CM/CMG comply with UL 1581; CMP comply with NFPA 262.
4. Rating Type: Comply with NFPA 70 for each installation application.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN complying with UL 83, in raceway; or power-limited cable complying with UL 83, concealed in building finishes.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.7 FIRE ALARM WIRE AND CABLE

A. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG; or larger size if recommended by system manufacturer.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

B. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.8 IDENTIFICATION PRODUCTS

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. Brady Worldwide
   2. Panduit
   3. HellermannTyton
   4. Kroy

B. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Factory test cables on reels for opens and shorts.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 LOW-VOLTAGE ELECTRONIC SECURITY WIRING METHODS

A. Routing:
   1. Cabling may be installed in accessible ceilings unenclosed, unless otherwise indicated on the Drawings.
   2. Install cable and conduit, concealed in accessible ceilings, walls, and floors where possible.
   3. Cabling may be installed unenclosed within consoles, cabinets, desks, and counters.
   4. In unfinished spaces, install cabling in conduit pathways; concealed in walls for new construction.
   5. Where installed within conduit, conduit size shall be minimum 3/4 inch, maximum conduit fill 40%.
   6. Refer to the Drawings for typical device conduit requirements.
   7. Control and data transmission wiring shall not share conduit with other building wiring systems.
   8. Install plenum cable in environmental air spaces, including plenum ceilings.
   9. For all installation applications, provide cabling rated for the environment in which it is installed.

B. Wiring within Enclosures:
   1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
   2. Install lacing bars and distribution spools.

3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
4. Install conductors parallel with or at right angles to sides and back of enclosure.
5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with security system to terminal blocks.
6. Mark each terminal according to system's wiring diagrams.
7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.2 INSTALLATION OF PATHWAYS

A. Comply with the following:
1. Section 280528 "Pathways for Electronic Safety and Security."
2. Section 260533 "Raceways and Boxes for Electrical Systems."
3. Section 260529 "Hangers and Supports for Electrical Systems."

B. Drawings indicate general arrangement and routing of primary cabling pathways.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:
1. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated terminals, consolidation or equipment enclosures.
3. Cables may not be spliced.
4. Secure and support cables not more than 6 inches from cabinets, boxes, fittings, racks, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. Open Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. J-hook installation: Suspend twisted pair cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart, and at each change in direction. Hook spacing shall allow no more than 6 inches of slack. Size J-hooks to allow a minimum of 25 percent future capacity without exceeding design capacity limits. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

F. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-E for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Section 260533 "Raceways and Boxes for Electrical Systems."
1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Conduit and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.

3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Class A Riser Circuits and Conduits: For fire alarm system requiring Class A wiring, install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: For fire alarm system requiring connection to a remote central-station transmitter device, provide 1-inchconduit between the fire alarm control panel and the transmitter. Supervised circuits are required for alarm and supervisory functions. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS

A. This section is inclusive of all Division 28 Electronic Safety and Security sections.

B. Comply with requirements of all included Division 28 Electronic Safety and Security sections.

3.7 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-E, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI TDMM.

3.8 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with requirements in Section 280526 "Grounding and Bonding for Electronic Safety and Security Systems."

3.9 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-C.

B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Cable Schedule: Install within each electronic security enclosure. List incoming and outgoing cables and their designations, origins, and destinations. Protect with clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project, which are aligned with the electronic security as-built drawings.

D. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination, where it is accessible in a cabinet or junction box.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number and identify each cable extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.10 FIELD QUALITY CONTROL

A. Perform the following inspections:
   1. Visually inspect low-voltage cable jacket materials for NRTL certification markings. Inspect cabling terminations within equipment panels and enclosures.
   2. Visually inspect low-voltage cable placement, cable termination, and labeling of cables.

B. Nonconforming Work:
   1. Cabling and terminations will be considered defective if it does not pass inspections.
   2. Correct terminations, or remove and replace cabling if required, to remedy deficient installation.

C. Assemble and submit inspection reports.

END OF SECTION

SECTION 280526 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.

1.2 RELATED DOUMENTS

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

B. This section is inclusive of all Division 28 sections.

1.3 DEFINITIONS

A. Reference Division 01 for additional project definitions. Division 01 supersedes any conflicts.

B. Signal Ground: The ground reference point designated by manufacturer of the system that is considered to have zero voltage.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: Division 28 Shop Drawings, as submitted under related sections, must include indication of grounding connections and typical details.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Division 28 As-Built Drawings, as submitted under related sections, which include indication of grounding connections and typical details.

PART 2 - PRODUCTS

2.1 CONDUCTORS

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. Harger Lightning and Grounding
   2. Panduit Corp
   3. Tyco Electronics Corp

B. Comply with UL 486A-486B.

C. Insulated Conductors:
   1. Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
   2. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

D. Bare Copper Conductors:
   1. Solid Conductors: Comply with ASTM B 3.

2. Stranded Conductors: Comply with ASTM B 8.
3. Tinned Conductors: Comply with ASTM B 33.
4. Bonding Conductor sizing: Refer to Part-3 Execution within for sizing requirements.

2.2 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

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. B-Line Systems
2. Burndy Corp
3. Chatsworth Products
4. Harger Lightning and Grounding
5. Panduit Corp

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING BUSBARS

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 Systems
2. Burndy Corp
3. Chatsworth Products
4. Harger Lightning and Grounding
5. Panduit Corp

B. Grounding Busbars: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inchesin cross section, 20" in length. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.
1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19-inchequipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 36 incheslong, with stainless-steel or copper-plated hardware for attachment to the rack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with IEEE 1100: Recommended Practice for Power and Grounding Electronic Equipment.
   1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
   2. Bond shields and drain conductors to ground at only one point in each circuit.

B. Signal Ground:
   1. For each system, establish the signal ground and label that location as such.
   2. Bond the signal ground to the alternating-current (ac) power system service by connecting to one of the following listed locations, using insulated No. 6 AWG stranded, Type THHN wire:
      a. Grounding bar in an electrical power panelboard if located in the same room or space as the signal ground.
      b. Telecommunications grounding busbar.

C. Comply with NECA 1: Good Workmanship in Electrical Construction.

3.2 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:
   1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
   2. Install without splices.
   3. Support at not more than 36-inch intervals.

3.3 CONNECTIONS

A. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

B. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.
   2. Pre-twist the conductor.
   3. Apply an antioxidant compound to all bolted and compression connections.

C. Shielded Cable: Where screened twisted-pair cables and/or coaxial cables are installed in communications rooms, bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

E. Ground system equipment and components as required, according to manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Refer to the following Sections:
   1. Section 014000: Quality Requirements, for retesting and reinspecting requirements.
   2. Section 017300: Execution, for requirements for correcting the Work.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 280528 - PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Hooks and hangers.
9. Wall and floor pathway devices.
10. Boxes, enclosures, and cabinets.
11. Handholes and boxes for exterior underground cabling

1.2 RELATED DOUMENTS

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

B. This section is inclusive of all Division 28 sections.

C. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

D. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

E. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

F. Section 270528 "Pathways for Communications Systems" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

1.3 DEFINITIONS

A. Reference Division 01 for additional project definitions. Division 01 supersedes any conflicts.

B. ARC: Aluminum rigid conduit.

C. EMT: Electrical metallic conduit.

D. ENT: Electrical non-metallic conduit.

E. GRC: Galvanized rigid steel conduit.

F. IMC: Intermediate metal conduit.

G. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

A. Product Data for the following:

1. Surface pathways.
2. Wireways and fittings.
3. Boxes, enclosures, and cabinets.
4. Underground handholes and boxes.
5. For each type of product to be used on Project.

B. Sustainable Design (LEED) Submittals, as applicable to Project:
1. Product Data for Credit IEQ 4.1: Documentation of printed statement indicating that solvent cements and adhesive primers have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: As applicable for custom enclosures and cabinets, and custom underground handholes or boxes. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway 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 pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer, if required per Section 014000.

C. Seismic Qualification Certificates: For pathways racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

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. AFC Cable Systems
   2. Allied Tube & Conduit
   3. Alpha Wire Company
   4. Anamet Electrical
   5. Electri-Flex Company
   6. O-Z/Gedney
   7. Picoma Industries
   8. Republic Conduit
   9. Robroy Industries
   10. Southwire Company
   11. Thomas & Betts Corp
   12. Western Tube and Conduit Corp
   13. Wheatland Tube Company

C. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-E.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. ARC: Comply with ANSI C80.5 and UL 6A.

F. IMC: Comply with ANSI C80.6 and UL 1242.

G. PVC-Coated Steel Conduit: PVC-coated GRC.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. FMC: Comply with UL 1; Zinc-coated steel.

J. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

K. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Compression.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch**,** with overlapping sleeves protecting threaded joints.

L. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

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. AFC Cable Systems
   2. Allied Tube & Conduit
   3. Anamet Electrical
   4. Arnco Corp
   5. CANTEX
   6. CertainTeed Corp
   7. Condux International
   8. Electri-Flex Company
   9. Kraloy
   10. Lamson & Sessions: Carlon
   11. Niedax-Kleinhuis USA
   12. RACO
   13. Thomas & Betts Corp

C. General Requirements for Nonmetallic Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-E.

D. ENT: Comply with NEMA TC 13 and UL 1653.

E. LFNC: Comply with UL 1660.

F. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

G. Rigid HDPE: Comply with UL 651A.

H. Continuous HDPE: Comply with UL 651B.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

L. Solvents and Adhesives: As recommended by conduit manufacturer.

M. Solvents and Adhesives for LEED projects, as applicable:
   1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

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. Alpha Wire Company
2. Arnco Corp
3. Dura-Line
4. Endot Industries.
5. IPEX USA
6. Lamson & Sessions: Carlon

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with TIA-569-E.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

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. B-Line Systems
2. Hoffman
3. Mono-Systems
4. Square D

C. General Requirements: Sheet metal, complying with UL 870 and NEMA 250, Type 1 (indoor) and Type 4 (outdoor), unless otherwise indicate on Drawings. 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.
2. Comply with TIA-569-E.

D. Fittings and Accessories: Include 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.

E. Wireway Covers: Screw-cover type unless otherwise indicated.

F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

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. Allied Moulded Products
2. Hoffman
3. Lamson & Sessions: Carlon
4. Niedax-Kleinhuis USA

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-E.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

F. Solvents and Adhesives for LEED projects, as applicable:
1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.6 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

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. Mono-Systems
2. Niedax-Kleinhuis USA
3. Panduit Corp
4. Wiremold / Legrand

C. Finish: Manufacturer's standard enamel finish in color selected by Architect.

D. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with TIA-569-E.

2.7 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

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. Lamson & Sessions: Carlon
2. Mono-Systems
3. Panduit Corp
4. Quazite: Hubbell Power Systems
5. Wiremold / Legrand

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with TIA-569-E.

2.8 HOOKS AND HANGERS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

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. MonoSystems
   2. Panduit Corp
   3. Wiremold / Legrand

C. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with TIA-569-E.

E. Galvanized steel.

F. J shape.

2.9 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

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. Adalet
   2. Cooper Crouse-Hinds
   3. EGS/Appleton Electric
   4. Erickson Electrical Equipment Company
   5. Hoffman
   6. Lamson & Sessions: Carlon
   7. Milbank Manufacturing Co
   8. Molex
   9. Mono-Systems
   10. O-Z/Gedney
   11. Quazite: Hubbell Power Systems
   12. RACO
   13. Robroy Industries
   14. Spring City Electrical Manufacturing Company
   15. Stahlin Non-Metallic Enclosures
   16. Thomas & Betts Corp
   17. Wiremold / Legrand

C. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-E.
   2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for use in wet locations.
   3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   4. Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep, unless otherwise indicated on Drawings.

5. Gangable boxes are allowed.

D. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 (indoor) and Type 4 (outdoor), unless otherwise indicated on Drawings. Provided with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures:
      a. Material: Plastic.
      b. Finished inside with radio-frequency-resistant paint, if indicated on Drawings.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:
   1. NEMA 250, Type 1 (indoor) and Type 4 (outdoor), unless otherwise indicated, 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.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      a. .

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway 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. Pathway locations include those such as:
   a. Loading docks.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
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. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
9. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inchtrade size for copper and aluminum cables; 1 inchfor optical-fiber cables; and 1 inchfor Category data cables. Refer to the Drawings for project specific conduit sizing requirements.

D. Pathway Fittings: Compatible with pathways 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 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. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-E for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NECA 105 and NECA 111 for cable tray systems, as applicable.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
   1. ANSI/BICSI N1-2019

F. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

G. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

H. Comply with requirements in Section 280544 "Sleeves and Sleeve Seals for Electronic Safe and Security Pathways and Cabling" for sleeves and sleeve seals for safety and security.

I. Arrange stub-ups so curved portions of bends are not visible above finished slab.

J. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

K. Conceal EMT conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

L. Support conduit within 12 inches of enclosures to which attached.

M. Pathways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-footintervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange pathways to keep a minimum of 1 inchof concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. When running ENT in slab, change from ENT to RNC Type EPC-40-PVC before rising above floor.

N. Stub-ups to above accessible, recessed ceilings:
   1. Use EMT for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

P. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install locknuts hand tight plus 1/4 turn more. Install insulated bushings on conduits terminated with locknuts.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

U. Surface Pathways:
1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inchradius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway sealing fittings according to NFPA 70.

X. Install devices to seal pathway 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 pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. 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 temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. 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.

AA. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feeton center.
5. Provide a hook at each change in direction.

BB. 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 center of box unless otherwise indicated.

CC. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EE. 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.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. 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 in Section 312000 "Earth Moving" for pipe less than 6 inchesin nominal diameter.
   2. Install backfill as specified in Section 312000 "Earth Moving."
   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 inchesof finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
      a. 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.
   5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inchsieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, as based on documented frost line for project site. Confirm frost line criteria with Architect.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors, per manufacturer instructions. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed. Cutting not required if conduits enter enclosure through open bottom or manufacturer-supplied openings through the sides.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 280544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 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

SECTION 280544 - SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Fire-rated self-seal pathways.
5. Grout.
6. Pourable sealants.
7. Foam sealants.

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.

B. This section is inclusive of all Division 27 sections.

C. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Sustainable Design Submittals, as applicable to Project:
1. Product Data for Credit IEQ 4.1: Documentation of printed statement indicating that solvent cements and adhesive primers have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. General, for exterior walls above and below grade:
1. When placing sleeve during new wall construction, provide steel or cast iron wall sleeves.
2. Where sleeves are required for penetrations of existing walls, provide non-flanged pipe sleeves made of standard Schedule 40 conduit cut flush at both sides of the wall.

B. Wall Sleeves, Steel:

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
   b. CCI Piping Systems
   c. Flexicraft Industries
   d. EnPro Industries: GPT
2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.2 SLEEVE SEAL SYSTEMS

A. Sleeve seal systems:
   1. For conduit penetrations in slabs-on-grade and in below-grade exterior walls, use sleeve seal systems.
   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. Advance Products & Systems
      b. BWM Company
      c. CALPICO
      d. Flexicraft Industries
      e. Metraflex Company
      f. Pipeline Seal and Insulator
      g. Proco Products

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.
   1. Provide sleeve-seal fittings as required for the application.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Where hydrocarbons are present in soil, use Nitrile (Buna N) rubber gasket material.
   3. Include type and number required for pipe material and size of pipe.
   4. Pressure Plates: Carbon steel.
   5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 FIRE-RATED, SELF-SEAL PATHWAYS

A. Fire-rated, self-seal pathways:
   1. Provide fire-rated, self-sealing pathway device system(s), where indicated on Drawings.
   2. May be installed in horizontal wall partitions or floor slabs as vertical cable pathway.
   3. Installed devices must meet fire-rating of application for which it is installed.
   4. 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. STI Firestop: EZ Path
      b. Hilti
   5. Description:
      a. Self-sealing firestop system, available in modular, gangable design.

b. Offer both fire-rated and non-fire-rated devices.
c. Allow for ease of cable modification (adds, changes) following initial installation.

2.4 GROUT

A. Grout for sealing of conduit or cable penetrations.

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. WR Meadows

C. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

D. Sustainability Criteria for LEED projects, as applicable:
1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.5 POURABLE SEALANTS

A. Pourable sealants may only be used as an alternate to sealing of conduit or cable penetrations where permitted by applicable codes and local AHJ.

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. Carlisle SynTec
2. GAF
3. Johns Manville

C. Description: Single-component, 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.

D. Sustainability Criteria for LEED projects, as applicable:
1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

2.6 FOAM SEALANTS

A. Foam sealants may only be used as an alternate to sealing of conduit or cable penetrations where permitted by applicable codes and local AHJ.

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. Dow Chemical Company.
2. Innovative Chemical Products

C. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

D. Sustainability Criteria for LEED projects, as applicable:
   1. Refer to requirements identified under Action Submittals for LEED Sustainable Design projects.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1 and TIA-569-E for installation requirements except where requirements on Drawings or in this section are stricter.

B. 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 space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
      b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   2. Use round pipe sleeves unless penetration arrangement requires rectangular sleeved opening, or is otherwise indicated on the Drawings.
   3. Size pipe sleeves to provide 1/4-inchannular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
   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.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inchannular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:
   1. For new construction, install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inchannular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeves during construction of floor or wall.

2. For existing walls requiring core drill, install steel pipe sleeves. Size sleeves to allow for 1-inchannular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Install sleeve-seal fittings in new walls and slabs as they are constructed.

D. 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.

E. Secure nailing flanges to concrete forms.

F. Using grout, seal the space around outside of sleeve-seal fittings.

G. Install devices per manufacturer written instructions.

3.4 INSTALLATION OF FIRE-RATED SELF-SEAL PATHWAYS

A. Install fire-rated, self-sealing pathway devices where indicated on Drawings.

B. Comply with NECA 1 and TIA-569-E for installation requirements.

C. Installed devices must meet fire-rating of application for which it is installed.

D. Install devices per manufacturer written instructions.

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION

SECTION 280800 – ELECTRONIC SAFETY AND SECURITY SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the contractor is partially responsible to execute, is defined in SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) contracted by IHS will manage the commissioning process.

B. Related Sections:
   1. The requirements of this Section apply to all Sections of Division 28
   2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
   3. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

1.2 DEFINITIONS

A. Refer to SECTION 01 91 13 GENERAL COMMISSIONING REQUIREMENTS, for definitions.

1.3 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 28 is part of the construction process. Documentation and testing of these systems, as well as training of O&M personnel in accordance with the requirements of Division 01 and 28 Sections, is required in cooperation with the IHS and CxA.

B. The ELECTRONIC SAFETY AND SECURITY Systems Commissioning will include the systems listed in SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

1.4 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The CxA will provide a list of Submittals earmarked for CxA review. This list will be reviewed and approved by IHS prior to sharing with the contractor. Refer to SECTION 01 33 00 – SUBMITTAL PROCEDURES for further details.

B. The commissioning process requires Cx Submittal review simultaneous to A/E Submittal review. Specific submittal requirements related to the Commissioning Process are specified in SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 START-UP AND CONSTRUCTION INSPECTIONS

A. General. Commissioning of the Building Electronic Safety and Security Systems will require inspection of individual elements of the Electronic Safety and Security System construction throughout the construction period. The Contractor shall coordinate with the CxA in accordance with SECTION 01 91 13 – GENERAL COMMISSIONING

REQUIREMENTS and the Commissioning Plan to schedule inspections as required to support the commissioning process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. General. Pre-functional Checklists are developed and completed for all major equipment and systems being commissioned. The checklist captures equipment nameplate and characteristics data, confirming the as-built status of the equipment or system. These checklists also ensure that the systems are complete and operational, so that the functional performance testing can be scheduled. The checklists are drafted by the CxA and completed (filled out) by the installing Contractor.

B. Review. Upon notification of checklist completion, the CxA and IHS will review the Pre-Functional Checklists for accuracy. If the CxA or IHS determine that the information provided on a checklist is not accurate, the marked-up checklist will be returned to the Contractor for correction and resubmission. An item be added to the Commissioning Issue Log (CIL) to track the deficiency.

If the CxA or IHS determine that a significant number of completed checklists for similar equipment are not accurate, all the checklists for the equipment type will be returned to the Contractor for correction and resubmission.

Refer to SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

3.3 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. In general, each system should be operated through all modes of operation where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure,, equipment failure, alarm processing and handling, prioritization, interaction with connected systems, etc. shall also be tested.

B. Development of Test Procedures. Before test procedures are written, the CxA 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 CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA shall review contracted or factory testing which the CxA is not responsible to oversee and shall determine what further testing may be required to comply with the Contract Documents. Redundancy of testing shall be minimized.

C. 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 the control system's data logging and historian capabilities and/or by stand-alone data recorders. The CxA will determine the most appropriate methods to be used.
   2. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor

executing the test shall provide all necessary materials, system modifications, etc. to produce or simulate the necessary conditions, etc. necessary to execute the test to meet the required conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

3. Sampling. Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy will be developed by the CxA and approved by the Owner's Representative. For details on Sampling, refer to the Commissioning Plan. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units are tested at the Contractor's expense. Sampling of Life Safety Systems and Building Security Systems – including Intrusion Detection Systems, Access Control Systems and Video Surveillance Systems is NOT permitted.

D. Coordination and Scheduling. The Contractor shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the Owner's Representative. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractor shall execute the tests.

E. Problem Solving. The CxA will recommend solutions to problems found; however, the burden of responsibility to solve, correct, and retest problems lie with the Contractor and their subcontractors.

3.4 O&M PERSONNEL TRAINING REQUIREMENTS

A. Training Plans: Contractor shall develop an instructional program that includes individual training modules for each system, subsystem, and equipment as specified in SECTION 01 79 00 – DEMONSTRATION AND TRAINING.

B. The minimum training requirements for Electronic Safety and Security Systems are specified in technical sections.

C. The CxA shall review and provide comment on the training plans developed by the contractor for alignment with the requirements of the OPR and BOD.

-- END OF SECTION --

SECTION 281300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Access control and alarm management system.
2. System server and client stations.
3. System access control panels.
4. Card readers and access devices.
5. Integrated Reader-Locks
6. Door Contacts
7. Duress and alarm devices.
8. Intrusion detection system.
9. Video intercom system.
10. Emergency call blue light stations.
11. Ancillary devices and interfaces.
12. Cabling for Security Systems

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.

B. This section is inclusive of Division 08 Door Hardware specification and Architectural door schedule.

C. Section 014000 - Quality Requirements.

D. Section 260533 "Raceways and Boxes for Electrical Systems."

E. This section is inclusive of all Division 27 Communications specification sections.

F. This section is inclusive of all Division 28 sections.

G. Section 078413 "Penetration Firestopping."

H. Section 142000 Vertical Transportation specification.

I. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

J. Design Binder #4 - System Integration Matrix.

K. Owner Security Standards:
1. FGI Guidelines for the Design and Construction of Hospitals (2022).
2. FGI Guidelines for the Design and Construction of Outpatient Facilities (2022).
3. IAHSS Security Design Guidelines for Healthcare Facilities 3rd Edition.
4. IAHSS Healthcare Security Industry Guidelines 13th Edition.
5. The Joint Commission Planning, Design, and Construction of Health Care Facilities 4th Edition.
6. Refer to owner security standards, as applicable to the Project.

L. Professional Services
1. Each bidder shall review the professional services scope of work document, associated costs, and all other relevant sections of this specification that require professional services. This review is a mandatory component of the bid response. To ensure compliance, each bid must include a completed and signed Professional Services Compliance Checklist, attached to this bid document.

1.3 DEFINITIONS

A. Reference Division 01 for additional project definitions. Division 01 supersedes any conflicts.

B. Abbreviations and Acronyms:
1. ACAMS: Access Control and Alarm Management System; aka ACS.
2. ACS: Access Control System; aka ACAMS.
3. AES: Advanced Encryption Standard.
4. API: Application Protocol Interface.
5. CA: Certificate Authority.
6. CPU: Central Processing Unit.
7. EULA: End User License Agreement.
8. FIPS: Federal Information Processing Standards.
9. GUI: Graphic User Interface.
10. HSS: High Security Switch (HSS).
11. HTML: Hyper Text Markup Language.
12. HTTPS: Hyper Text Transfer Protocol Secure.
13. IDS: Intrusion Detection System.
14. IPS: Infant Protection System.
15. I/O: Input/Output.
16. IP: Internet Protocol.
17. LAN: Local Area Network.
18. NTP: Network Time Protocol.
19. OSDP: Open Supervised Device Protocol.
20. PIV: Personal Identity Verification.
21. RAID: Redundant Array of Independent Disks.
22. RF: Radio Frequency.
23. RTE: Request to Exit.
24. RTSP: Real Time Streaming Protocol.
25. SDK: Software Development Kit.
26. SMS: Security Management System; aka ACS, ACAMS.
27. SOAP: Services Oriented Architecture Protocol.
28. TCP/IP: Transmission Control Protocol / Internet Protocol.
29. UPnP: Universal Plug and Play.
30. UPS: Uninterruptible Power Supply.
31. VI: Video Intercoms.
32. VMS: Video Management System.
33. WAN: Wide Area Network.

C. Descriptions:
1. Application Programming Interface (API): Set of clearly defined methods of communication between various software components.

2. Archived Media Storage: Secondary media storage used for storing video, audio and metadata beyond an initial retention period.
3. Authentication: Process that establishes the origin of information or determines an entity's identity.
4. Authorization: Process that associates permission to access a resource or asset with a person and the person's identifier(s) for the purpose of granting or denying access.
5. Bit Rate: Number of bits per time unit sent over a network.
6. Central Processing Unit (CPU): General purpose electronic circuitry within a computer that carries out the instructions of a computer program, typically contained in a single integrated circuit chip.
7. Graphical User Interface (GUI): A visual way of interacting with a computer using items such as windows, icons.
8. Intrinsic safety: A protection method used in hazardous locations to prevent explosions and ensure safety. The principle behind intrinsic safety is to limit the energy in an electrical circuit under both normal and fault conditions so that any spark or thermal effect produced is incapable of causing ignition of a hazardous material.
9. Kerberos: Ticket-based network authentication protocol designed to provide strong authentication for client/server or server/server applications.
10. Lock Down: Function used to enhance security by quickly securing a facility in response to a threat or emergency.
11. Universal Plug and Play (UPnP): Set of networking protocols that permits networked devices, such as personal computers, printers, Internet gateways, Wi-Fi access points, IP video cameras and mobile devices to seamlessly discover each other's presence on the network and establish functional network services for data sharing and communications.
12. Manufacture's Professional Services: Services offered by the manufacturer of the access control system designed to ensure the effective deployment and operation of the installed solution. These often include:
    a. System Design and Planning
    b. Installation and configuration
    c. Testing and support
    d. Integration Services

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project.

B. Shop Drawings: Include device floor plans, one-line diagrams, network interfaces, block diagrams, riser diagrams, controller wiring details, battery calculations, security door rough-in details, and typical device details.

C. Sustainable Design Submittals, if applicable to Project.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
1. Installer certification from access control system manufacturer.
2. Manufacturer certifications for technicians and installation supervisor.
3. Manufacturer certification for API interface software, as applicable.

B. Field quality-control reports.

C. Test Reports: Submit the following reports directly to Project Manager from Manufacturer's Quality Control Inspector, with copy to Contractor. Prepare reports in conformance with Section 014000 - Quality Requirements:
   1. Testing plan.
   2. Pre-test.
   3. Acceptance test.

1.6 CLOSEOUT SUBMITTALS

A. Closeout Documentation:
   1. Operation and Maintenance Data: Include data for each type of product, including features, testing plan and operating sequences, both automatic and manual. Include user's software data and recommendations for spare parts to be stocked at the site. Provide names, addresses, and telephone numbers of service organizations that stock repair parts for the system.
   2. Project Record Documents: Record actual locations of equipment and devices, and routing of alarm wiring.
   3. Licensing
      a. Software
      b. Hardware
      c. Firmware
      d. Operational/ User
      e. Administrative
   4. Completed Readiness Checklist.
   5. Final Test Result Report.
   6. As-Built Drawings.
   7. Operation and Maintenance Manuals (O&Ms).
   8. Warranty Information.

1.7 QUALITY ASSURANCE

A. Installer/Contractor Qualifications:
   1. Installer must be certified by the access control system manufacturer to design and install the provided system.
   2. Installer must have certified technicians and project supervisor certified by the access control system manufacturer to install the provided system.
   3. Minimum 5 years' experience of satisfactory performance on projects of similar size and scope. Provide owner with references upon request. Prime system manufacturer and manufacturers of major system components required to qualify separately.
   4. Installers shall be licensed where required by state or county.

B. All supplied equipment shall be current models in production by manufacturer. If any items listed within are no longer produced, notify Architect of the planned substitution with the most current equivalent product.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Facility Management Compliance: Provide RPM-approved access control systems and components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Servers, CPUs, Controllers, Printers and consumables
   1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
   2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Do not deliver or install equipment until HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.10 COORDINATION

A. Coordinate access control and security door conduit pathway requirements with door hardware set equipment listed in Div-08 door hardware specification.

B. Coordinate security conduit pathway requirements with EC and GC prior to rough-in work.

C. Coordinate telecom data cabling requirements with Division 27 structured cabling contractor.

D. Coordinate security installation and commissioning requirements with owner security personnel.

E. Coordinate security equipment networking requirements with owner IT personnel.
   1. Equipment and devices will communicate over owner LAN, via owner provided PoE switches.
   2. Assemble and maintain an IP security device schedule, itemizing data port quantities, locations, and other networking requirements, for coordination with owner IT during installation.

F. Coordinate fire alarm control relay connection requirements with fire alarm supplier, for stair doors and other code required fail-safe doors which must release upon fire alarm or loss of building power.

G. Coordinate elevator cab devices and floor control interface requirements with elevator supplier.

H. Coordinate vehicle gate control interface requirements with vehicle equipment supplier.

I. Coordinate overhead door interface requirements with equipment supplier.

J. Coordinate powered door opener/operator interface with the GC and EC.

1.11 WARRANTY

A. Warranty Period: Provide one (1) year warranty from date of Substantial Completion on all parts and installation.

PART 2 - PRODUCTS

A. ACCESS CONTROL AND ALARM MANAGEMENT SYSTEM MANUFACTURER
   1. The manufacturer shall have regularly produced, as one of the manufacturer's principal products, an Access Control and Alarm Management System (ACAMS) similar to that specified for this project for at least ten (10) years.
   2. Proposed product substitutions must conform to the functional requirements of this specifications document. System architectural differences are acceptable as long as functional requirements are met under alternate architecture.
   3. Access Control and Alarm Management System, Basis-of-Design Product: Subject to compliance with requirements, the SMS shall be the Avigilon Unity on-premise access control solution. The hardware manufacturer shall be an ISO 9001:2000 registered company.

B. **System Description**:
   1. Provide a complete, operational, turn-key ACAMS system, as indicated on the Drawings and Specifications. Provide all necessary equipment, cabling, installation, software, licensing, configuration, programming, and commissioning.
   2. The ACAMS must be capable of supporting an unrestricted number of users, devices, servers, and sites, with options for central administration and monitoring operations and mobile devices.
   3. System equipment and installation must comply with all provisions and requirements of this specification as well as all applicable national, state, and local codes and standards.

C. **Integration Requirements**:
   1. Video Management System (VMS) Integration:
      a. Provide API integration of the Video Management System into the Access Control and Alarm Management System (the primary security management platform), refer to Section 282300 Video Surveillance.
      b. Automated video alarm verification via video call-up shall occur based on an alarm event with the nearest camera. Coordinate security alarm automatic camera call-up functional requirements with the owner during system configuration and programming.
   2. Motorola Radio Solution Integration:
      a. The ACAMS must integrate seamlessly with Motorola Radio solutions to ensure effective communication and coordination during security operations.
      b. Provide necessary hardware, software, and configuration to enable integration with Motorola Radio systems, ensuring real-time communication and alerting capabilities.

3. Infant Protection System Integration (IPS): The ACAMS must integrate seamlessly with infant protection system to provide an output based on a two-factor access granted with the additional functionality to override the IPS or clear an active IPS alarm at a door with an IPS installed.
4. Synchronized Clocks Integration: The ACAMS shall utilize the synchronized clocks to obtain system time for all components.
5. Fire Alarm Integration: THE ACAMS system shall be seamlessly integrated with the Fire Alarm System through the use of fire relays to:
   a. Override delayed egress hardware in the event of an active fire alarm.
   b. Intercept power from the ACAMS lockset forcing a door unlock event in the event of an active fire alarm.

D. System Components:

1. Server:
   a. With operating system and applications software.
2. Client Stations:
   a. Operator and administrator station, with appropriate software.
3. Access Devices:
   a. Communicate with field panels using a dedicated cable infrastructure.
4. Controllers / Field Panels:
   a. Communicate to server through fast Ethernet TCP/IP network.
5. Growth and Scalability:
   a. Capable of entry-level system to enterprise system by increasing CPU power, memory, database, and/or software.
6. Modular Nature:
   a. Expand system capacities without major changes to system operation.
7. Defined System Data:
   a. Maintain historical information.
8. Customizable User Interfaces:
   a. Manage system information and activity for administrators and operators.
9. Encryption:
   a. Support FIPS 197-listed AES 256-bit encryption between server and client stations, and controllers, field panels.
10. ISO Certification:
    a. System hardware manufactured by an ISO 9001:2000 registered company.
11. ID Card Badging:
    a. Capable of ID card badging using client station GUI for badge design.

2.2 SYSTEM DESCRIPTION

A. Access Control and Alarm Management System (ACAMS): Provide a complete, operational, turn-key ACAMS system, as indicated on the Drawings and Specifications. Provide all necessary equipment, cabling, installation, software, licensing, configuration, programming, and commissioning. Including termination of wires and programming of card reader locks and exit device card reader lever trim included in section 087100.

B. The ACAMS must be capable of supporting an unrestricted number of users, devices, servers and sites, with options for central administration and monitoring operations and mobile devices.

C. System equipment and installation must comply with all provisions and requirements of this specification as well as all applicable national, state and local codes and standards.

D. The ACAMS shall be an integrated system utilizing a single, industry-standard relational database management system for storage and manipulation of related data, including the following primary components and criteria:
   1. Server: With operating system and applications software.
   2. Client stations: Operator and administrator station, with appropriate software.
   3. Access devices: Communicate with field panels using a dedicated cable infrastructure.
   4. Controllers / field panels: Communicate to server through fast Ethernet TCP/IP network.
   5. Growth and scalability: Capable of entry-level system to enterprise system by increasing CPU power, memory, database, and/or software.
   6. Modular in nature, expand system capacities without major changes to system operation.
   7. Defined system data and historical information to be maintained.
   8. Customizable user interfaces for the management of system information and activity for administrators and operators.
   9. Support FIPS 197-listed AES 256-bit encryption between server and client stations, and controllers, field panels.
   10. System hardware manufactured by an ISO 9001:2000 registered company.
   11. Capable of ID card badging using client station GUI for badge design.
   12. Capable of enrollment of government issued PIV class credentials and their use at facility card readers.

E. The ACAMS solution shall provide the following:
   1. Be an enterprise-level solution, providing flexible command and control functionality. System must be sustainable, flexible, and capable of expansion.
   2. Be managed centrally and offer both thick client and thin client web-based monitoring and control capabilities. Password-protected operator login and access.
   3. Multiuser and multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
   4. Graphical user interface software shall manage devices, control functions, and alarm monitoring.
   5. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of Microsoft Windows.
   6. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows. Open-database-connectivity compliant.
   7. System must be capable of API integration with industry standard, open architecture third-party solutions and devices.
   8. Alarm integration for VMS camera call-up:
      a. Provide API integration of the Video Management System into the Access Control and Alarm Management System (the primary security management platform), refer to Section 282300 Video Surveillance.
      b. Coordinate security alarm automatic camera call-up functional requirements with owner during system configuration and programming.

9. The system must provide robust cyber security protection, including industry standard certifications, and offer manufacturer cyber security hardening guide.
10. Cyber security protection:
    a. Custom certificate management, configurable by end-users.
    b. Encrypt data both at rest and in transit.
    c. Support at minimum TLS 1.2 encryption.
    d. No backdoor and/or default passwords. Passwords set only by customer or installer.
    e. Offer Role Based Access Control authorizations.
    f. Enforce unapproved login protections. Limit the number of log on attempts.
    g. Obfuscate all passwords while being typed.
    h. Users can change passwords without administrator assistance.
    i. Contain rules that govern password formation, expiration, reuse, and other restrictions.
    j. Support active directory integration and management of user accounts.
    k. Automatically log users out after a period of inactivity.
    l. Log all security events, user actions, and diagnostic logs.
    m. Compatible with an encrypted database.
    n. Compatible with high availability or disaster recovery solutions.
11. Support for HSPD-12 FIPS 201 PIV criteria:
    a. Customize a system-wide Card Holder Unique Identification number (CHUID).
    b. Use Hashed Message Authentication Codes (HMAC) for medium assurance profile.
    c. Enhanced data fields per FIPS 201 standard, including Agency Code, System Code, Credential Series and Credential Issue Code.

2.3 SYSTEM OPERATION

A. The ACAMS provides the following general operational functionality:
1. Control access to a designated area.
2. Validate Cardholder Credentials: Use downloaded personnel records, card formats, PINs, biometric enrollment, and multiple active cards. Compare time, location, and unique credential number of an attempted entry with information stored in memory.
3. Access to a Designated Area: Validated when a user's credential has a valid number for its facility and number is valid for current time and for reader where it is used.
4. System accesses hardware that validates the person and monitors security of a building by use of controllers, doors, readers, elevators, inputs, and outputs. When access is validated, a signal activates the door locking device enabling alarm-free access at that location.
5. Configures itself as required with client workstations. Provides configuration templates.
6. Monitors access control activities using client workstations, alarm notifications screens, dynamic graphical maps displays, door and event activity, and integration with the security video system.
7. Restricts administrative and monitoring activities by use of user authentication and privileges.

8. Reports on various aspects of system by use of reports, canned and configurable. Reports are exportable to PDF or printer.
9. Report off-normal security device conditions both audibly and visually.
10. Control hardware from client stations using manual actions, events, and cause lists.
11. Record and data management by use of historical journal archive to provide full audit trail.
12. Data can be imported from other manufacturers and products using database migration tools, such as card holder data from 3rd party applications using XML formatted data exchange.
13. Maintain an accurate system time for servers, workstations and controllers through the use of an externally sourced a NTP time server integration.

B. ACAMS Parameters:
1. Single server capabilities:
   a. Online readers: 5,000.
   b. Online inputs: 20,000.
   c. Online outputs: 20,000.
   d. Enabled personnel records: 1,000,000.
   e. Simultaneous clients: 100.
2. Enterprise architecture capabilities:
   a. Enterprise server:
      1) Satellite servers: 60.
      2) Global enabled personnel records: 1,000,000.
      3) Simultaneous clients: 100.
   b. Online readers: 200,000.
   c. Online inputs: 800,000.
   d. Online outputs: 800,000.
   e. Local enabled personnel records: 20,000,000.
   f. Global enabled personnel records: 500,000.

C. Distributed Processing: A fully distributed processing system.
1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
2. Intermediate controllers for access control are prohibited.
3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the server.

D. System Network Requirements:
1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.

E. The server shall manage client station operator interface, interaction, display, control, and dynamic and real-time monitoring. Server shall control system networks to interconnect all system components, including client workstations and field installed controllers.

F. Field equipment shall include controllers, sensors, and controls.
   1. Controllers shall serve as an interface between the server and sensors and controls.
   2. Data exchange between the server and the controllers shall include down-line transmission of commands, software, and databases to controllers.
   3. The up-line data exchange from the controller to the server shall include status data such as intrusion alarms, status reports, and entry-control records.
   4. Controllers are classified as alarm-annunciation or entry-control type.

G. System Response to Alarms:
   1. Field device network shall provide a system end-to-end response time of one second or less for every device connected to the system.
   2. Alarms shall be annunciated at the client workstation within one second of the alarm occurring at a controller or at a device controlled by a local controller.
   3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the server.
   4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
   5. This response time shall be maintained during system heavy load.

H. False-Alarm Reduction: The design of the server and controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

I. Error Detection:
   1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the server.
   2. Interactive or product error-detection codes alone will not be acceptable.
   3. A message shall be in error if one bit is received incorrectly.
   4. Retransmit messages with detected errors.
   5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
   6. Server shall generate a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
   7. Monitor the frequency of data transmission failure for display and logging.

J. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

K. Door Hardware Interface:
   1. Comply with requirements in Division 08 Door Hardware for door hardware required to be monitored or controlled by the security access system.
   2. Include termination of wires and programing of card reader locks and exit device card reader lever trim included in Section 087100. Note quick connect wiring harnesses will be installed in the door and the frame under section 087100. Wires above the frame will need to be terminated under this section.

3. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

2.4 SYSTEM APPLICATION SOFTWARE

A. Client Workstation Software:
   1. System users may administer Access Control and Alarm Management System from:
      a. ACAMS client workstations with thick client software application.
      b. Thick client software application loaded on owner workstations.
      c. Brower-based (web-based) thin client application.
      d. Mobile device client application.

B. Controller Software:
   1. Controllers shall operate as autonomous, intelligent processing units.
      a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
      b. Controllers shall be part of a fully distributed processing-control network.
      c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.
   2. Individual Controller Operation:
      a. Controllers shall transmit alarms, status changes, and other data to the server when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the server, shall be stored for later transmission to the server. Storage capacity for the latest 1024 events shall be provided at each controller.
      b. Card-reader ports of a controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
      c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
      d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
      e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
      f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
      g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.

h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the server.
i. Controllers shall be equipped with an integrated interlock to create an alarm event when the enclosure door is opened.

C. Server to Controller Communications:
1. Server database communications shall use the following:
a. Fast Ethernet TCP/IP LAN protocol.

D. Security:
1. Manufacturer system hardening guide which:
a. Describes data security, network security and physical security measures and best practices for securing the installed ACAMS against cyber-attacks. This includes security considerations for the hardware and software of servers, clients and network device components of an access control and alarm management system.
b. Incorporates standards-based and best-practice-based security and privacy controls and maps them to each hardening recommendation.

2.5 SYSTEM DATABASE

A. Access Card Operation and Management: Access authorization shall be by access control credential card.
1. Access authorization shall verify the facility code first, the card validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visible annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only at particular doors.
11. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9999 that regulates the number of times the card can be used before it is automatically deactivated.

12. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

2.6 SYSTEM SERVER

A. Provide ACAMS system server(s), where indicated on Drawings.

B. General Criteria:
   1. Provide all associated hardware, software, and licensing as required.
   2. Meet or exceed minimum technical requirements as recommended by ACAMS manufacturer.
   3. Be sized and configured to manage all access control readers, alarm devices, and security devices, as indicated on the Drawings, and be capable of expansion.
   4. Be rack mount server; coordinate final rack location in equipment room with owner IT.
   5. Basis-of-Design Server:
      a. Rack mount server, manufacturer branded.
      b. Be procured directly from the ACAMS manufacturer.
      c. Minimum technical specifications, as recommended by manufacturer.
      d. Supplied with software, configuration, and licensing, specific to the Project.

C. Back-Up Power:
   1. Provide rack mount, dedicated security UPS unit to support the server.
   2. Sized to provide eight-hour runtime at normal load. Runtime can be reduced to 30 minutes if line voltage power is supplied by back-up emergency generator.
   3. Basis-of-Design Product:
      a. APC Smart-UPS series products.

2.7 CLIENT WORKSTATIONS

A. Provide ACAMS system client workstation(s), where indicated on Drawings.

B. Client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package.

C. Hardware shall be one in the same with VMS Client Workstation(s), refer to section 282300.

D. General Criteria:
   1. Provide all hardware, software, and licensing as required.
   2. Meet or exceed minimum technical requirements as recommended by ACAMS and VMS manufacturers.
   3. Be tower style workstation; coordinate final location with owner.
   4. Basis-of-Design Workstation:
      a. Minimum technical specifications, as recommended by manufacturer.
      b. Supplied with software, configuration, and licensing, specific to the Project.
      c. Refer to section 282300, Client Workstations.
   5. Display Monitors:
      a. Provide (2) 24" monitors with each client station.

b. 16:9 aspect ratio; 1920x1080 resolution.
c. Utilize HDMI or DP video input.
d. Utilize VESA mounting capability.
e. Basis-of-Design Product:
1) Bosch UML-245-90
2) Beetronics 24HD7M.

E. Back-Up Power:
1. Provide tower style, dedicated security UPS unit to support each workstation.
2. Sized to provide four-hour runtime at normal load. Runtime can be reduced to 30 minutes if line voltage power is supplied by back-up emergency generator.
3. Basis-of-Design Product:
a. APC Smart-UPS series products.

F. Additional ACAMS Monitoring Applications:
1. Thick client software installed on owner provided PC (meeting manufacturer min spec):
a. Provide and install client software on up to (2) owner workstations.
2. System shall be capable to support and provide:
a. Brower-based (web-based) thin client application.
b. Mobile device client application.

2.8 BADGING STATION

A. The SMS shall include an embedded ID Badging Subsystem. The ID Badging subsystem shall utilize a common database with and be an integral part of the SMS. The ID Badging Subsystem shall provide the ability to capture cardholder images and design and print user-defined badge layouts.

B. General Criteria:
1. Provide all associated hardware, software, and licensing as required.
2. Meet or exceed minimum technical requirements as recommended by ACAMS manufacturer.
3. Be tower style workstation; coordinate final location with owner.
4. Basis-of-Design Badging Station:
a. Tower style workstation, manufacturer branded.
b. Be procured directly from the ACAMS manufacturer.
c. Minimum technical specifications, as recommended by manufacturer.
d. Supplied with software, configuration, and licensing, specific to the Project.
5. Display Monitors:
a. Provide 24" monitor with badging station.
b. 16:9 aspect ratio; 1920x1080 resolution.
c. Utilize HDMI or DP video input.
d. Basis-of-Design Product:
1) Bosch UML-245-90
2) Beetronics 24HD7M.

C. Badging Printer:
1. ID Direct-to-Card type printer, capable of dual-sided printing.
2. Compatible with ACAMS system and supplied access card credentials.
3. Integrate badging printer and associated equipment with ACAMS badging software.

4. Provide associated peripherals including dry film ribbon, printer cleaning kit, card slot punch.
5. Basis-of-Design Product:
   a. Fargo DTC1250e series printer, with 45000 ribbon.

2.9 ACCESS CONTROL PANELS

A. Provide ACAMS controllers at locations where indicated on Drawings.

B. Provide controllers in quantity and configuration at each head-end location, as required to support the card reader doors and security alarm devices shown on Drawings.

C. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the server or workstation for monitoring or controlling its operation.

D. Intelligent controllers may include:
   1. Access control panels.
   2. Input and/or output panels.
   3. Elevator control panels.
   4. Other intelligent field panels.

E. Basis-of-Design Product, subject to compliance with requirements:
   1. Controllers and hardware as recommended by ACAMS manufacturer.
   2. Installed within secured enclosures with tamper alarm.

F. Controller Power Supply:
   1. Provide power supply as recommended by ACAMS manufacturer.
   2. Refer to Power Supply item below.

G. Controller Enclosures:
   1. Provide controller enclosures as recommended by ACAMS manufacturer.
   2. High grade steel design, secured with lock and key.
   3. Provide tamper alarm, wired to system alarm input.
   4. Enclosure may be one in the same with ACAMS Power Supply, refer to Power Supply item below.
   5. Detachable doors.
   6. Provide prewired controller enclosure with integrated power supplies.
   7. Basis of Design:
      a. LifeSafety Unified ProWire Managed Power (Level 3) enclosures.

2.10 POWER SUPPLIES

A. Provide system and lock power supplies, collocated with ACAMS controllers.

B. Provide power supplies in quantity and configuration at each head-end location, as required to support system controllers and the associated electrified door hardware.

C. Basis-of-Design Product, subject to compliance with requirements:
   1. LifeSafety Power, Unified Power Series.
      a. Designed to house system and lock power supplies, and controller boards.
      b. Integrated design, configuration specific to supplied controller boards.

D. Controller and Lock Power Supplies:
   1. General:
      a. Sized to support maximum connected load, with minimum 20% spare capacity.
      b. Supervised through the ACAMS system.
      c. UL Listed power supplies.
   2. Controller power supply:
      a. Type and connections as recommended by ACAMS manufacturer.
   3. Lock power supply:
      a. Individual outputs: PTC protected power limited, auto-resettable.
      b. Integral fire alarm input, programmable to output channels.
      c. Coordinate lock power requirements with Division 08 Door Hardware specifications.
      d. Provide interface circuit between lock power supply and fire alarm control module. FA control module provided by fire alarm supplier, contact closure upon general fire alarm.

E. Power Supply Enclosures:
   1. High grade steel design, secured with lock and key.
   2. Provide tamper alarm, wired to system alarm input.
   3. Enclosure one in the same with ACAMS controller enclosure, designed to house controller boards, system power supplies, and lock power supplies.
   4. Includes integral wire management within enclosure.
   5. Alternate configuration:
      a. Power supply enclosures independent of controller enclosures.
      b. Basis-of-Design Product:
         1) LifeSafety Power.

F. Battery Back-Up:
   1. Provide battery back-up for all low voltage security power supplies.
   2. Sealed, lead acid type, complying with UL 924.
   3. Sized to provide four-hour runtime at normal load, for each power supply. Runtime can be reduced to 30 minutes if line voltage power is supplied by back-up emergency generator.
   4. Battery Calculations: As part of shop drawing submittals, assemble and submit battery back-up runtime calculations, demonstrating the specified criteria is met.
   5. Basis-of-Design Products:
      a. Power Sonic.
      b. Yuasa.

2.11 CARD READERS AND CREDENTIALS

A. Provide contactless, proximity card readers, where indicated on Drawings.

B. See section 07100 for card reader locks and exit device card reader lever trim provided and installed under this section. See hardware sets for card reader lock/card reader exit device model numbers.

C. Device uses swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards, with unique, encoded identification number.

D. General Criteria:
1. Response time: Card reader shall respond to passage requests by generating signal sent to the controller. Response time 800 ms or less, from time of card read to generated response signal.
2. Display: Two-color LED provides visible status indications and audible tone. Indicates power on, lock status, and whether user passage requests have been accepted or rejected.
3. Read range: Up to four inches from card reader device.
4. Power input: Powered from associated controller, including backup power source.
5. Technology: Multi-tech reader, capable of 125kHz standard proximity, 13.56MHz smart card, and mobile access using mobile credentials (NFC 13.56MHz or BLE 2.4GHz).
6. Communication protocol: OSDP.
7. Compatible with owner existing and/or new supplied credential cards.
8. Federal Government PIV compliance: HSPD-12 FIPS 201 compliant.
9. Keypad requirement: Provide reader with integral keypad, where indicated on drawings.
10. Mount application: Provide readers sized for installation application, ie wall or mullion mount.

E. Basis-of-Design Product, subject to compliance with requirements:
1. HID Signo series multi-tech readers.
a. Communication protocol: OSDP.
2. Wavelynx Ethos series multi-tech readers.
a. Communication protocol: OSDP.

F. Credential Cards:
1. Quantity to be provided: 500.
2. Compatible with direct-to-card badging printer.
3. Compatible with supplied card readers and access devices.
4. Technology: 13.56MHz smart cards.
5. HSPD-12 FIPS 201 compliant.
6. Basis-of-Design Product, subject to compliance with requirements:
a. HID type: iCLASS 200x iCLASS credentials.
b. Wavelynx type: MIFARE DESFire EV2 credentials.

2.12 INTEGRATED READER-LOCKS

A. Provide Integrated Reader-Locks as indicated on the Drawings.
1. Wired Integrated Reader-Locks and Battery-Operated Wireless Integrated Reader-Locks are specified within Division 08 Door Hardware, to be provided by Division 28 Security Contractor.
2. When installing integrated reader locks or wall mounted locks on fire rated doors or walls utilize manufacture's methodologies and parts to maintain fire rating on doors and walls.
3. Refer to Division 08 Door Hardware specifications.

B. Integrated Reader-Lock installation scope delineation:
1. General Contractor is responsible for physical installation of Integrated Locksets on doors.

2. Security Contractor is responsible for procurement of Integrated Locksets, mounting hardware, low-voltage terminations, integration with ACAMS, programming, commissioning, testing, and warranty.

C. Provide ACAMS manufacturer certified API integration between the ACAMS and the supplied Integrated Reader-Locks.

D. General Criteria:
1. Card reader shall respond to passage requests by generating signal sent to the controller.
2. Read range: Up to four inches from card reader device.
3. Power input: Powered from PoE connection (wired) or on-board batteries (wireless).
4. Technology: Multi-tech reader, , 13.56MHz smart card, and mobile access using mobile credentials (NFC 13.56MHz or BLE 2.4GHz).
5. Communication protocol: OSDP, via Ethernet or Wireless Hub.
6. Compatible with owner existing and/or new supplied credential cards specified within under Card Readers and Credentials item.
7. Federal Government PIV compliance: HSPD-12 FIPS 201 compliant.
8. Mount application: Integrated Reader-Lock, mounted on door.

E. Basis-of-Design Product, subject to compliance with requirements:
1. As listed in Division 08 Door Hardware specifications.

2.13 DOOR CONTACTS

A. Standard Recessed Door Contacts:
1. Provide recessed door contacts on standard doors, as indicated on Drawings.
2. Provide contacts for all card reader doors and all monitored-only alarmed doors.
3. Meet UL634; standard for connectors and switches used in Burglar alarm systems
4. Switch and Magnet housing made of UL 94HB plastic or aluminum
5. Internal switches must be Magnasphere technology (BMS)
6. Contacts must be fully potted using 94HB rated material
7. Lead wires to be solid color coded
8. The magnetic door contact must be used with End of Line (EOL) resistors and be copaitable with control panel models that accept contact inputs.
9. Maximum electrical rating:
   a. 250mA
   b. 30VDC (Resistive)
   c. .25W
   d. UL634 Listed
10. Recessed ¾"-diameter door contacts, required for new work and new frames/doors.
11. Basis-of-Design Product:
    a. Magnasphere MSS series concealed/Recessed contact UL634 Level 1White or brown, to match door frame color.

B. Surface Mount Door Contacts:
1. Provide surface mount door contacts, only where specifically indicated on Drawings.
2. Provide contacts for all card reader doors and all monitored-only alarmed doors.

3. Meet UL634; standard for connectors and switches used in Burglar alarm systems
4. Switch and Magnet housing made of UL 94HB plastic or aluminum
5. Internal switches must be Magnasphere technology (BMS)
6. Contacts must be fully potted using 94HB rated material
7. Lead wires to be solid color coded
8. The magnetic door contact must be used with End of Line (EOL) resistors and be compatible with control panel models that accept contact inputs.
9. Maximum electrical rating:
    a. 250mA
    b. 30VDC (Resistive)
    c. .25W
    d. UL634 Listed
10. Surface mount door contacts, acceptable only for renovation work where recessed door contacts cannot be installed due to existing field conditions.
11. Installed on secured side of door, within the protected space.
12. Basis-of-Design Product:
    a. Magnasphere MSS series surface mounted UL634 Level 1White or brown, to match door frame color.

C. Overhead Door (OHD) Contacts:
1. Provide OHD door contacts for overhead roll-up doors, as indicated on Drawings.
2. Provide overhead door contacts for all monitored overhead doors, where indicated on Drawings.
3. Meet UL634; standard for connectors and switches used in Burglar alarm systems
4. Switch and Magnet housing made of UL 94HB plastic or aluminum
5. Internal switches must be Magnasphere technology (BMS)
6. Contacts must be fully potted using 94HB rated material
7. Lead wires to be solid color coded
8. The magnetic door contact must be used with End of Line (EOL) resistors and be compatible with control panel models that accept contact inputs.
9. Maximum electrical rating:
    a. 250mA
    b. 30VDC (Resistive)
    c. .25W
    d. UL634 Listed
10. Basis-of-Design Product:
    a. Magnaspher MSS series Overhead door contact UL634 Level 1, as required for application.

D. High Security Switch (HSS) Door Contacts:
1. Provide high security door contacts where indicated on Drawings.
2. Provide high security balanced magnetic switch (BMS) contacts, where indicated on Drawings.
3. Installed on secured side of door, within the protected space.
4. Meet UL634; standard for connectors and switches used in Burglar alarm systems, Level 2 High Security

5. UL913 Standard for Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, II, III, Division 1, Hazardous Locations (includes UL60079-11, the US adoption of the IEC 60079-11 standard for intrinsic safety, talking a national deviation to correspond to the definition in the national electrical code. Sections 3.1.1, 5.4 and associated DV and DR deviations - Simple Apparatus
6. The High Security Switch must have integrated Removal Tamper Circuit and hardware, to actuate on removal of switch from mounting surface.
7. The HSS must be used with, or contain embedded Endo of Line (EOL) resistors and be compatible with control panel models that accept contact inputs.
8. The HSS shall be rated for both indoor and outdoor use
9. The HSS must qualify as an Intrinsically Safe - Simple Apparatus
10. Switch and Magnet housing made of UL 94HB plastic or aluminum
11. Internal switches must be Magnasphere technology (BMS)
12. Contacts must be fully potted using 94HB rated material
13. Lead wires to be solid color coded with stainless steel armored jacket or conduit.
14. The magnetic door contact must be used with End of Line (EOL) resistors and be compatible with control panel models that accept contact inputs.
15. Integrated Removal Tamper Circuit / hardware
16. When utilized in Hazardous Locations the door contact shall be paired with an Isolator/Barrier device such as the Magnasphere model D5030D
17. Maximum electrical rating:
    a. 250mA
    b. 30VDC (Resistive)
    c. .25W
    d. UL634 Level 2 High Security Listed
18. Recessed/Concealed versions of the HSS shall not be used in hazardous locations where intrinsic safety is a requirement.
19. Security Criteria: UL 634 Level 2 (Pharmacy, vault, and hazardous locations spaces), as designated on Drawings.
20. Basis-of-Design Product:
    a. Magnasphere HSS-L2D series UL 634 Level 2 High Security contacts (surface mounted)
    b. Magnasphere HSS-L2C series UL 634 Level 2 High Security (recessed/Concealed)

2.14 REQUEST-TO-EXIT (RTE) DEVICES

A. Hardware Integral RTE Switches:
   1. Provide connection to RTE switches, where integral within electrified door hardware.
   2. Coordinate locations and requirements with Division 08 door hardware specification.

B. RTE Motion Sensors:
   1. Where required, provide RTE PIR motion sensor for alarm shunt upon normal exiting.
   2. Required at doors with electric strikes, or magnetic locks, at minimum.
   3. Coordinate locations and requirements with Division 08 door hardware specification.
   4. Basis-of-Design Product:

a. Bosch DS160 series.
b. White or brown, to match surface finish.

C. RTE Motion Sensors with integrated sounder
1. Where required, Provide RTE PIR motion senor for alarm shunt upon normal existing and where door status is important such as pharmacy, security zones and fire doors.
2. Required at doors with electric strikes, or magnetic locks, at a minimum.
3. Coordinate locations and requirements with Division 08 door hardware specification.
4. Basis-of-Design Product:
a. Bosch DS160 Series.
b. White or brown, to match surface finish.

D. Emergency Door Release Button:
1. Provisioned by Division 08, terminated by security contractor.
2. Provide EM door release button and exit delay timer for doors with magnetic locks.
3. Exit equipment and function to be compliant with applicable codes and regulations.
4. Coordinate locations and requirements with Division 08 door hardware specification.
5. Basis-of-Design Product:
a. Exit button, Alarm Controls products.
b. Delay timer, Altronix products.

2.15 MOTION AND GLASS BREAK DETECTORS

A. Provide intrusion detectors for alarmed areas, where indicated on Drawings.

B. Connect intrusion detector alarms to IDS system when IDS is specified for project. Connect intrusion detector alarms to ACAMS, when ACAMS is used as the primary security alarm monitoring system.

C. Motion Detector Criteria:
1. Wall or celling mount, as required for application.
2. Dual technology: Passive infrared (PIR) and microwave technologies.
3. 60' coverage range.
4. UL 639.
5. Basis-of-Design Product:
a. Bosch Professional TriTech series products.

D. Glass Break Detector Criteria:
1. Wall or celling mount, as required for application.
2. Use microprocessor-based sound / frequency analysis technology.
3. Each detector shall provide the receiver, signal processing, alarm relay and operating power circuity in the same enclosure.
4. The detector hall provide a coverage range of 25 feet for glass sizes over 12" by 12".
5. The detector shall be designed to detect plate, tempered, laminated, and wired glass types with a minimum thickness of 1/8" for plate glass and ¼" for other glass types.

6. The detector shall contain a microphone tuned to the audio frequencies of breaking glass. To guard against false alarms, any audio frequencies detected outside of the specifically tuned frequency range shall be ignored by the detector.
7. The detector shall contain a normally closed cover tamer switch and shall provide with terminal strip connections. The switch will provide an open condition when the cover is removed.
8. Detector shall be rated to operate within the temperate range of minus 20degree Fahrenheit to plus 120 degrees Fahrenheit.
9. The detector shall be mounted in accordance with manufacturer's requirements. Mounting of design basis detector are:
    a. Opposite wall mounting
        1) Mount the detector where there are no objects between itself and the glass
        2) Do not mount the detector closer than five (5) feet to the wall that the glass being protected is on, or any hard, sound reflecting surfaces.
        3) The detector should be within +/- 30 degrees of the center of the glass to be protected.
        4) Make sure the detector is no farther than 25 feet from any corner of the glass.
    b. Celling Mounting
        1) The recommended location is half the distance between the glass and its opposite wall or 2/3 of the rated range whichever is smaller.
        2) Mount the detector where there are no objects between itself and the glass.
        3) Mounting to drop ceiling tiles is acceptable.
        4) Do not mount the detector closer than five (5) feet to the wall that the glass being protected is on, or any hard, sound reflecting surface.
        5) Make sure the detector is no farther than 25 feet from any corer of the glass.
        6) The detector should be within +/- 30 degrees of the center of the glass to be protected.
    c. Multiple Detectors
        1) When multiple detectors will be used to protect larger glass.
        2) When the glass is wider than 20 feet, multiple detectors shall be used.
        3) Place each detector in-line with the center of each 20 foot section of glass.
        4) Space the detectors evenly across the glass, but no father than 20 feet apart.
        5) Do not mount the detectors closer than 5 feet to the wall that the glass being protected is on, or any hard sound reflecting surface.
        6) Make sure each detector is no father than 25 feet from any corner of its 20 foot section.)
10. When window coverings (curtains or blind) covering the window, the location of the detector shall be tested prior to install by testing the location based on the manufacturer's testing requirements.
11. The detectors shall be installed in locations where there are no environmental disturbances are present.
12. UL 639.

13. Basis-of-Design Product:
    a. Bosch DS11xx series products.

E. Glass Break Tester
1. Handheld unit supplied by the security contractor.
2. Compatible with glass break sensor installed and used to test functionality.
3. Provide two (2) glass break sensors at turn over.
4. Basis-of-Design Product:
    a. Bosch DS1110i

2.16 PANIC BUTTONS

A. Provide panic buttons under desk/counter or wall mount, where indicated on Drawings.

B. Connect panic button alarms to ACAMS and IDS system when IDS is specified for project.

C. General Criteria:
1. Desk type, protected, recessed switch.
2. Wall type, with protective cover.
3. Basis-of-Design Product:
    a. Under desk: Honeywell 269R, latching, key reset.
    b. Wall mount: STI SS2224EM-EN.
        1) EMERGENCY text, confirm with owner.
        2) Yellow, confirm color with owner (cannot be red).

2.17 LOCKDOWN BUTTONS

A. Provide lockdown buttons under desk/counter or wall mount, where indicated on Drawings.

B. Connect lockdown buttons to ACAMS system, to initiate controlled door lockdown function.

C. Functionality requirements:
1. When activated, shall initiate lockdown and transmit location specific lockdown duress alarm within the ACAMS system, based on owner security protocol and standard operating procedures (SOP).
2. When activated, shall change the state of reader to a more secure status. Example: unlock to card and pin with restricted access group.
3. When activated, shall provide a disable signal via relay to powered door operators and RIMs on doors identified in the lockdown area.
4. Momentary type button, requires system reset via system software.
5. Coordinate sequence and functional requirements with owner prior to programming.

D. General Criteria:
1. Desk type, protected, recessed switch.
2. Wall type, with protective cover.
3. Basis-of-Design Product:
    a. Under desk: Honeywell 269R, latching, key reset.
    b. Wall mount: STI SS2424LD-EN.
        1) LOCKDOWN text, confirm with owner.
        2) Blue, confirm color with owner (cannot be red).

2.18 DOOR RELEASE BUTTONS

A. Provide door release buttons under desk/counter, where indicated on Drawings.

B. Connect door release buttons to ACAMS system, to unlock associated entry door and shunt alarm.

C. General Criteria:
   1. Protected, recessed switch.
   2. Momentary contact.
   3. Basis-of-Design Product:
      a. SDC 15-2.

2.19 VIDEO INTERCOM SYSTEM

A. Provide Video Intercom door stations and master stations, where indicated on Drawings.

B. Provide all door stations, master stations, ancillary components, network SIP communications configuration, and licensing as required for a fully operational video intercom system.

C. Video Intercom Stations:
   1. IP PoE Video-Intercom (VI) station, network connected, SIP enabled.
   2. VI stations will provide audio communications with video verification to security operations staff, either on-prem or remote via network SIP protocol.
   3. Connect to network within nearest IDF room.
   4. Capable of integration to owner VoIP phone system via SIP protocol.
   5. VI includes integral IP camera, full-duplex audio, and output relay for controlling local door lock or for interface to access control system.
   6. Integrate VI camera with the VMS system for archiving, refer to section 282300 for VMS.
   7. Provide wiring interface from VI output relay to access control system, to allow security staff to remotely grant access to visitors through associated controlled door. VI shall be wired directly to door lock circuit only in instances where there is no ACAMS installed.
   8. Coordinate networking, programming and functional requirements with owner security and IT personnel prior to installation and wiring interface.
   9. Wall mount locations: Flush mount only, with specialty recessed back-box. coordinate with GC and EC. Turn backbox over to EC for rough-in installation.
   10. Basis-of-Design Product:
      a. AiPhone IXG-DM7-HIDA series
      b. Black with black button.
      c. Provide recessed backbox and mounting plate.

D. Video Intercom Master Stations:
   1. IP PoE Video-Intercom Master (VIM) station, network connected, SIP enabled.
   2. Desk mount unit with 8" HD IPS LCD touch screen.
   3. Dual-mic HD speakerphone with noise reduction and echo cancel.
   4. 16 lines with up to 16 SIP accounts.
   5. Basis-of-Design Product:
      a. IX-MV7-HW-JP

2.20 IP POE ETHERNET EXTENDERS - PASSIVE

A. Provide passive IP PoE Ethernet extender units (pair) for data circuits which exceed Category cabling 295' maximum length due to routing path or field conditions. Where distances do not permit passive devices, provide a powered IP PoE solution as specified in next section.

B. General Criteria:
   1. Passive IP PoE Ethernet extender units which do not require power may be used where applicable.
   2. Where multiple extender unit circuits terminate in a common equipment room, multi-channel, rack mount head-end extender unit is to be used. Coordinate work in equipment rooms with owner IT.
   3. Install head-end equipment and Ethernet extender devices per manufacturer written recommendations.
   4. Basis-of-Design Product:
      a. Nitek products.
      b. Veracity products.

2.21 IP POE ETHERNET EXTENDERS - ACTIVE

A. Provide active/powered IP PoE Ethernet extender solution using powered-fiber cable media, for data circuits which exceed Category cabling 295' maximum length due to routing path or field conditions, and cannot be served with passive IP PoE Ethernet extenders.

B. General Criteria:
   1. Active/powered IP PoE Ethernet extender solution must be used where required, for applications where passive extender units will not comply.
   2. Where multiple extender unit circuits terminate in a common equipment room, the manufacturer solution multi-channel head-end unit is to be rack mounted. Coordinate work in equipment rooms with owner IT.
   3. Install head-end equipment and Ethernet extender devices per manufacturer written recommendations.
   4. Provide and install manufacturer branded powered-fiber cable media, or powered-fiber cable media as recommended by supplied solution manufacturer.
   5. Basis-of-Design Product:
      a. Altronix Netway Spectrum PoE Extender System.
      b. Leviton OneReach PoE Extender System.

2.22 ELEVATOR INTERFACE - FLOOR CONTROL

A. Provide card readers in elevator cabs or at destination dispatch kiosks, where indicated on Drawings.

B. Provide soft integration between ACAMS and elevator system to support elevator secured floor control.

C. Technical Criteria:
   1. Integrate the access control system with the elevator control system via network software interface to provide secured floor control for each cab indicated with card reader.

2. Provide manufacturer certified API integration between the ACAMS and the Project elevator management system.
3. Where an elevator destination dispatch system (DDS) is to be implemented:
   a. Card readers are to be integral with or be located within the elevator DDS kiosks.
   b. DDS kiosk readers to meet technical criteria of standard card readers, specified herein.
   c. Where an elevator DDS is to be implemented, ACAMS network API integration in required. A traditional hardwired, control interface to elevator controller inputs is not acceptable.
4. Refer to and coordinate with Division 142000 Vertical Transportation specification sections.
5. Coordinate hardware, installation, and software requirements with elevator supplier and GC.
6. Coordinate elevator floor control functional sequence with owner security personnel.

D. Hardwired Interface (Alternate):
1. A traditional hardwired control interface between the ACAMS and elevator system is an alternate solution which may be proposed, if the following conditions are met:
   a. An elevator DDS system is not being implemented; and, a certified API integration or similar network soft interface is not available from the respective manufacturers.
   b. The proposed alternate ACAMS and hardwired control interface must be submitted to the Design Team for review and comment no less than four weeks prior to bid date.
2. Security contractor to provide Elevator Interface Cabinet (EIC) within each elevator equipment room to provide the demarcation hand-off point between the security and elevator systems.
3. The EIC shall be sized appropriately to house all wire management, terminal strips, relays, and other peripheral devices as required.
4. Provide dry contact terminal strips for security to elevator interface cabling, as required.
5. Interface the access control system with the elevator control system to provide secured floor control for each cab indicated with card reader.
6. Refer to and coordinate with Division 142000 Vertical Transportation specification sections.
7. Coordinate elevator equipment room locations, hardware, and installation requirements with elevator supplier and GC.
8. Coordinate elevator floor control functional sequence with owner security personnel.

2.23 SURGE PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

2.24 TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICES

A. Provide Transient Voltage Surge Suppression (TVSS) device for each exterior security device connected with copper cable for communications, control signal, or low voltage power circuit.

B. Install TVSS device per manufacturer written recommendations, including grounding and bonding.

C. Basis-of-design product:
1. Ditek products.

2.25 TAMPER PROTECTION

A. Tamper Protection:
1. Provide tamper switches on all control units, cabinets, enclosures, pull boxes, and other susceptible system components.
2. Tamper switches shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Security monitoring station shall communicate system tamper alarms and identify locations.

2.26 CABLING FOR SECURITY SYSTEMS

A. Provide low voltage security cabling infrastructure to support all security systems and devices indicated on the Drawings and specified herein. All cabling must meet the minimum technical criteria recommended by the associated equipment manufacturer, as supplied for the project.

B. Category data cabling circuits for network connected Ethernet devices will be provided and installed by Division 27 telecom cabling contractor. Security contractor to provide Category patch cords at security device end, which match the installed data cable Category rating.

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. Belden.
2. General Cable.
3. Paige Datacom.
4. West Penn Wire.

D. Specialty Cabling for Access Control Doors:
1. For each card reader controlled door, provide Access Control Composite Cable (banana type).
2. Access control composite cable includes bundled, individual cables for: Card reader, lock, door status, and request-to-exit.

3. Card reader cable communications criteria: Provide ACAMS composite cable to support the communications protocol of the specified and supplied Card Readers.
4. Composite cable to meet card reader manufacturer recommended specifications.
5. For atypical card reader door configurations requiring more cables than the identified composite cable, provide additional security cabling as necessary to support the devices and function.

E. For all installation applications, provide cabling rated for the environment in which it is installed.

F. Comply with Section 280513 Conductors and Cables for Electronic Safety and Security.

G. Comply with NFPA 70.

H. Identification Products:
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 Worldwide.
b. Panduit.
c. HellermannTyton.
2. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
3. Comply with requirements in Part 3 "Identification" within this section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for security device cabling conduit systems to verify actual locations of conduit and back boxes before device installation.

C. Ensure security door conduits are coordinated with Division 08 electrified hardware specifications, and properly roughed-in.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

B. Verify and obtain all necessary licenses and construction permits required to complete the Project scope.

3.3 INSTALLATION

A. Install access control, security equipment, and cabling as recommended by manufacturer(s).

B. All equipment installed shall be maintained with manufacturer's provided software and firmware. At turnover the manufacturer's most current version of both software and firmware shall be installed on all devices inclusive of all patches and updates.

C. Comply with all state and local ordinances, codes, and regulations.

D. Coordinate all security conduit rough-in requirements with EC and GC prior to work.

E. Coordinate all security equipment installation and IT LAN requirements with owner.

F. ACAMS Manufacture's professional services shall be subcontracted by security vendor for all programing and integration tasks.

G. All active devices to include but not limited to servers, UPS, controllers, readers, duress/panic switches, door releases, intercoms, tamper switches and wireless devices that are field installed shall be reflected on the red line and as-built drawing packages.

H. Keys: Installation contractor shall turn over a minimum two keys for each security enclosure installed. The contractor shall turn over a minimum of two security bits for each type of security screw/lock installed.

I. Back-up: ACAMS server shall be installed with an external solid state hard drive for back-up purposes. A full back-up of the configuration file and card holder database shall be scheduled to be conducted nightly. Supply three (3) external hard drives as part of installation. Intent is the owner will swap media regularly to maintain an offline and offsite backup in addition to an active backup.

3.4 INTEGRATIONS:

A. Intrusion Detection Integration: Access control system shall interface with intrusion detection systems to initiate alarms or lockdown procedures automatically upon qualifying events. System shall provide operators immediate situational awareness through coordinated event response.

B. Emergency Help Point Interface: Access control system shall integrate with emergency help points to enable redirection of security personnel to the help point location when activated, facilitating efficient emergency response.

C. Security Radios: Upon detection of qualifying alarm as programed, access control system shall transmit real-time alerts to security personnel via designated security radio channels for prompt incident response.

D. Synchronized Clock Server: Access control system servers shall be time-synced and timestamp all events using a synchronized clock server to maintain accurate and consistent records across integrated security platforms.

E. Fire Alarm Integration: Access control systems automatically unlock designated doors in response to fire alarm activation, supporting safe evacuation and emergency responder access. Additionally, the fire alarm system shall be integrated with the access control system to activate fire relays in accordance with NFPA and Authority Having Jurisdiction (AHJ) requirements, ensuring an unobstructed path of egress.

F. RTLS/Infant Protection Integration: Access control system shall monitor Real-Time Location System (RTLS) infant protection system at controlled portals, automatically locking when a tagged infant approaches a secured exit, disable elevators with access control to prevent vertical movement, creating radio dispatch of alarm, and creating a video verification event. Authorized clinical staff will be able to bypass these restrictions with the proper access authorization utilizing a card reader to enhance protection of vulnerable individuals.

G. RTLS/Duress Response: Upon activation of duress alarms from RTLS badges, access control system shall display the alert, call up the nearest camera via video integration and create a radio alarm event and notify security teams with precise location information of the person in distress.

H. Dashboard Monitor Display: The Access control system shall be integrated with dashboard monitors to display preselected events - such as active shooter alerts, lockdowns, and other alarm-trigged scenarios-on all or designated screens.

I. Temperature Monitoring Integration: The access control system shall interface with temperature monitoring devices to generate alarms for operators, video verification of area, and dispatch personnel via radio, enabling rapid and efficient response to temperature-sensitive assets such as vaccines and property, to ensuring timely intervention.

J. CAD System Integration: Access control system shall interface with Computer-Aided Dispatch (CAD) systems to transmit real-time security events and automated alerts, providing dispatchers with incident location and status updates for rapid emergency personnel deployment. Additionally, it enables officers to attach dispatch metadata to alarm events.

K. Mapping: Access Control shall be integrated with mapping interface and show all devices to aid in investigations, alerts, alarms, status indicators, and dispatch. Mapping shall be at scale with accurate room names and numbers and include all campus buildings to include but not limited to hospitals, parking lots, wastewater treatment plants, pumping stations, residences (structures only), etc. The maps shall have interactive icons depicting where new and existing devices are located, icons shall allow for call up of the device.

3.5 WIRING METHODS

A. Routing:
1. Cabling may be installed in accessible ceilings unenclosed, unless otherwise indicated on the Drawings.
2. Install cable and conduit, concealed in accessible ceilings, walls, and floors where possible.
3. Cabling may be installed unenclosed within consoles, cabinets, desks, and counters.
4. In unfinished spaces, install cabling in conduit pathways; concealed in walls for new construction.
5. Where installed within conduit, security cabling conduit size shall be minimum 3/4 inch, maximum 40% conduit fill.
6. Refer to the Drawings for typical device conduit requirements.

7. Data transmission and low voltage security control wiring shall not share conduit with other building wiring systems.
8. Install plenum cable in environmental air spaces, including plenum ceilings.
9. For all installation applications, provide cabling rated for the environment in which it is installed.

B. Wiring within Enclosures:
1. Bundle, lace, and train cables within enclosures.
2. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
3. Provide and use lacing bars and distribution spools.
4. Install conductors parallel with or at right angles to sides and back of enclosure.

C. Grounding: Provide independent-signal circuit grounding if recommended by manufacturer.

D. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

3.6 INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement and routing of primary cabling pathways.

B. Comply with the following Sections:
1. 260533 "Raceways and Boxes for Electrical Systems."
2. 270528 "Pathways for Communications Systems."
3. 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

C. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.7 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM "Firestopping Systems" article.

3.8 IDENTIFICATION

A. Label all security control panels, enclosures, cabinets, and cabling.

B. Identify system components, wiring, and cabling complying with TIA/EIA-606-C.

C. Cable and Wire Identification:
1. Label each cable within 4 inches of termination, where it is accessible within an enclosure.
2. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
a. Individually number and identify each cable extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

D. Labels: Must be flexible vinyl or polyester type label, which flexes as cables are bent. Label text must be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color.

E. Cable Schedule: Install a cable schedule within each electronic security enclosure. List incoming and outgoing cables and their designations, origins, and destinations. Protect printed schedule with clear plastic cover. Furnish an electronic copy of all final schedules provided for the Project.

F. All labeling and cable schedules shall be aligned with the submitted closeout security as-built drawings.

3.9 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing controllers, servers, or workstations that have been powered up shall be locked and secured, as coordinated with owner.

3.10 STARTUP SERVICE

A. Perform system startup and commissioning.
   1. Complete installation and startup checks according to approved procedures that were developed in conjunction with owner in "Preparation" Article and based on manufacturer's written instructions.
   2. Coordinate system startup schedule and logistical requirements with owner prior to work.

3.11 CLEANING

A. Clean installed items using methods and materials recommended by manufacturer.

B. Clean access control system panels, enclosures, servers, workstations, and components as needed.

3.12 DEMONSTRATION

A. Perform 100% pre-testing for all system functionality and complete the initial readiness checklist. Correct and resolve all deficiencies. Update and submit the completed readiness checklist identifying corrections, and request for approval of Substantial Completion.

B. Perform final field test in conjunction with owner, demonstrating that all features and functionality are 100% complete and operational to owner's satisfaction.

3.13 TRAINING

A. Provide up to Four (4) two (2)-hour sessions of user/operator training The sessions may be similar (to allow additional staff to be trained) or may cover different topics while going into more depth, as determined and requested by the owner. Training shall cover the following basic aspects of the system:
   1. System operation and monitoring.
   2. Integrations between systems
   3. Scenario based examples such as lockdown, duress, infant protection, door held, door forced, and others as determined by owner.

B. Provide up to two (2) four (4)-hour sessions of administration training The sessions may be similar (to allow additional staff to be trained) or may cover different topics while going into more depth, as determined and requested by the owner. Training shall cover the following basic aspects of the system:
   1. Software configuration and administration
   2. Device configuration and adjustments.
   3. System operation and monitoring.
   4. Integrations between systems
   5. Scenario based examples such as lockdown, duress, infant protection, door held, door forced, and others as determined by owner.
   6. End-user maintenance.

C. Provide up to one (1) eight-hour session of train-the-trainer. The session may be similar to the user/operator training and the administrator/operator training sessions, as determined and requested by the owner. Training shall cover the aforementioned topics above but will allow the sessions to be recorded by internal IHS staff or their delegates.

D. Training should be used to provide guidance on installed systems not used to upsell beyond the current capabilities. In the event staff ask questions on features that are not purchased they should be directed to their leadership for discussion on that topic.

E. The training team shall be comprised of at a minimum of four people:
   1. Lead-Trainer: Person who will facilitate training.
   2. Manufacture's professional services representative.
   3. Lead-Installer: person who led the installation of the system.
   4. Role-player: Person who can trigger alarms in the field during training.

3.14 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of the date of Substantial Completion, provide on-site assistance in adjusting the system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
   1. Verify proper operation of controllers and devices.
   2. Verify operation of audio communications devices.
   3. Verify operation of alarm device notification and alarm integration with the VMS for automatic camera call-up of associated camera(s).
   4. Check operation of interface to other systems such as fire alarm, stair door release, vehicle control, and elevator floor control.
   5. Recommend changes to device configuration or programming, to improve Owner's use of the access control and alarm management system.
   6. Provide a written report of adjustments and recommendations.

END OF SECTION

SECTION 281600 - INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 Section Includes:

A. Intrusion detection devices.

B. Alarm control panel.

C. Control stations (keypads).

D. Signaling devices.

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.

B. This section is inclusive of Division 08 Door Hardware specification and Architectural door schedule.

C. Section 014000 - Quality Requirements:

D. Section 260533 "Raceways and Boxes for Electrical Systems."

E. This section is inclusive of all Division 27 Communications specification sections.

F. This section is inclusive of all Division 28 sections.

G. Section 078413 "Penetration Firestopping."

H. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

I. Appendix ## - System Integration Matrix

J. Owner Security Standards:

1. FGI Guidelines for the Design and Construction of Hospitals (2022)
2. FGI Guidelines for the Design and Construction of Outpatient Facilities (2022)
3. IAHSS Security Design Guidelines for Healthcare Facilities 3rd Edition
4. IAHSS Healthcare Security Industry Guidelines 13th Edition
5. The Joint Commission Planning, Design, and Construction of Health Care Facilities 4th Edition
6. Refer to owner security standards, as applicable to the Project.

K. Professional Services

1. Each bidder shall review the professional services scope of work document, associated costs, and all other relevant sections of this specification that require professional services. This review is a mandatory component of the bid response. To ensure compliance, each bid must include a completed and signed Professional Services Compliance Checklist, attached to this bid document.

1.3 REFERENCES

A. As specified in Section 260500 - Common Work Results for Electrical.

B. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code.

C. Underwriters Laboratories Incorporated (UL):

1. UL 609 - Local Burglar Alarm Units.
2. UL 634 - Connectors and Switches for Use with Burglar-Alarm Systems.
3. UL 639 - Intrusion Detection Devices.

4. UL 681 - Installation and Classification of Mercantile and Bank Burglar-Alarm Systems.
5. UL 1023 - Household Burglar-Alarm Systems.
6. UL 1076 - Proprietary Burglar Alarm Units and Systems.
7. UL 1449 (4th Edition) - Transient Voltage Surge Suppressors.

D. International Association for Healthcare Security and Safety (AHSS) Security Design Guidelines for Healthcare Facilities (copyright 2020).

E. Phoenix Area Pharmacy Policy

1.4 DEFINITIONS

A. Reference Division 01 for additional project definitions. Division 01 supersedes any conflicts.

B. Intrusion Detection System (IDS): A physical security system consisting of sensors capable of detecting one or more types of phenomena, signal media, annunciators, energy sources, alarm assessment systems, and alarm reporting elements including alarm communications and information display equipment. The termin IDS has no association with a cyber IDS which is a cyber/network security technology designed for detecting vulnerabilities such as unauthorized intrusion into network or computer systems.

C. Central Station: A physical location where alarm signals from multiple protected locations are received and monitored.

D. Alarm Monitoring Service: A service that monitors alarm systems and dispatches security personnel or law enforcement when an alarm is triggered.

E. Wireless Monitoring: Security systems that transmit signals wirelessly, often using radio frequencies, to the central station.

F. Hardwired System: Security systems that use physical wires to connect components, such as sensors and control panels, to the central station.

G. Wireless alarm system: A security system that relies on wireless communication for transmitting signals.

H. Keypad: A control panel with buttons or touchscreen used to arm, disarm, and operate the security system.

I. Perimeter Intrusion Detection System (PIDS): A system designed to detect unauthorized access to the perimeter of a secure area.

J. Motion Sensors: Devices that detect movement within a specified area.

K. Glass Break Detectors: Sensors that detect the sound and/or vibration of breaking glass.

L. Door/Window Contact: Magnetic Sensors that trigger an alarm when a door or window is opened. This type of switch does not a balanced nor tampering prevention features.

M. Balanced Magnetic Switch: A magnetically operated switch using a balanced magnetic field, designed to detect the operation of a secured door, window or other point entry. In addition, it detects attempts to defeat the switch by substituting a magnetic field and may have provisions for internal adjustments and detection of switch tampering attempts.

N. Double Pole Double Throw (DPDT) contact: This means a sensor has two independent circuits that can each switch between two states (open and closed). This allows for more complex monitoring and control. These type of sensors can be found in both balanced and unbalanced (standard) sensors.

O. Vibration Sensors: Devices that detect vibration caused by tampering or forced entry.

P. Infrared Sensors: Sensors that detect body heat or infrared radiation emitted by intruders.

Q. Video Management System: A network of cameras, recorders, and monitors used to monitor and record activities in a specific area.

R. Alarm Control Panel: The central unit that receives signals from sensors and triggers alarms.

S. Access Control Systems: Systems that manage and restrict entry to secured areas using keycards, biometrics, or PIN codes.

T. Arming: Refers to the mechanism that activates an alarm system.

U. Disarming: Refers to the mechanism that deactivate an alarm system.

V. Exit delayed Mode: Refers to a feature that allows users to arm the system and then exit the premise within a specified time frame without triggering an alarm.

W. Audible Alarms: These alarms emit a loud sound to alert occupants and deter intruders.

X. Silent Alarms: These alarms do not make any noise but send a signal to a monitoring center or security personnel.

Y. Panic / Duress alarms: These can be manually triggered by individuals in distress to alert security or emergency services.

Z. False Alarm: An a alarm for which the specific cause is unknown but is not an attempt to defeat the detection system nor is it caused by an individual not following procedures (e.g. an individual forces open a door without using the card reader). False alarms can be indication of electronic malfunction as component failure, communications failure, loose connections, power faults, or many other issues.

AA. Nuisance Alarms: The alarm produced by an intrusion detection sensor in response to a known stimulus (e.g. wind, lighting, thunder, accident) unrelated to an intrusion attempt.

BB. Nuisance Alarm Rate (NAR). The frequency at which nuisance alarms occur.

CC. End of Line Resistor (EOL): Resistors, of a known value, that are used to terminate protective circuits or alarm zones, the purpose of which is to provide zone supervision e.g allow the field processor to supervise the field wiring for open or short circuit conditions.

DD. Dual Reporting: Term used in intrusion detection and access control security systems refers to the practice of sending alerts or notifications to two separate entities or locations simultaneously.

EE. Daisy Chaining: Refers to the practice of connecting multiple sensors in a series along a single circuit.

FF. Home Run: Refers to the practice of running individual cables from each sensor or device directly back to the control panel, rather than a daisy chaining them together.

GG. Point/Zone: An individual sensor or device within an IDS system. Each point is a specific location where a sensor is installed to monitor security breaches.

HH. Partition: A logical grouping of points that can be armed or disarmed independently of other partitions.

II. Supervisory alarm: Type of alart generated to indicate that a component of the system requires attention or maintenance. Unlike alarms that signal an immediate security break, supervisory alarms are typically non-urgent and highlight issues that could affect the system's performance if not addressed. Common examples are low battery levels.

JJ. KNOX BOX: is a secure, wall-mounted safe that holds building keys, access cards, other important items needed for emergency entry. It is primarily used by fire departments, emergency medical services, and sometimes police to gain quick access of a building during emergencies without causing damage.

KK. Multiplex System: Communications link using signaling method characterized by simultaneous or sequential transmission, or both, and reception of multiple signals in a communication channel, including means for positively identifying each signal.

LL. Dial-Up System: Communication link utilizing a dedicated, voice grade, incoming copper "Plain Old Telephone System" (POTS) telephone line which connects alarm to central station through dial-up circuit.

MM. Internet Protocol (IP) Communication: Transmits data over IP networks, allowing for remote monitoring and integration with other networked systems.

NN. Cellular backup: A technology that ensure continuous connectivity and functionality of security systems even when the primary internet connection fails.

OO. Video Alarm call-up: The process of using video footage to verify and respond to alarms triggered by an intrusion detection system.

PP. Testing Plan: Testing plan shall include how all installed systems are to be tested based on the manufacture guidelines or other recognized industry best practices and a matrix on how often the devices shall be tested based on applicable references and manufacture recommendations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product to be used on Project. Data for system components, including UL listing data and list of materials, dimensioned plans, sections, and elevations showing minimum clearances, mounting arrangements, and installed features and devices

B. Shop Drawings: Include device floor plans, one-line diagrams, network interfaces, block diagrams, wiring details, battery calculations, riser diagrams, and typical device details.

C. Sustainable Design Submittals, if applicable to Project.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. Installer certification from intrusion detection system manufacturer.
   2. Manufacturer certifications for technicians and installation supervisor.
   3. Manufacturer certification for API interface software, as applicable.

B. Field quality-control reports.

C. Test Reports: Submit the following reports directly to Project Manager from Manufacturer's Quality Control Inspector, with copy to Contractor. Prepare reports in conformance with Section 014000 - Quality Requirements:
   1. Testing plan.
   2. Pre-test.
   3. Acceptance test.

1.7 CLOSEOUT SUBMITTALS

A. Closeout Documentation:
   1. Operation and Maintenance Data: Include data for each type product, including features, testing plan and operating sequences, both automatic and manual. Include user's software data and recommendations for spare parts to be stocked at the site. Provide names, addresses, and telephone numbers of service organizations that stock repair parts for the system.
   2. Project Record Documents: Record actual locations of equipment and devices, and routing of alarm wiring.
   3. Licensing
      a. Software
      b. Hardware
      c. Firmware
      d. Operational/ User
      e. Administrative
   4. Completed Readiness Checklist.
   5. Final Test Result Report.
   6. As-Built Drawings.
   7. Operation and Maintenance Manuals (O&Ms).
   8. Warranty Information.

1.8 QUALITY ASSURANCE

A. Installer/Contractor Qualifications:
   1. Installer must be certified by the intrusion detection system manufacturer to design and install the provided system.
   2. Installer must have certified technicians and project supervisor certified by the intrusion detection system manufacturer to install the provided system.
   3. Minimum 5 years' experience of satisfactory performance on projects of similar size and scope. Provide owner with references upon request. Prime system manufacturer and manufacturers of major system components required to qualify separately.
   4. Installers shall be licensed where required by state or county.

B. All supplied equipment shall be current models in production by manufacturer. If any items listed within are no longer produced, notify Architect of the planned substitution with the most current equivalent product.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Comply with UL Standard 609, 639, 1023, and 1076

F. Facility Management Compliance: Provide RPM-approved intrusion detection systems and components.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Controllers:
   1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
   2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: Do not deliver or install equipment until HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.11 COORDINATION

A. Coordinate intrusion detection and security door conduit pathway requirements with door hardware set equipment listed in Div-08 door hardware specification.

B. Coordinate security conduit pathway requirements with EC and GC prior to rough-in work.

C. Coordinate telecom data cabling requirements with Division 27 structured cabling contractor.

D. Coordinate security installation and commissioning requirements with owner security personnel.

E. Coordinate security equipment networking requirements with owner IT personnel.
   1. Equipment and devices will communicate over owner LAN, via owner provided PoE switches.
   2. Assemble and maintain an IP security device schedule, itemizing data port quantities, locations, and other networking requirements, for coordination with owner IT during installation.

F. Coordinate elevator duress with elevator supplier.

G. Coordinate vehicle gate control interface requirements with vehicle equipment supplier, as applicable.

1.12 WARRANTY

A. Warranty Period: Provide one (1) year warranty from date of Substantial Completion on all parts and installation.

1.13 SYSTEM DESCRIPTION

A. Design Requirements:

1. System: Central microprocessor, remote intrusion sensors and detection devices, and a communications link to perform monitoring and alarm functions. System physically and electronically modular with provision for field expansion. System self-monitoring and self-diagnostic.
2. Communication Link: System shall utilize internet Protocol (IP) communications as the primary form of communications with central monitoring center with a cellular back-up communication path.
3. Environmental: Design to withstand the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
   a. Altitude: Sea level to 4000 feet.
   b. Ambient Temperature for Interior Elements: 0 degrees C to plus 40 degrees C.
   c. Relative Humidity for Interior Elements: 5 to 95 percent, noncondensing.
   d. Ambient Temperature for Exterior Elements: Minus 25 degrees C to plus 50 degrees C.
   e. Relative Humidity for Exterior Elements: 0 to 100 percent.
4. Integrations: The IDS system shall be integrated with the flowing systems:
   a. Access Control: Duress (panic) alarms shall be dual reporting and report on both the IDS and access control system as alarm events.
   b. Access Control: Door Contacts on partitions which require two functions shall be DPDT contacts (example: perimeter door of the pharmacy which is both an IDS point and used with the access control system to determine door status)
   c. Video Management System: The IDS system shall be integrated with the video management system to provide an alarm call-up event in the security operations center. The call up shall persist until such time as the alarm is cleared. This integration may be accomplished via the access control system verse the IDS system as long as all alarm events create a video call up on alarm of the nearest camera to the alarm.

B. Performance Requirements:
1. Intrusion Detection: Performed by indicated intrusion detection devices. Devices are assigned to detection points/zones as indicated.
2. Alarm Indication: Based on the location of the alarm the following shall occur:
   a. Security operations center: Audible signal sounds and alphanumeric display at the alarm keypad identifying the zone originating an alarm. An alarm displayed at the keypad will annunciate with an audible tone. Alarm keypad provides alpha text as to the location of the alarm zone.
   b. Partition with dedicated Alarm Keypad: Audible signal sounds and alphanumeric display at the alarm keypad identifying the location originating an alarm. An alarm displayed at the keypad will annunciate with an audible tone. Alarm keypad provides alpha text as to the location of the alarm point.
   c. Duress / Panic alarms will not annunciate on local keypads, they shall only announce on the security operations keypad, access control system, and notify the central monitoring center 24/7.
3. A local 120 decibel strobe siren is to be attached to alarm module Relay A output.

1.14 OWNER'S INSTRUCTION

A. Installer will provide training to end user operators.

B. Installer will provide training to end user administrators.

1.15 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match products installed, packaged with protective covering for storage and identified with labels clearly describing contents.
   1. Intrusion Detection Devices: Furnish quantity equal to 5 percent of the number of units of each type installed, but not less than one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering specified Products which may be incorporated in the Work include the following:
   1. Bosch Security, Fairport,NY (800) 289-0096 (alarm & keypad).
   2. Visonic, Inc., Bloomfield, CT (888) 223-0020.

B. Section 016000 - Product Requirements: Product options and substitutions.
   1. Conflicts, deviations, or change requests shall be submitted in writing to Project Manager with supporting documentation. Include written justification, designs, manufacturer's specifications, cost benefits, and any special circumstances dictated by local conditions. Documentation package shall be submitted in sufficient time to minimize any adverse effects of the proposed changes to the project construction schedule. Project Manager reserves the right to reject substitute and other systems.
   2. Substitutions are not permitted for control panel, expansion boards, and control stations.

C. Specified Products:
   1. Door Switches:
      a. Magnasphere MSS series surface mounted UL634 Level 1 Contacts with pigtail leads,
      b. George Risk Industries TS-20 tamper switch.
      c. Magnasphere MSS series concealed/Recessed contact UL634 Level 1,
      d. Magnaspher MSS series Overhead door contact UL634 Level 1
      e. Magnasphere HSS-L2D series UL 634 Level 2 High Security contacts (surface mounted)
      f. Magnasphere HSS-L2C series UL 634 Level 2 High Security (recessed/Concealed)
   2. MOTION AND GLASS BREAK DETECTORS
      a. Provide intrusion detectors for alarmed areas, where indicated on Drawings.
      b. Connect intrusion detector alarms to IDS system when IDS is specified for project. Connect intrusion detector alarms to ACAMS, when ACAMS is used as the primary security alarm monitoring system.
      c. Motion Detector Criteria:
         1) Wall or celling mount, as required for application.

2) Dual technology: Passive infrared (PIR) and microwave technologies.
3) 60' coverage range.
4) UL 639.
5) Basis-of-Design Product:
a) Bosch Professional TriTech series products.

d. Glass Break Detector Criteria:
1) Wall or celling mount, as required for application.
2) Use microprocessor-based sound / frequency analysis technology.
3) 25' coverage range.
4) UL 639.
5) Basis-of-Design Product:
a) Bosch DS11xx series products.

e. Glass Break Tester
1) Handheld unit supplied by the security contractor.
2) Compatible with glass break sensor installed and used to test functionality.
3) Provide two (2) glass break sensors at turn over.

3. Control Panel: Bosch: #B9512G-USA Control Panel.
a. 40 VA, 16.5 VAC, Plug-In Transformer: Bosch #D1640 (included with panel).
b. 12 VAC, 7 Ah Standby Battery: Bosch #D126.
c. Dual Battery Harness (17 inch; 18/AWG); Bosch #D122.
d. Battery Charger Module: Bosch #D8132 (included with panel).
e. Attack Resistant Enclosure: Bosch #D8108A (includes lock, tamper switch and key set).
f. Telephone Jack (RJ31X): Bosch #D166.
g. Modular Telephone Cord (2 ft.): Bosch #D162.
h. Plug-In Telephone Communicator (for POTS line interface): Bosch #B430 (included with panel).
i. Conettix IP Ethernet Communication Module: Bosch #B426 (included with panel).
j. Accessory Mounting Bracket: Bosch #D137.
4. Expansion Boards: Bosch: #B208 Octo-Input Module (8 zone).
5. Control Stations (Keypad): Bosch: #B920 Command Center.
6. End of Line Resistors: ADI Pro 0E-MCR21KPK2 sealed pigtailed resistor pack (or equal).

2.2 INTRUSION DETECTION EQUIPMENT

A. Surge Protection: Comply with minimum requirements of UL Standard 1449 for each component using solid-state devices and having line voltage power source connection or exterior underground signal connection.

B. Interference Resistance: Systems and equipment and their operation not affected by radiated radio frequency interference and electrical induction of 15 V/m over frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25 V rms injected into power supply lines at 10 to 10,000 MHz.

2.3 INTRUSION DETECTION DEVICES

A. Types, features, accessories, and mounting conditions of individual devices are as indicated.

B. Alarm Contact Arrangement: Contact-making intrusion detection devices are single-pole, double-throw type.

C. The 1K ohm resistors shall be installed at the end of line devices. Resistors for active zones shall not be installed within the control panel.

2.4 DOOR SWITCHES

A. Comply with UL Standard 634.

B. All door contacts will have 1 K resistors added or 1 K resistor built in.

C. Balanced magnetic type. Magnet part designed for installation in door; magnetically operated switch installed in door frame. Unit uses bias magnet and sensitive read switch to resist compromise by introduction of foreign magnetic fields.
   1. Flush-Mounted Units: Flush with surface of door frame and door.

2.5 SPACE INTRUSION DETECTION DEVICES

A. Comply with UL Standard 639 and the following general requirements:
   1. Configuration: Dual Technology Devices (passive infrared and microwave) as required to perform functions. Single Technology Devices may not be used.
      a. Intrusion is detected by monitoring both body motion and infrared energy emitted within protected zone. Units detect presence of an intruder and are sensitive to infrared wavelengths emitted by human body. Devices are insensitive to general area thermal variations.
         1) Wall-Mounted Units: Maximum detection range for individual units exceeds scheduled distance by 25 percent, but is not less than 50 feet.
         2) Ceiling-Mounted Units: Full 360 degree conical spot-detection pattern. With device mounted at 8 feet above floor the pattern at floor level is minimum diameter of 7 feet. With device mounted at 25 feet above floor the pattern at floor level is minimum diameter of 18 feet.
      b. Detection by either or both methods results in an alarm signal. A control in device selects operating mode.
   2. Power Source Characteristics: Dedicated 12 VDC from alarm control panel.
   3. Detection Indicator: LED in unit housing, latching-type where indicated.
   4. Self-Testing Capability: Devices shall automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Test failure is signaled to control panel by a trouble signal.
   5. Anti-Masking Capability: Devices shall automatically check operation continuously or at intervals of a minute or less and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Such detection is signaled to the control panel as an alarm signal.
   6. Addressability: Devices shall include communication transmitter and receiver with unique identification and status-reporting capability to system control panel.
   7. Remote Controllability: Devices are individually monitored at system control panel for calibration, sensitivity, and alarm condition and are individually adjustable for sensitivity from panel.

2.6 CONTROL PANEL

A. Comply with UL Standard 1076.

B. Cabinet: Lockable steel enclosure. Arrange panel so operations required for testing or for normal operation and maintenance are performed from front of enclosure. If more than single unit is required to form complete control panel, provide exact matching, keyed alike panels. Accommodate components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure by engraved, laminated, phenolic resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.

C. Control Modules: Types and capacities as required to perform functions of system. Visible and audible signals in control panel indicate alarm, supervisory, and trouble conditions for each zone. Each type of audible alarm has distinct sound.

D. Expansion Boards: Provide and install as many 8-zone, expansion boards (#B208 Octo-Input) as necessary to connect all door contacts and motion sensors. All expansion boards shall be installed in the control panel cabinet or in a like cabinet immediately adjacent to the control panel cabinet. All unused points shall have EOL resistors installed. Popits are not allowed.

E. Zones: Quantity of alarm and supervisory zones and zone assignment numbers as indicated. Provide expansion boards with capacity for expanding number of zones by minimum of 25 percent.

F. Power Supply Circuits: Panel provides power for remote power-consuming detection devices. Provide adequate circuit capacity for at least a 25 percent increase in load. Transformer near the panel, minimum 18AWG copper wire. Earth ground, use #12AWG solid copper wire (minimum).

G. Controller Power Supply: power supply supporting controller hall be a dedicated power supply, plug in transformers (wall warts) shall not be utilized.

H. Power Supply Back-up Battery: All power supplies supporting the IDS controller or remote power-consuming detection devices shall have a back-up battery capability of supporting the provided load for 48 hours.

I. Control Station Keypad (Bosch #B920): Individual LED annunciation for each point. Alphanumeric display for each control panel section/area display devices on the keypad. Manual toggle test-switches or push test-buttons shall not require key to operate. Alarm and supervisory signals display the associated zone.
   1. Alarm keypads installed in areas outside of the operations center shall not produce an audible annunciation for a duress alarm in the spaces to which they are installed, duress alarms shall be silent. Example: Pharmacy duress alarm when active shall not produce an audible tone in the pharmacy.

J. Resetting: Controls permit silencing audible signals for individual zones but prevent the resetting of alarm, supervisory, or trouble signals while condition still exists.

K. The IDS Control Panel shall be located in the Pharmacy IDF room.

2.7 SECURE-ACCESS CONTROL STATIONS

A. Keypad and display module are arranged for entering and executing commands for system-status changes and for displaying system status and command-related data.

2.8 Strobe Siren

A. 30 Watt, 12 VDC, 120 decibel, two-tone, siren type horn with a visual strobe powered by control panel with battery backup.

2.9 KNOX Box

A. The KNOX box shall be connected to the IDS system via two zones to indicate when the box has been opened and when the box has been removed from its mounted location. These tamper zones shall be dual reporting and denoted as high priority.

2.10 WIRE AND CABLE

A. Stranded copper. Size conductors as indicated but not less than recommended by system manufacturer.

B. Cable for Low-Voltage Control and Signal Circuits: All sensors and keypad shall be homerun wired to the #B9512G-USA control panel. Wire will be Class 3, type CL3P/CMP, unshielded, 8-conductor, 22 AWG, stranded copper wire (minimum), except where manufacturer recommends shielded cable. Use wire colors red, green, black, orange, yellow, blue, brown, and white.
   1. Basis of Design: Tappan/Southwire #P20018.1/575631.

2.11 SPECIAL REQUIREMENTS FOR CABLE ROUTING AND INSTALLATION

A. The majority of IDS wiring in this building will be installed above ceilings without conduit. All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC) article 725. All cabling shall bare CMP and/or appropriate markings for the environment in which they are installed.

B. Seal openings between floors, existing or created, for cable pass through fire rated and smoke walls. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the Contractor. Any openings created and left unused, shall also be sealed.

C. Support cables installed in ceiling spaces with wide-base canvas loop suspension devices such as the Erico Caddy #425 Loop anchored to building structural steel (red iron).
   1. Minimum and Maximum Spacing Between Supports: 4 to 5 feet.
   2. Furnish and install additional supports as required.
   3. Install complete cable support device system before starting installation of cable.
      a. Installation of cable before completion of support system not permitted.
      b. Unsupported cable shall not be permitted.
   4. Organize and group cables. Install cable group as single run through ceiling spaces following column and building lines. Do not install cable group runs diagonally across center of building.
   5. Cabling shall not be suspended from any electrical conduits, sprinkler systems, gas, or water pipes, etc.
   6. Cabling shall not be attached to suspended ceiling grid system.
   7. No element of the building structure (i.e. webbing of trusses) shall be used to support any low voltage cabling.

D. Cabling routed underground, or exterior of the building, or through inaccessible ceilings or less than 10 feet A.F.F. in the workroom shall be contained in conduit. Provide flush boxes within finished areas and surface mounted, factory boxes in unfinished areas. Provide 3/4-inch conduit risers with 90 degree sweep-bend and bushing for all wall mounted devices.

2.12 POWER REQUIREMENTS

A. Normal System Power Supply: 120 V 60 Hz from locked disconnect device. System components are supplied with power through system control panel.

B. Power Source Transfer: When normal power is interrupted, system is automatically switched to backup supply without degradation of critical system function or loss of signals or status data.
   1. Backup Source: Batteries in power supplies of individual system components. Such batteries are an integral part of power supplies of components. When system is in "Alarm" mode, power source shall provide a minimum of 4 hours of battery backup, with 48 to 72 hours in "Normal" mode.
   2. Annunciation: Switching of system or any system component to backup power is indicated on system control panel as a change in system condition.

C. The 120 volt feed to the control panel shall be equipped with surge protective device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Execution Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates, and conditions are as required, and ready to receive Work.

C. Report in writing to Project Manager prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost.

3.2 INSTALLATION

A. Install system according to NFPA 70, applicable codes, and manufacturer's published instructions.

B. Comply with UL Standard 681.

C. Installer to be manufacture Certified. Installer will meter test the system to insure proper wiring and function. Do not leave installer lock code in panel. Lock code should be the Bosch Security default code.

D. Connection and Programming Protocol:
   1. Connect the panel to a identified network switch.
   2. Connect cellecuar backup system, install antenna in location to receive adequate signal for operation without the use of building internal cell repeaters.
   3. Adjust the sensitivity of all sensors, adjust and mask if necessary, to prevent false activations.

4. Sensors will not be mounted in close proximity to air handling vents, as this will cause false activations.
5. No sensor to include but not limited to duress/panic, door contacts, or motion detectors will be supervised at the intrusion panel.
6. Tamper switches will be installed on all enclosures, power supplies, and junction boxes utilized to support pharmacy wiring.
7. All IDS cables located in the pharmacy shall be in rigid conduit with threaded connectors.
8. Integrated tamper devices where available will be wired as a separate point.
9. Duress/Panic alarm switches shall be installed under counter/desk approximately 3.5 inches back from the surface edge and in a location not to be accidently bumped by the occupant chair. Switch location shall be installed in such a manner that security force can easily reset the device.
10. Programing shall be coordinated with the customer, ensuring the customer reviews the devices names prior to programing to determine if any changes need to be made.

E. Wiring Within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Provide and use lacing bars and distribution spools.

F. Number of Conductors: As recommended by system manufacturer for functions indicated.

G. Tighten connections to comply with tightening torques specified in UL Standard 486A.

H. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so media are identified and coordinated with system wiring diagrams as specified in Section 260500 - Common Work Results for Electrical.

I. Install power supplies and other auxiliary components for detection devices at alarm control panel or at a data-gathering panel except as otherwise indicated. Do not install such items in vicinity of devices they serve.

J. Install panel and keypad at locations indicated on drawings.

K. Grounding: Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

L. All IDS system wiring shall be homerun from each individual device back to IDS control panel, zone extender, or POPIT (as applicable).

M. All IDS zone extenders and POPITs shall be installed in an enclosure.

N. All IDS zone extenders, POPITs, tamper switches, wireless transceivers, wireless repeaters that are field installed shall be reflected on the red line and as-built drawing packages.

O. At IDS control panel consolidate individual cable runs at a junction box located above ceiling near the IDS control panel with a single conduit down to the IDS control panel. Splicing within any cable run is not acceptable.

P. Keys: Installation contractor shall turn over a minimum two keys for each security enclosure installed and 25 duress reset keys.

3.3 FIELD QUALITY CONTROL

A. Inspection:
   1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
   2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

B. Pretesting: Align and adjust system and perform pretesting of components, wiring, and functions to verify conformance with specified requirements. Correct deficiencies by replacing malfunctioning or damaged items with new items. Retest until satisfactory performance and conditions are achieved.

C. Acceptance Operational Tests:
   1. Perform operational system tests to verify conformance with specifications. Test modes of system operation and intrusion detection. Methodically test for false alarms in each zone of space intrusion detection devices by simulating activities outside indicated detection patterns.
   2. Provide minimum 10 days notice of acceptance test performance schedule to Project Manager who will coordinate.

D. Retesting: Correct deficiencies and retest until total system meets the requirements of Specifications and complies with applicable standards.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within one year of date of Final Acceptance, provide on-site assistance in adjusting and reprogramming to suit actual occupied conditions. Provide up to 2 visits to site for this purpose at no additional cost.

END OF SECTION

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Video management system.
2. Network video recording server.
3. Client workstations.
4. UPS units.
5. Display monitors.
6. Security cameras.
7. Media converters and enclosures.
8. TVSS devices.
9. Ancillary devices and interfaces.

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.

B. This section is inclusive of Division 08 Door Hardware specification and Architectural door schedule.

C. Section 014000 - "Quality Requirements"

D. Section 260533 "Raceways and Boxes for Electrical Systems."

E. This section is inclusive of all Division 27 Communications specification sections.

F. This section is inclusive of all Division 28 sections.

G. Section 078413 "Penetration Firestopping."

H. Section 142000 Vertical Transportation specification

I. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

J. Section 275123 "Emergency Help Points and Call Boxes."

K. Appendix - System Integration Matrix

L. Owner Security Standards:
1. FGI Guidelines for the Design and Construction of Hospitals (2022)
2. FGI Guidelines for the Design and Construction of Outpatient Facilities (2022)
3. IAHSS Security Design Guidelines for Healthcare Facilities 3rd Edition
4. IAHSS Healthcare Security Industry Guidelines 13th Edition
5. The Joint Commission Planning, Design, and Construction of Health Care Facilities 4th Edition
6. Refer to owner security standards, as applicable to the Project.

M. Professional Services
1. Each bidder shall review the professional services scope of work document, associated costs, and all other relevant sections of this specification that require professional services. This review is a mandatory component of the bid response. To ensure compliance, each bid must include a completed and signed Professional Services Compliance Checklist, attached to this bid document.
2. As part of commissioning, the contractor and manufacture professional services shall tune detection zones and thresholds for visual analytics.

1.3 DEFINITIONS

A. Reference Division 01 for additional project definitions. Division 01 supersedes any conflicts.

B. Abbreviations and Acronyms:
1. ACAMS: Access Control and Alarm Management System.
2. ACC: Advanced Audio Coding.
3. AES: Advanced Encryption Standard.
4. API: Application Protocol Interface.
5. CA: Certificate Authority.
6. CPU: Central Processing Unit.
7. DLNA: Digital Living Network Alliance.
8. EULA: End User License Agreement.
9. FIPS: Federal Information Processing Standards.
10. FPS: Frames per Second.
11. Full HD: High Definition video resolution of 1920 x 1080 pixels.
12. GOP: Group of Pictures.
13. GUI: Graphic User Interface.
14. H.264/H.265: Video compression formats.
15. HD: High Definition video resolution of 1280 x 720 pixels.
16. HTML: Hyper Text Markup Language.
17. HTTPS: Hyper Text Transfer Protocol Secure.
18. IDP: Identity Provider.
19. IPS: Infant Protection System
20. I/O: Input/Output.
21. IP: Internet Protocol.
22. JPEG: Joint Photographic Experts Group (image format).
23. LAN: Local Area Network.
24. LPR: License Plate Recognition.
25. MPEG: Moving Picture Experts Group (video format).
26. NAS: Network Attached Storage.
27. NAT: Network Address Translation.
28. NDAA: National Defense Authorization Act.
29. NTP: Network Time Protocol
30. NVR: Network Video Recorder; aka Recording Server.
31. ONVIF: Open Network Video Interface Forum.
32. PTZ: Pan-Tilt-Zoom.
33. RAID: Redundant Array of Independent Disks.
34. RAID-0: Block Level Striping without parity or mirroring (Minium 2 drives).
35. RAID-1: Mirroring without Parity or striping (Minium 2 drives).

36. RAID-5: Block Level Striping with Distributed Parity (Minium 3 drives).
37. RAID-6: Block Level Striping with Double Distributed Parity (Minium 4 drives).
38. Raid-10: (1+0) for mirroring without parity and block level stripping (minimum 4 drives).
39. RTSP: Real Time Streaming Protocol.
40. SDK: Software Development Kit.
41. SOAP: Services Oriented Architecture Protocol.
42. SVQR: Scalable Video Quality Recording.
43. TCP/IP: Transmission Control Protocol / Internet Protocol.
44. UPnP: Universal Plug and Play.
45. UPS: Uninterruptible power supply.
46. VMS: Video Management System.
47. WAN: Wide Area Network.

C. Descriptions:
1. AAC Audio Codec: Advanced Audio Coding is a proprietary audio coding standard for lossy digital audio compression.
2. Active Media Storage: High-performance media storage used for active video, audio and metadata recording.
3. Application Programming Interface (API): Set of clearly defined methods of communication between various software components.
4. Archived Media Storage: Secondary media storage used for storing video, audio and metadata beyond an initial retention period.
5. Authentication: Process that establishes the origin of information or determines an entity's identity.
6. Authorization: Process that associates permission to access a resource or asset with a person and the person's identifier(s) for the purpose of granting or denying access.
7. Bit Rate: Number of bits per time unit sent over a network.
8. Central Processing Unit (CPU): General purpose electronic circuitry within a computer that carries out the instructions of a computer program, typically contained in a single integrated circuit chip.
9. Graphical User Interface (GUI): A visual way of interacting with a computer using items such as windows, icons,
10. Digital Living Network Alliance: Standards-making group for consumer electronics manufacturers establishing interoperability among consumer devices for picture and video display.
11. G.711 Audio Codec: ITU-T standard audio codec that provides toll-quality audio.
12. G.726 Audio Codec: ITU-T ADPCM speech codec standard covering the transmission of voice.
13. Graphics Processing Unit (GPU): Specialized electronic circuit designed to rapidly decode video, manipulate images and accelerate the creation of video images in a video frame buffer intended for output to a display device, much more efficiently than can be done by general purpose computer CPUs. GPUs are used in mobile phones, personal computers, workstations and game consoles.
14. Hardware Acceleration: Use of computer hardware (such as a GPU) to perform some functions more efficiently than is possible in software running on a more general-purpose CPU.
15. Kerberos: Ticket-based network authentication protocol designed to provide strong authentication for client/server or server/server applications.

16. Manufacture's Professional Services: Services offered by the manufacturer of the video management system designed to ensure the effective deployment and operation of the installed solution. These often include:
    a. System Design and Planning
    b. Installation and configuration
    c. Testing and support
    d. Integration Services
17. Multi-site: Reference to a VMS that spans multiple physical site locations.
18. Open Network Video Interface Forum (ONVIF): Global and open industry forum for the creation of standards for how IP-networked products within video surveillance and other physical security areas can communicate with each other.
19. Perpetual license: A software licensing model where a user pays a one-time fee to use a specific version of the software indefinitely. Unlike subscription models, it does not require ongoing recurring payments. While the user owns the software version.
20. Pre-buffering: Temporary storage of video and audio for pre-recording.
21. Pre-recording: Automatically recording video and audio starting a specified number of seconds just before the event or time condition that initiated the recording.
22. Post-recording: Automatically continuing the recording of video and audio for a specified number of seconds after the end of the event or time condition that initiated the recording.
23. PTZ Patrolling or PTZ Tour: Automatically moving a camera through a specified series of preset PTZ positions, dwelling on those positions for a specified amount of time, and transitioning between the preset positions at a specified speed.
24. Reseller: Contractor authorized by manufacturer to furnish, install and maintain manufacturer's VMS, who may be the primary contractor or a subcontractor for the provision of this project's VMS.
25. Universal Plug and Play (UPnP): Set of networking protocols that permits networked devices, such as personal computers, printers, Internet gateways, Wi-Fi access points, IP video cameras and mobile devices to seamlessly discover each other's presence on the network and establish functional network services for data sharing and communications.

1.4 ACTION SUBMITTALS

A. Product Data: Complete product data and technical specification data sheets that include manufacturer's data for all material and equipment..

B. Shop Drawings: Shop Drawings and Schematics: Shall depict the VMS in final proposed "as built" configuration. The following must be provided:
    1. Device floor plans,
    2. Connection diagrams for interfacing equipment.
    3. One-line diagrams
    4. Network interfaces
    5. Block diagrams,
    6. Riser diagrams,
    7. Typical device installation details,
    8. List of connected equipment.

9. Locations for all major equipment components to be installed under this specification.

C. Video storage calculations, based on equipment provided for Project.

D. Sustainable Design Submittals, as applicable to Project.

E. Test Reports: Submit the following reports directly to Project Manager from Manufacturer's Quality Control Inspector, with copy to Contractor. Prepare reports in conformance with Section 014000 - Quality Requirements:
1. Testing plan.
2. Pre-test.
3. Acceptance test.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
1. Installer certification from video management system manufacturer.
2. Manufacturer certifications for technicians and installation supervisor.
3. Manufacturer certification for API interface software, as applicable.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Closeout Documentation:
1. Operation and Maintenance Data: Include data for each type product, including features, testing plan and operating sequences, both automatic and manual. Include user's software data and recommendations for spare parts to be stocked at the site. Provide names, addresses, and telephone numbers of service organizations that stock repair parts for the system.
2. Project Record Documents: Record actual locations of equipment and devices, and routing of alarm wiring.
3. Licensing
   a. Software
   b. Hardware
   c. Firmware
   d. Operational/ User
   e. Administrative
4. Completed Readiness Checklist.
5. Final Test Result Report.
6. As-Built Drawings.
7. Operation and Maintenance Manuals (O&Ms).
8. Warranty Information.

1.7 QUALITY ASSURANCE

A. Installer/Contractor Qualifications:
1. Installer must be a factory authorized and certified installer of the security equipment supplied in this project and shall have been regularly engaged in the installation of the type of security equipment, hardware, and software. The contractor shall be factory trained on the VMS and associated products they propose and shall submit with their proposal a certificate from the manufacture indicating their satisfactory completion of training for the VMS proposed.

2. Installer must have certified technicians and project supervisor certified by the video management system manufacturer to install the provided system.
3. Minimum 5 years' experience of satisfactory performance on projects of similar size and scope. Provide owner with references upon request. Prime system manufacturers and manufacturers of major system components are required to qualify separately.
4. Installers shall be licensed where required by the state or county.

B. All supplied equipment shall be current models in production by manufacturer. If any items listed within are no longer produced, notify Architect of the planned substitution with the most current equivalent product.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Facility Management Compliance: Provide RPM-approved video surveillance systems and components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Cameras, recording servers, and CPUs:
1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Do not deliver or install equipment until HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.10 COORDINATION AND MEETINGS

A. Location: Conduct conferences on project site or other location a directed by the Architect/Owner.

B. Preinstallation Conference
1. The purpose of the preinstallation conference is to:
a. Coordinate between trades, so all un

C. Coordinate security conduit pathway requirements with EC and GC prior to rough-in work.

D. Coordinate telecom data cabling requirements with Division 27 structured cabling contractor.

E. Coordinate security installation and commissioning requirements with owner security personnel.

F. Coordinate security equipment networking requirements with owner IT personnel.
   1. Equipment and devices will communicate over owner LAN, via owner provided PoE switches.
   2. Assemble and maintain an IP security device schedule, itemizing data port quantities, locations, and other networking requirements, for coordination with owner IT during installation.

G. Coordinate elevator cab devices with elevator supplier.

H. Coordinate VMS devices with help point (blue light) supplier.

I. Coordinate video intercom recording with intercom supplier.

J. Coordinate pharmacy device installation, workstation, recorder replacement, and camera field of views with GC, electrician and owner's representative.

K. Coordinate Visual Alerts (AI-Assisted Event Detection) cameras and behaviors for with owner to determine which cameras analytics shall be applied to.

1.11 WARRANTY

A. Warranty Period: Provide one (1) year warranty from date of Substantial Completion on all parts and installation.

B. Special Warranty: Provide minimum three (3) year manufacturer warranty on all supplied cameras, servers and recorders.

PART 2 - PRODUCTS

2.1 VIDEO MANAGEMENT SYSTEM MANUFACTURER

A. Manufacturer shall have regularly produced, as one of the manufacturer's principal products, an ACAMS similar to that specified for this project for at least ten (10) years.

B. Proposed product substitutions must conform to the functional requirements of this specifications document. System architectural differences are acceptable as long as functional requirements are met under the alternate architecture. Windows 32-bit applications may not be substituted for 64-bit applications.

C. Video Surveillance System, Basis-of-Design Product is Avigilon Unity Video system.
   1. Avigilon Unity Video.

D. Security Cameras, Basis-of-Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include:
   1. Avigilon

E. VISUAL ALERTS - AI-ASSISTED EVENT DETECTION
   1. Basis of Design: Avigilon Visual Alerts powered by AI Appliance (Current Generation)

2.2 SYSTEM DESCRIPTION

A. Video Management System (VMS): Provide a complete, operational, turn-key VMS system, as indicated on the Drawings and Specifications. Provide all necessary equipment, cabling, installation, software, licensing, configuration, programming, and commissioning.

B. The VMS must be capable of supporting an unrestricted number of users, devices, servers and sites, with options for central administration and monitoring operations and mobile devices.

C. System equipment and installation must comply with all provisions and requirements of this specification as well as all applicable national, state and local codes and standards.

D. General Requirements:
1. The solution shall be managed centrally and provide web-based monitoring and control capabilities.
2. VMS shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
3. The system shall be an enterprise-level network video solution, providing flexibility for video monitoring and storage methods, and redundant capabilities. System must be capable of expansion and provide sustainability.
4. Graphical user interface software shall manage all IP-based video camera and control functions, alarm monitoring and control, recording, and video archive/retrieval management.
5. VMS shall be an open architecture platform, be non-proprietary, and be ONVIF compliant.
6. System design shall include all necessary compression software for high-performance, dual-stream, H.264, H.265, and MPEG-4 video.
7. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
8. Cameras shall be high-definition IP PoE type units, ruggedly built and designed for adverse environments where applicable, complying with NEMA Type environmental standards.
9. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
10. The system must provide robust cyber security protection, including industry standard certifications, and offer manufacturer cyber security hardening guide.
11. VMS must be capable of automatic, scheduled, long-term archiving to alternate data storage method, such as cloud-based applications or connected storage hardware.
12. System must be capable of API integration with industry standard, open architecture third-party solutions and devices.
13. System must be capable of privacy masking.
14. Camera call-up via ACAMS alarm integration:
    a. Provide API integration of the Video Management System into the Access Control, Motorola Radio System, and Alarm Management System (the primary security management and communication platform), refer to Section 281300 Access Control.

b. Automated video alarm verification via video call-up shall occur based on an alarm event with nearest camera. Coordinate security alarm automatic camera call-up functional requirements with owner during system configuration and programming.
c. Provide alarm call up and live video on Motorola radios (provided by other).

15. Camera call-up via Intercom integration.
    a. Provide API integration of the video management system and the IP intercom system, refer to Section 281300 Access Control.
    b. Automated intercom call-up for calls into the security operations center from exterior intercoms based on the initiation of the call with the nearest camera. Coordinate security alarm automatic camera call-up functional requirements with the owner during system configuration and programing.
16. Provide an AI analytics engine that ingests live camera streams from the Video Management System (VMS) to detect security-relevant objects and events using Natural Language Prompts for 800 camera lenes.
17. Visual Alerts Service: Provide a service that subscribes to designated camera streams and posts alert objects into the VMS event pipeline for rules, alarms, and search. System shall support standalone architecture for Generative AI processing.

E. System Architecture: The VMS shall consist of:
1. Servers: Capable of one or more VMS servers.
    a. Provide Physical Recording Server(s) as indicated on the Drawings
        1) VMS must be capable of Virtualized Windows servers, using:
            a) Microsoft Hyper-V.
            b) VMWare.
    b. Provide UPS units to support physical servers, POE devices, cameras, and client workstation. Sized to provide four-hour runtime at normal load. Runtime can be reduced to 30 minutes if line voltage power is supplied by back-up emergency generator.
        1) Basis-of-Design Product:
            a) APC Smart-UPS series products.
2. Server Software Components: One or more software components by Manufacturer, or software components made by others as noted, per VMS server.
    a. Management Server: Central service component of the VMS responsible for handling system configuration, distributing the configuration to other system components, such as recording server services, and for facilitating user authentication.
    b. VMS must be capable to support Server Failover. Where indicated on drawings, provide a second server which shall take over the management server function if the first server fails.
        1) Failover Management Server: Installation of the management server service in a Microsoft Windows Failover Cluster, or similar compatible third-party software.
    c. Recording Server: Service responsible for communications, recording and event handling for all devices (cameras, video and audio encoders, I/O modules, metadata sources, etc.), including:

1) Retrieving video, audio, metadata and I/O event streams from devices.
2) Recording video, audio and metadata.
3) Providing access to live and recorded video, audio and metadata.
4) Transmit live audio from operator's microphone to one or more camera speakers or supported IP speakers.
5) Providing access to device status.
6) Triggering system and video events on device failures, events, etc.
7) Writes video streams, audio streams and their metadata to a high-performance media database.
8) Performing motion detection and generate smart search metadata.

d. Event Server: Service that handles various tasks related to events, alarms, maps and third-party integrations via the Software Development Kit (SDK).
e. Log Server: Service that writes all system, audit and rule-triggered log messages to database.
f. Service Channel: Service responsible for communicating the following:
1) Service and configuration messages to full viewing client.
g. Mobile Server: Service responsible for hosting the web client and for providing access to the VMS for web client and mobile client users.
h. ONVIF Out: Optional server, plus 64-bit plug-in for management client. This is to enable private-to-public video integration.
i. DLNA Out: Service to enable display of live video on any DLNA compliant TV or displays without the need for additional equipment.
j. Microsoft SQL Server: Microsoft database server service for the management server, event server and log server services.
k. API Gateway: Service that provides a front-end and common entry point for RESTful API services on other VMS server components. Microsoft Active Directory: Active Directory is not required for single-site systems but is recommended for cyber security purposes.

3. PC or Laptop Workstations: One or more PCs or laptops for client software applications intended to run on Windows-based PCs and laptops.
a. Management Client: The administration interface for all parts of the VMS, designed to be run remotely from, for example, an administrator's computer.
b. Full Viewing Client: Designed for day-to-day use by dedicated operators, to be run remotely on the operator's computer. Full viewing client provides dedicated task-oriented tabs for Live Video, Video Playback, Search, plus dockable tabs for Alarm Monitor. Full viewing client supports definable keyboard and joystick button shortcuts for frequently-used actions, including window or camera selection.
c. Web Client: Browser-based application for the occasional or remote user that needs easy access to live video monitoring and audio listening with PTZ control including use of presets, and video and audio playback and export, with defined exports available for later usage or download.
4. Video Walls: VMS must have the ability to support one or more video walls.

5. Networks:
    a. Multiple Network Segments: The VMS must support network segmentation into separate device, server and internet-connected networks.
    b. Device Network: Local network whose capacity and configuration are suitable for the level of video, audio and metadata data transmission established by the system design and its intended usage.
    c. Server Network: Local network whose capacity and configuration are suitable for the level of video data transmission, systems integration, and user operations established by the system design and its intended usage.
    d. Internet-Connected Network: Internet-connected network providing connection to remote VMS sites and private-to-public connection via ONVIF Out. This network is also used for remote user access via the mobile server.
    e. Network Traversal:
        1) Enable software clients to access recording server services from outside a NAT firewall, by the use of public addresses and port forwarding.
        2) Provide Remote Connect Services that enable secure remote connections to devices across different types of private and public networks.

F. Multi-System Architectures: Provide the following architecture option for multi-site deployments:
    1. Distributed Recording Server Services: Intended for sites with stable network connections between the central site and any number of remote sites.
        a. Management server at central site is providing user authentication and authorization for all distributed recording server services.
        b. Each site has at least one recording server.

G. AI Analytics engine shall:
    1. Performance Requirements: The engine shall:
        a. Process server-side (no camera firmware dependency) and classify people/vehicles and other supported object types.
        b. Support definable detection zones, schedules, and suppression/exclusion regions to reduce nuisance alarms.
        c. Publish alert metadata (time, source camera, object class, confidence, thumbnail) to the VMS for alarm handling, search, and audit.
        d. Operate on a dedicated analytics appliance (Avigilon AI Appliance 2X Model CG3).
        e. Use encrypted transport for inter-service communication consistent with the VMS existing HTTPS/TLS controls.
        f. Be fully NDAA-compliant.
    2. Video Input Quality & Environmental Constraints:
        a. High Definition Requirement: To ensure Generative AI accuracy, the system shall leverage High Definition video streams.
        b. Stream Selection:
        c. For native manufacturer cameras, the system shall utilize the secondary stream configured to a minimum of 2MP resolution (untiled).
        d. For third-party cameras, the system shall utilize the primary high-resolution stream.

e. Lighting Constraints: Analytics shall be applied to scenes with adequate visible spectrum lighting. IR-illuminated (Night Mode) scenes shall not be utilized for Generative AI detection due to insufficient detail for reliable classification.
f. Lens Distortion: Analytics shall be applied primarily to standard rectilinear views. Panoramic or Fisheye views shall be utilized only if the video stream is de-warped prior to analysis or if detection is limited to the non-distorted center of the field of view.

2.3 TECHNICAL CRITERIA

A. Scalability: Provide component-based system architecture to support scaling of VMS from small systems (up to 100 devices) to very large systems (several thousand devices) for single-site or multi-site deployment, whereby:
1. For Large Systems: Software components can be installed on separate dedicated servers to scale and distribute the load.

B. Availability and High Performance: Provide the following capabilities to ensure high VMS availability and performance.
1. Failover Recording Server: Provide hot and cold failover recording server capabilities.
2. Management Server, Event Server, Log Server, API Gateway: Support Windows Server Failover Clustering, or similar.
3. Storage solution shall be configured with RAID10 for Live database and RAID5 or RAID6 for archive database.

C. Operating Systems: Provide server and client software applications that are native 64 bit Microsoft Windows applications.

D. Network Addressing: Support both IPv4 and IPv6 addressing.

E. Video Standards: Provide simultaneous live streaming and recording of video from IP cameras and IP video encoders without any software limitations on the number of cameras per recording server, with support for the following codecs and options:
1. Codecs:
a. H.264 and H.265
b. MPEG-4 and MPEG-4 ASP
c. MJPEG
d. MxPEG
2. Options:
a. Toggling between recording key frames only or full video stream for MPEG-4, H.264 and H.265 video.
b. Adjustable GOP length for MPEG-4, H.264 and H.265 video.
c. Toggle between recording full framerate from the camera and any lower FPS for MJPEG video.

F. Video De-Interlacing: Provide live video views with an adaptive de-interlacing option, to improve the quality of interlaced video, based on the actual video content received, for example, to smooth area of an image where object lines would otherwise appear as jagged lines.

G. Multi-Live Video Streaming: Provide multiple streams for live viewing using any combination of supported standards, video resolutions and frame rates.

H. Adaptive Streaming: Depending on the requested resolution, provide automatic selection between the video streams configured for multi-live video streaming to these clients:
   1. Full Viewing Client: Live video streams from the Recording Server to the full viewing client or video wall.
   2. Web Client: Live video streams from the Mobile Server to the web client.
   3. Mobile Client: Live video streams from the Mobile Server to the mobile client.

I. Direct Streaming: Provide live video streams in these codecs directly from the Mobile Server to clients without transcoding:
   1. Web Client: Provide MJPEG and H.264 live video streams.
   2. Mobile Client: Provide H.264 and H.265 live video streams.

J. DLNA Support: Provide the ability to easily display live video from the installed cameras directly onto any modern consumer-grade TV supporting DLNA functionality.

K. Hardware Acceleration Full Viewing Client: Provide the following hardware acceleration capabilities to offload full viewing client video processing from the computer CPU to dedicated hardware video processing capabilities:
   1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding, color correction, and scaling.
   2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding, color correction, and scaling.
   3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.
   4. Provide the ability to show which GPU is used to decode which stream.

L. Hardware Acceleration Recording Server: Provide the following hardware acceleration capabilities to offload recording server video processing from the computer CPU to dedicated hardware video processing capabilities:
   1. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding to enable server-side motion detection.

M. Hardware Acceleration Mobile Server: Provide the following hardware acceleration capabilities to offload mobile server video processing from the computer CPU to dedicated hardware video processing capabilities:
   1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding to enable adaptive transcoding.
   2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding to enable adaptive transcoding.
   3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.

N. ONVIF Out Functionality: Provide access to live and recorded video, and the ability to control pan-tilt-zoom cameras in compliance with the relevant ONVIF Profile G and Profiles S standards.

O. Camera-Independent Motion Detection: Provide real-time, camera-independent motion detection with:

1. Configurable Sensitivity: Configurable and automatic motion-detection sensitivity per camera
2. Searchable Metadata: Searchable motion detection metadata created during motion detection.
3. Exclusion Zones: Multiple motion exclusion zones definable per camera to keep irrelevant motion from triggering recording.

P. PTZ Control Priorities:
1. Provide 3 PTZ priority levels for control of rights between different operators and automatic scanning and patrolling schemes.
2. PTZ Scans and Patrols shall pause for higher-priority manual or event-based camera control, and resume after manual session timeout and completion of event camera control period.

Q. Configurable Pre-Buffering: Provide pre-buffering with variable buffer length, with the ability to place buffer on disk or in memory.

R. Device Video Quality Optimization: Provide video quality optimized per available bandwidth, device screen resolution, and camera view window sizes in these clients:
1. Full Viewing Client Optimization:
   a. Switch between all configured live video streams from the cameras to optimize bandwidth consumption and workstation performance.
   b. Optimize viewing performance for remote viewing according to the available bandwidth and view layouts, maximizing video stream quality per display capabilities of defined views.
2. Web Client and Mobile Client Optimization: Optimize transcoding by capping video stream resolution and frame rate for transmission to web client and mobile client.

S. Multiple Language Support: Provide support for multiple languages in these clients:
1. Management Client User Interface: American English, Chinese (Simplified), Chinese (Traditional), Danish, French, German, Italian, Japanese, Korean, Portuguese (Brazilian), Russian, Spanish, Swedish and Turkish.
2. Management Client Built-In Help: American English, Chinese (Simplified), French, German, Japanese, Korean and Portuguese (Brazil).
3. Full Viewing Client, Web Client and Mobile Client User Interface: American English, Arabic, Bulgarian, Chinese (Simplified), Chinese (Traditional), Croatian, Czech, Danish, Dutch, Farsi, Finnish, French, German, Hebrew, Hindi, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian (Bokmål), Polish, Portuguese (Brazilian), Russian, Serbian, Slovak, Spanish, Swedish, Thai, Turkish, and Ukrainian.
4. Full Viewing Client Built-In Help: American English, Arabic, Chinese (Simplified), Chinese (Traditional), Czech, Danish, Dutch, French, German, Italian, Japanese, Korean, Polish, Portuguese (Brazilian), Russian, Spanish, Swedish and Turkish.
5. Web Client and Mobile Client Built-In Help: American English, Danish and Japanese.

T. True Multi-Window Support: Provide true multi-window support in full viewing client whereby secondary windows have full functionality and can be operated in independent mode or synchronized mode where they follow the control of the main window.

U. System Capacities: Provide the following maximum capacities, constrained only by the physical performance capabilities of installed server hardware and network infrastructure:
1. Unrestricted devices.
2. Unrestricted client software users.
3. Unrestricted mobile devices.
4. Unrestricted client PCs or laptops.
5. Unrestricted servers.
6. Unrestricted sites.
7. Unrestricted system rules.
8. Unrestricted time profiles.
9. Three software client profiles.
10. Unrestricted media storage.
11. Recording rates of at least 30 FPS per camera, limited only by hardware capabilities.

V. Analytics Processing: The system shall support server-side visual analytics with:
1. RTSP/H.264/H.265 ingest from VMS-managed cameras.
2. Intelligent Stream Management: System shall automatically select the optimal stream for analysis (e.g., untiled secondary stream for bandwidth efficiency on native cameras) to maximize appliance throughput without affecting recorded video quality.
3. Tuning parameters (confidence thresholds, dwell times) per alert type.
4. Health monitoring and alerting when analytics are degraded or offline.

2.4 SECURITY

A. Control and Information Security: Provide the following data protection measures and user rights management capabilities in support of system confidentiality, integrity and availability:
1. Data in Transit: Encrypted communication between servers and clients using secure communication CA digital certificates.
   a. HTTPS connections from recording server to devices that support HTTPS connections.
   b. Encrypted communication between the recording server and services that retrieve streaming data using customer-provided CA digital certificates for connections to the recording server.
   c. Encrypted communication between the management server and the recording server using customer-provided CA digital certificates.
   d. HTTPS connections from VMS clients, SDK clients and services that support HTTPS connections to recording server.
2. System Configuration Data: Provide password protection of the system configuration backup.
3. Off-Premises Live and Recorded Video in Transit: HTTPS connections must use trusted CA certificates and support HTTPS connections from:
   a. Mobile server to browser-based web client and mobile client app.
   b. ONVIF Out to remote public systems.
4. Data Integrity of Exported Video:
   a. Export video in database format that can only be viewed in the Full Viewing Client - Player.
   b. Per-export password protection for playback.

c. 256-bit AES encryption.
d. Digitally signed media exports with SHA-2 algorithm to establish a means of detecting modification of exported video.
e. Full Viewing Client - Player's Verify Signatures function to validate authenticity of exported video recording.
f. Option to prevent re-export of exported video.

5. Digital Certificates: Use of customer-provided CA digital certificates for connections to the mobile server.
6. Data Access Control: Provide:
   a. User profiles restricting device access and video viewing, playback and export, including by day and time-of-day.
   b. Timestamped audit log of who logged in, viewed live or recorded video, or exported video.

B. User Authentication:
1. Log-in Options: Log-in authentication via:
   a. Microsoft Active Directory.
   b. Local Windows user accounts.
   c. External IDP using Open ID Connect to facilitate single sign-on.
   d. Basic user system account (username and password credentials).
      1) Ability for basic user to change password during login.
      2) Ability for system administrator to enforce password change during login.
      3) Ability to enforce password complexity.
   e. Dual authentication, a.k.a. two-person rule, requiring two verified persons to gain access.
2. Auto-Log-In: Use of last used credentials for authentication, with Auto-log-in and auto-restore of camera views.
3. Kerberos Authentication: Provide strong authentication via Kerberos support.

C. User Rights Management: Provide common and central detailed management of user rights across all user and programmatic (SDK) interfaces, using roles, users, and user groups:
1. User Rights: Define roles, add and delete users, manage permissions for roles, user groups and users, generate user rights management reports.
2. Roles: Defining roles establishes permissions (also called "rights") that determine which system features may be accessed by users and groups. Provide the following security settings for roles:
   a. Role Info:
      1) General: Full viewing client profiles, dual authorization rights.
      2) Applications: Login to full viewing client, web client and mobile client.
      3) Anonymous PTZ Sessions: Enabling anonymous user information for PTZ sessions.
   b. Users and Groups: Users and groups can be assigned to multiple roles.
   c. Overall System Permissions: Globally allow or deny permissions for servers, devices and functions (such as manage, read, edit and delete).
   d. Specific System Permissions: Allow permissions for specific individual devices and functions:

1) Cameras: Visibility, live view (within time profile), playback (within time profile), search sequences, smart search, export, manual recording, bookmark functions, AUX commands.
2) Microphones and Speakers: Visibility, listen to live audio (within time profile), playback audio (within time profile), search sequences, export, manual recording, bookmark functions.
3) Inputs and Outputs: Visibility, activation.
4) PTZ Control: Manual control, activate PTZ presets, PTZ priority, manage PTZ presets and patrolling.
5) Speech: Speak to speakers, speak priority.
6) Remote Recordings: Retrieve remote recordings.
7) External Events: Visibility, edit, delete, trigger.
8) View Groups: Visibility, edit, delete, operate.
9) Servers: Professional server access and authentication details.
10) Matrix: Visibility.
11) Alarms: Manage, view, disable alarms, receive notifications.
12) SDK: SDK plug-in permissions.

D. Client Authentication: Provide management server authentication and authorization of connecting clients (full viewing client, management client and SDK clients) and use a session-limited access token for controlling access to the recording server.

E. System Hardening: Manufacturer system hardening guide which:
1. Describes data security, network security and physical security measures and best practices for securing the installed VMS against cyber-attacks. This includes security considerations for the hardware and software of servers, clients and network device components of a video surveillance system.
2. Incorporates standards-based and best-practice-based security and privacy controls and maps them to each hardening recommendation.

F. GDPR: The system must facilitate compliance to GDPR:
1. GDPR-Ready Certification: The VMS must have a European Privacy Seal from GDPR ready certificate.
   a. The vendor shall provide comprehensive guides and templates to aid in configuring a GDPR compliant system.
   b. The vendor shall have a clear and concise privacy policy.
2. The system shall provide warnings when use of the system is at risk of going outside GDPR compliance.
3. Privacy by default: The VMS must have privacy settings set by default.
   a. The system shall have audio data processing disabled by default.
   b. The system shall have metadata, recording, transmission, and other processing disabled by default.
   c. The system shall have online map services disabled by default.

G. FIPS 140-2 compliant mode: The VMS has the ability to operate in a FIPS 140-2 compliant mode.

2.5 LOGGING

A. Provide logging of errors, warnings, system information, user activity, and logs about rules to a centralized database with time, date, and other related information. Logs provide multi-system support and configurable logging limits.

1. System Logs: Log all system related errors, warnings and system information, to be used for troubleshooting.
2. Audit Logs: Log user activity in client applications including, but not limited to, user system access, configuration changes and operator actions.
3. Rule-Triggered Logs: Log rules in which the system administrator has specified the "Make new log entry" action.
4. Log Exporting: Logs can be exported as comma-separated-values (.csv) files.
5. Log Filtering: Logs can be filtered based on time frame, source name, source type, user, user location, rule name, etc.
6. Log-Related Options: Settings can be changed about:
    a. Log retention time.
    b. Which levels (error, warning, and system information) are logged.
    c. Log security.

2.6 FUNCTIONALITY

A. Configuration Management:
1. Real-Time Configuration Change Application: Immediately apply authorized changes of system configuration data for all sites, including, but not limited to licenses, devices, rules, schedules, users, maps, alarms, recording, client views, including while recording is in operation.
2. Configuration Data Caching for Continued Operation: Cached recording server configuration data shall ensure continuous operation of recording server during periods where the management server is inaccessible.
3. Backup and Restore: Built-in backup and restore support for manual system backup of all configuration data, including but not limited to:
    a. All system configuration data.
    b. Full device configuration data.
    c. Maps.
    d. Alarm settings and definitions.
    e. Software client views.
    f. User-defined rules and events. Defined video bookmarks.
4. Configuration Reporting: Provide complete or partial documentation of system configuration, including custom and site-specific free-text information, contractor's notes and option for logo inclusion.

B. Application Workspace Optimization:
1. Options for optimizing application workspaces in the management client software:
    a. Application Layout: Rearranging layout via drag-and-drop.
2. Options for optimizing application workspaces in the full viewing client software:
    a. General: Control general look and feel and navigation properties, such as color mode, camera title bar, grid sizes.
    b. Personal or Centrally Enforced: Optimization can either be made as individual personalization managed by each operator, or centrally enforced using full viewing client profiles.
    c. View Layouts: Availability of specific view layouts enforced using full viewing client profiles.
    d. Themes: User interface color schemes enabling user choice of dark or light themes.

e. Control Panes Availability: Control availability of control panes and functions in live and playback tabs, and in setup mode.
f. Timeline Information: Control information included in timeline in playback tab.
g. Export Behavior: Control behavior and availability of export function.
h. Keyboard and Joystick Setup: Setup of keyboard short cuts and joystick controls.
i. Alarm and Access Control Notifications: Control behavior of alarms and access control notifications.
j. Application Language: Control application language.
k. Advanced Application Settings: Control advanced application settings such as use of hardware acceleration, videos diagnostics overlay and time zone settings.

C. Device Discovery and Management:
1. Add Hardware wizard to automatically discover and upon approval add devices to system using Universal Plug and Play (UPnP) discovery, IP network range scanning, or manual device detection. User ability to perform initial setup of credentials on devices without factory default credentials detected. Must be supported for Axis, Bosch, Hanwha Tecwyn, and for other ONVIF profile Q conformant devices.
2. Replace Hardware wizard for swift replacement of malfunctioning devices with preservation of configuration settings and recordings, including those for attached cameras, microphones, speakers, inputs, outputs and metadata devices.
3. Move Hardware wizard for moving devices and related devices from one recording server to another during runtime with no loss of settings, recordings, rules, permissions etc.
4. User ability to enable and disable devices for purposes of maintenance or temporary deactivation.
5. User ability to change the password of one or multiple devices based on a pre-configured time interval. Must be supported for Axis, Bosch, Hanwha Techwin, and for other ONVIF-compliant devices.
6. User ability to see the firmware version of each device.
7. User ability to update information about the firmware and features available for a device.
8. User ability to upgrade the firmware of single devices. Must be supported for Axis, Bosh, Hanwha, Techwin and ONVIF.
9. For ONVIF Profile T & Q compliant devices. User ability to manage a VMS user account that communicates with a device. Add a user, list an existing user, and delete a user.
10. For ONVIF Profile T & Q compliant devices. User ability to manage network configuration. Change IP address, subnet mask, and default gateway.

D. Camera Image and Video Stream Management: Adjustment of per-camera and per-video stream settings, with each camera allowed one or more streams for live viewing and one stream for recording, including an optional per-camera or per-camera-group preview window:

1. Per Camera:
   a. General Settings: Change all camera specific general settings such as brightness, color level, compression, maximum bit rate, resolution and image rotation.
   b. Camera Video Stream Settings: Define as many different streams as specific camera support. Change individual stream settings such as FPS, resolution, image quality, video encoding format and resolution.
2. Per Camera Group:
   a. General Settings: Change all common camera specific general settings for the camera group such as brightness, color level, compression, maximum bit rate, resolution and image rotation.
   b. Camera Video Stream Settings: Define as many different streams as specific camera support for the camera group. Change individual stream settings such as FPS, resolution, image quality, video encoding format and resolution.
   c. One camera can be associated to multiple camera groups.
3. Video Streams: Define one camera video stream used for recording and one camera video stream to be used for live viewing.
4. Recording: Manage recording functionality including:
   a. Related device recording.
   b. Manual recording timer.
   c. Pre-buffer use.
   d. Recording framerate.
   e. Media storage assignment.
   f. Automatic retrieval of edge recordings.
5. Fisheye Lens Viewing: Capability for fisheye lens camera views provided through utilization of panomorph lens technology.
6. Motion Detection: Manage motion detection functionality including:
   a. Motion sensitivity.
   b. Processing all frames or keyframes only.
   c. Generation of motion metadata for smart search.
   d. Exclusion zones.
7. Camera Events: Define which camera events will be forwarded to the VMS.
8. Client Settings: Define client related functionality including:
   a. Related devices.
   b. Keyboard shortcut.
9. Privacy Masks: Permanent and liftable system-defined camera image privacy masks hide certain areas in the camera image for live view, recording, and video export.
   a. Permanent Masks: Allow a system admin to mask areas in cameras at all times and for all users. Permanently masked areas cannot be revealed once recorded.
   b. Liftable Masks: Allows a system admin to establish default mask areas in cameras at all times and for all users, but with the option to sufficiently privileged operators to temporarily remove the masks for authorized users if needed - such as during investigation.
   c. Masking Level: When establishing a privacy mask, system admins may select a mask level on a scale between 'light blur' to 'solid grey'.

E. PTZ Camera Control: Camera-based and system-based PTZ camera control including the following capabilities.
   1. Camera PTZ preset positions: Camera-based PTZ presets may be imported from the camera and renamed for use in system-based manual and automatic PTZ control.
   2. Automated Use of PTZ Presets: Scheduled and event-based rules capability to move PTZ cameras to pre-set positions.
   3. System-Based PTZ Preset Positions: System-based PTZ presets are definable for use in system-based manual and automatic PTZ control.
   4. PTZ Patrolling: Multiple per-camera PTZ patrolling schemes may be defined with the following options:
      a. Adjustable wait times between preset position changes.
      b. Disabling of motion detection to avoid false detection alarms.
      c. Multiple patrolling schedules per camera per day, with different schedule for days, nights 2.0C-H6A-DO1 and weekends.

2.7 EVENT AND ALARM MANAGEMENT

A. Rules Engine: Provide rules for automating of different aspects of the system, including camera control, system behavior and external devices, based on events or time profiles, or a combination of events and time profiles.
   1. Trigger Events: Provide a Microsoft-Outlook-style configuration dialog where pre-defined and custom-defined events are used in rules to trigger actions.
      a. Event Categories: Organize events into the following categories:
         1) Hardware: Physical hardware devices connected to the system.
         2) Devices: Certain functions and states of devices available via connected hardware devices.
         3) External: Relating to VMS integrations.
         4) Recording Server: Archiving and database functions.
         5) Analytics: From integrated analytics applications and systems.
         6) User-Defined: Custom-configured events enabling users to manually trigger actions and events in the system.
   2. Start Actions: Triggering events may initiate a wide set of system actions, including, but not limited to:
      a. Control start and stop of recording, including scheduled and event-based recording.
      b. Change camera stream properties.
      c. PTZ camera preset positions and patrols.
      d. Event-based notifications, including email notifications to single or multiple recipients with optional attachment of a camera still image or AVI video clip.
      e. External system interactions.
      f. Play pre-recorded audio.
      g. Retrieve video and audio from edge storage devices.
      h. Single rule allows for executing multiple system actions.
      i. Rule actions shall be triggered by event, time interval or a combination of event and time.
      j. Rules shall be optionally stopped by event or after a specified time.
      k. Unrestricted number of rules.

B. Time Profiles: Provide the following time profile functionality for use with profiles, rules and triggers:
   1. Time profiles contain one, or more, single or recurring periods of time.
   2. A single time period may span one or more days, defined by a starting date and time and an ending date and time.
   3. A recurring period of time is defined as a time range with recurrence pattern and range:
      a. Time range is a starting and ending time within a day.
      b. Recurrence pattern may be Daily, Weekly, Monthly or Yearly.
      c. Recurrent range is a starting and ending date, or a starting date with a duration in days.
   4. Unrestricted number of time profiles.

C. Single-Point Event/Alarm Management: Provide central management of all internal system alarms and external security alarms. Events are pre-defined or user-specified incidents on the VMS that can be set up to trigger an alarm, including analytics events and manual control actions. Event and alarm management capabilities shall include but not be limited to:
   1. Alarm Data Settings:
      a. Customizable alarm priorities, statuses and categories to enable alignment of the alarm handling workflow with existing workflows and security systems.
      b. Optional sound notifications for different alarm priorities for notification of new incoming alarms.
      c. Manage which alarm priorities trigger desktop notifications for alarms.
      d. Manage which alarm data are shown in the Alarm Manager, including but not limited to:
         1) ID.
         2) Image.
         3) Location.
         4) Message.
         5) Owner.
         6) Priority Level.
         7) Source.
         8) State Level.
         9) State Name.
         10) Time.
      e. Optional Reasons for Closing to be chosen when an alarm is closed.
      f. Add audio files in wav-format to be used as alarm notification sounds.
      g. Manage how long alarms instances are kept in the system before being automatically deleted.
   2. Alarm Configuration:
      a. User-definable alarm descriptions and work instructions.
      b. Select triggering event and source.
      c. Alarm time profiles specifying that response actions must take place within the specified time profile.
      d. Select start and stop events specifying that response actions must take place within the specified event window.
      e. Select a user defined event to be triggered if an alarm is not acknowledged within a defined time limit.

f. Association of alarms with one or more cameras, with automatic display of camera video in the alarm preview window, with a minimum of 15 cameras showing simultaneously in the alarm preview window.
g. Association of alarms to maps.
h. Association of initial alarm owner (individual user or group) and priority.
i. Association of alarm category.
j. Select user defined event to be triggered by the alarm.
k. Enable or disable desktop notifications for alarms.

3. Alarm Manager:
   a. Alarm list with extensive sorting and filtering capabilities.
   b. Instant preview of recorded video from primary and related cameras, at the time of the incident.
   c. Thumbnail image from primary camera, at the time of the incident.
   d. Alarm disabling option shall enable users to suppress alarms from a given device for a specified time period.
   e. Alarm handling reports providing information about alarm inflow and alarm handling performance.
4. Alarm Handling:
   a. Instant preview live video of primary camera.
   b. Instant preview of recorded video from primary and related cameras, at the time of the incident.
   c. Option to select any related cameras to be displayed in the live and playback view items.
   d. Present the alarm work instructions.
   e. Change priority and status of the alarm.
   f. Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.
   g. Present time logged alarm activities.
   h. Add time logged comments to the alarm incident.
   i. Desktop notifications shall allow immediate access to alarm handling.
5. Map Integration:
   a. Present incident location automatically on the map allowing operators to view and acknowledge active alarms.
6. All other map functionality must be available when viewing maps in the Alarm Manager. Web Client: Provide the following alarm list, alarm handling and investigation functionality:
   a. Alarm List:
      1) Alarm list with filtering capabilities:
         a) All or personal alarms.
         b) All or specific alarm states.
         c) All or specific alarm priorities.
      2) Thumbnail image from primary camera, at the time of the incident.
      3) Click to handle alarm.
   b. Alarm Handling:
      1) Instant preview of recorded video from primary and related cameras, at the time of the incident. Available incoming audio for cameras that have related microphones.
      2) Present the alarm work instructions.
      3) Change priority and status of the alarm.

4) Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.

7. Mobile Client: Provide the following alarm notification, alarm list, alarm handling and investigation functionality:
   a. Alarm Notification: Receive alarm notifications using Push Notifications. Notifications include access to:
      1) Video.
      2) Alarm information.
      3) Work instructions.
   b. Alarm List:
      1) Alarm list with filtering capabilities:
         a) All or personal alarms.
         b) All or specific alarm states.
         c) All or specific alarm priorities.
      2) Thumbnail image from primary camera, at the time of the incident.
      3) Click to handle alarm.
   c. Alarm Handling:
      1) Instant preview of recorded video from primary and related cameras, at the time of the incident.
      2) Present the alarm work instructions.
      3) Change priority and status of the alarm.
      4) Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.

2.8 VIDEO PROCESSING AND VIEWING

A. Multiple Monitor Support: Support multiple monitors where each monitor shall show multiple floating or full-screen windows for display of views or individual view items.

B. View Window Aspect Ratios: Support multiple views optimized for 4:3 and 16:9 display settings in both landscape and portrait orientations.

C. Private or Shared Views: Private views can only be access by the user who created them. Views may be shared generally and available to all roles or restricted to specific roles. Viewing of a content item in a shared view is subject to the viewer's permissions relating to the content item.

D. View Groups: View groups facilitate view navigation and simplify searching across multiple views by narrowing search scope.

E. View Layout Persistence: Same view layout in both live and playback modes.

F. View Arrange and Restore: Support simple drag-and-drop re-arrangement of cameras in views for optimized monitoring of incidents, including replacement of individual cameras with different cameras, with single-click restore of original view layout.

G. View Creation: Views that display up to 100 view items including cameras, web pages, still images, text and interactive items. View capabilities include, but are not limited to:
   1. Camera View Item: Live and recorded camera video displayed in resizable view windows, utilized in several workspaces within the application. Each camera view item contains the following:

a. Video Status Indicator: A round dot indicating one of four states:
   1) Green: A connection to the camera is established.
   2) Red: Video from the camera is being recorded.
   3) Yellow: Playing back recorded video.
   4) Gray: The video has not changed for more than two seconds.
b. Motion Indicator: An icon of a moving person that appears only when motion is detected since it was last cleared.
c. Bounding-Box Display: Display of metadata bounding boxes as provided by supported cameras and integrated analytics in live and playback views.
d. Update on motion only: Optimizes CPU use by allowing motion detection to control whether the image should be decoded and displayed.
e. PTZ Camera View Item: PTZ camera view item can be configured to provide virtual joystick camera control and PTZ navigation overlay buttons on the video image.
f. Overlay Buttons: Used to add manually controlled speakers, events, outputs, PTZ cameras and to start/stop recording.

2. Carousel: Allow a specific view item to automatically sequence rotate through pre-defined set of cameras that are not necessarily present in the view at the same time. Operators may select default or custom display times for each camera, and they are able to manually switch to the next or previous camera in the carousel list.
3. Hotspot: Global hotspot function shall allow users to work in detail with any camera selected from any view. Local hotspot function shall allow users to work in detail with a camera selected from the same view.
4. HTML Page: Show interactive HTML page.
5. Image: Show a still image.
6. Matrix: Shows live video from multiple cameras in any view layout with customizable rotation paths, remotely controlled by the computers sending matrix remote commands.
7. Navigable Map Pages: Static or active map pages may be used to provide a good overview of premises, and for switching between different views, such as map page displaying a floor plan.
8. Text: Add text.
9. 3rd party plug-ins: Add 3rd party plug-ins to extend the behavior of full viewing client.

H. Live Video: Views provide camera live viewing capabilities including, but not limited to:
1. Live Viewing: View live video of camera view items on the Live tab.
2. Manual PTZ Control: Manual PTZ control options:
   a. Video overlaid PTZ control.
   b. Joystick.
   c. Virtual joystick function.
   d. PTZ point-and-click control.
   e. PTZ preset positions.
   f. Overlay buttons to activate PTZ preset positions.
   g. PTZ zoom to a defined rectangle.
   h. Start, stop, and pause patrolling.
   i. View who have PTZ control and time to automatic release, including anonymous users.

3. Send Video to Destination: Option to send current camera to the following destinations:
   a. View item in an existing window.
   b. New floating window.
4. Digital Zoom: Magnification of video to facilitate detail viewing.
5. Bookmarks: Create quick or detailed bookmarks, to facilitate incident review and documentation.
   a. System generated headline for quick bookmark.
   b. Optional headline and description information for detailed bookmark.
6. Independent Video Playback:
   a. Playback of video in multiple camera view items, each on its own independent timeline.
   b. Option to initiate playback mode and synchronizing playback timeline with current time in independent playback.
7. Instant Change of Camera: Drag-and-drop placement of a different camera in a camera view item, instantly changes the content to video from the new camera, according to the camera view item's current timeline position.
8. Centralized Search: Initiate Centralized Search for the camera in a new window.
9. Manual Recording: Start and stop manual recording with automatic stop of recording after a configurable number of minutes.

I. Video Playback: Views provide additional camera playback capabilities including, but not limited to:
   1. Playback: Time synchronized play back video of camera view items on the Playback tab.
   2. Navigation: Advanced video navigation includes:
      a. Forward and backwards playback at different speeds:
         1) Playback Speeds: ¼x, ½x, 1x, 2x, 4x, 8x, 16x.
         2) Instant Realtime Speed: Toggle 1x playback speed or selected playback speed.
      b. Forward and backwards frame-by-frame.
      c. Skip to next or previous recorded sequence.
      d. Skip to beginning or end of recordings.
      e. Jump to date/time.
   3. Timeline: An overview of recorded sequences and bookmarks via integrated video timeline with time navigation and playback controls, including the following functionality:
      a. Timeline Video Playback: Video from multiple camera view items integrated to a common video timeline, with common timeline control from any of the integrated camera view item.
      b. Single and Consolidated Timeline: Two timelines with the first showing overview of selected camera view item and second showing a consolidated overview of all camera view items in the view.
      c. Timeline Period: Select which period timeline covers.
         1) 5, 10, 20 minutes.
         2) 1, 2, 4, 8, 12, 16, 20 hours.
         3) 1, 2, 4 days.
         4) 1, 2, 4 weeks.

d. Recorded Sequences Overview: Recorded sequences of video and audio are shown in the timeline. The timeline displaying light-red to indicate recording, red for motion, light-green for incoming audio, and green for outgoing audio. If there are additional sources of data available, these are displayed as other colors.
e. Bookmarks Overview: Bookmarks are shown in the timeline with instant preview of the recorded video.
f. Integrated Time Interval Selection: Integrated function to select a time interval for export or video and audio retrieval from edge storage devices.
1) Visual selection on timeline.
2) Select start and end date/time.
3) Loop selected period on playback.
g. Multi-Window Timeline: Ability to use one timeline to control playback of cameras in multiple view windows.

4. Recording Search: Search listing of camera sequences or bookmarks.
a. Preview: Search results may be previewed.
b. Print: Print of still image from the selected video clip may be initiated.
c. Export: Export of selected video clips may be initiated, reducing time needed to prepare forensic video material.

J. Centralized Search: Shall enable users to apply search categories and filters to find recording sequences, recordings with motion and bookmarks. From the search results, users shall be able to preview video and perform various actions, e.g. by exporting the search results or sending the search results to PDF. The search results shall be presented instantly as thumbnail images:
1. Sequence Search: Search in recording sequences on one or more cameras.
2. Motion Search: Search for sequences with motion, or Smart Search for motion in selected areas on one or more cameras.
3. Bookmark Search: Search for bookmark headlines or descriptions.
4. Navigation: Ability to jump to search results through a clickable timeline, or the ability to scroll through the search results.
5. Preview: Selected sequence previews with auto play and direct export support.

K. Video Export and Documentation: Full viewing client options for video export and documentation include, but are not limited to:
1. Snapshot: Produce instant visual documentation of a camera by saving the camera image to a file.
2. Print: Produce instant visual documentation of a camera by sending it directly to a printer.
3. Storyboarding: The storyboarding function makes it possible to include video sequences from different or overlapping time intervals from different cameras in the one and the same export.
4. Export Database Format: Export in database format; including the standalone Full Viewing Client - Player application for simple instant viewing by authorities.
5. Export Preview: Review video just prior to export, with looped playback option.
6. Export Other Formats: Create evidence material in media player format (AVI files), MKV format, or still image format (JPEG images).

7. Re-Export: Re-Export allows an authorized individual to export a digitally signed selection from the original video exported. Option to disable re-export, during initial export to database format, prevents undesirable re-distribution of sensitive video recordings.
8. Bulk Export: In a single step, export in multiple formats to multiple destinations, including direct export to optical media, to ensure consistency across exported video sequences in various formats, and reduce human error possibilities.
9. Export of Comments: Two video formats support inclusion of comments in exported video:
10. Database Format: Include general and/or camera-specific comments to a video export file.
11. Media Player Format: Include comments as pre/post slides.
12. Video Incident Report Printing: Utilize still images rather than clips to print incident reports including images, surveillance details and free-text user comments.

2.9 GRAPHICAL MAPS

A. Maps: Provide multi-layered physical overview of surveillance video coverage, with interactive access to and control of the VMS and related devices, including the following elements:
   1. Map Images: Illustrated maps or photographs. Supported image file formats are: BMP, GIF, JPEG, JPG, PNG, TIF, TIFF, and WMP.
   2. Camera Icons: Indicate camera locations on the map. Fixed camera icons show camera view as colored angle radiating from the camera. PTZ camera icons show preset camera views as colored angles radiating from the camera.
      a. Live Preview: Hover mouse pointer over camera icon to display a live preview in a resizable window.
      b. PTZ Preset Navigation: Click on PTZ preset view zone moves camera to the preset position.
   3. Microphone Icons: Microphone icons show microphone locations on the map.
      a. Live Listening: Place mouse over microphone icon; press and hold left mouse button to listen to incoming audio from microphone.
   4. Speaker Icons: Indicate speaker locations on the map.
      a. Live Speaking: Place mouse over speaker icon; press and hold left mouse button to talk through speaker.
   5. Control Icons: Icons to use for control of objects such as doors, gates, and lights.
   6. Hot Zones: Hot zones to provide vertical navigation through a hierarchy of maps by clicking on a hot zone.
   7. Map Overview Window: Navigable overview of map hierarchy set up in full viewing client.
   8. Map Image Updates: When map images are replaced by an updated version of the map image of the same scale, map icons and other elements are kept in their original locations.
   9. Map Display Information: Information display options include but are not limited to:
      a. Real-time status monitoring indication from all system components including cameras, I/O devices and system servers.
      b. Graphical visualization of the system status through color coding.
      c. Hierarchical propagation of status indications to higher ordered maps.

d. Different levels of status indications available (alarm, warning and errors).
e. System performance data for cameras and servers including camera resolution, FPS, network use and disk space.
f. Ability to suppress status indications (such as alarms and operational status) for a given device.
g. Editable device names in map and map-specific names and references assignable to devices in Map, subject to user permissions.

2.10 MEDIA STORAGE MANAGEMENT

A. Provide multiple media storage containers definable with the following characteristics:
1. Container: Each container consists of a live database and optionally one archive database, with container-specific archiving scheme and retention times. Archive database can reside on the same disk as the live database or on secondary disk or network drive.
2. Capacity: Maximum recording capacity shall be limited only by available disk space or configured container storage limit.
3. Device Assignment: Recording of each device is assigned to a specific storage container. The assigned storage container for a device or group of devices may be changed from one container to another.
4. Archiving: Recorded video data may be automatically moved from a container's live database storage to its archived storage. Archived data is still online and available to client software.
5. Maximum Recording Times: Maximum recording times may be set for manual recordings, with VMS deleting older video to free up storage for newer video.

B. Edge Video Storage: Provide utilization of camera-based storage including the following capabilities:
1. Video and Audio Retrieval: Retrieving video and audio recordings across low-bandwidth connections based on time profiles, events or manual requests.
2. Video and Audio Consolidation: Consolidating video and audio from multiple storage mechanisms:
a. Seamless merging of video and audio stored centrally in media database, and video and audio retrieved from associated camera edge storage, or from an interconnected system.
b. Optionally consolidate pre-event images recorded locally in camera or video encoder.
3. Scalable Video Quality Recording (SVQR): Capability to record high quality video using edge storage and record low quality video centrally, to minimize network bandwidth utilization, using the capabilities described above. High quality video can be retrieved when needed, on an event-driven, scheduled or manual basis.

2.11 MOBILE SERVER

A. User Authentication: Facilitate the following methods of user authentication:
1. Basic Authentication: Basic user VMS account.
2. Windows Authentication: Via Active Directory or local Windows user account. Possible to use current Windows user to facilitate single sign-on.

B. Dynamic Bandwidth Optimization: Optimize camera video stream from server to client to make optimum use of bandwidth.

C. Permissions: Mobile server shall only allow for the viewing of live video.

D. Bookmarks: Enable the use of bookmarks in live video

E. Smart Connect: Easy configuration of internet access to the mobile server by automatic configuration of firewalls and internet routers via UPnP, with verification of configuration and operation of internet connection, with option to email connection details to mobile client users. Includes automatic mobile server on LAN via UPnP.

2.12 WEB CLIENT

A. Provide the following browser-based capabilities:
   1. User Authentication:
      a. Require only username and password.
      b. Enable basic users to change password during login.
      c. User authentication and authorization is handled by mobile server.
   2. Inherit System Views: Automatically obtain the user's private and shared views configuration from the system.
   3. All-Camera View: Automatically generate a view for all cameras when no views are set up.
   4. Live Video Monitoring: View live video with PTZ control including use of presets, video playback, and triggering of camera-related outputs and events from within the camera's view.
   5. Search: Search function to find cameras, types of camera, cameras with related microphones, cameras with related speakers and camera views.
   6. Video Export: Provide video export, with the option to preview and store exported video on the server, and make it available for later usage or download, for example, when a higher-bandwidth connection is in use:
      a. AVI, MKV, Database Format files: Ability to create AVI, MKV or database format export files.
      b. Still Image Export: Provide camera view JPEG image export.
      c. Audio: Option to include audio in the export package.
      d. Export On Server: Ability to export on the server to avoid moving large files.
      e. Exceed Retention Time: Ability to store video recordings for a period that is longer than the retention time.
      f. Play Back Deleted Recordings: Ability to play back the recordings even if the recordings have been deleted from the media database.
      g. Reduced Download: Ability to download only needed files or save them for downloading when on a faster connection.
      h. Preview On Server: Preview exports on the server without downloading them.
   7. Data Integrity Of Exported Video:
      a. Encryption And Password Protection: Option to encrypt and password protect any of the available export formats.
      b. 256-bit AES Encryption: Ability to encrypt exports using 256-bit AES algorithm.
      c. Digital Signature: Digitally signed media exports with SHA-2 algorithm to establish a means of detecting modification of exported video.
   8. Bookmarks: Bookmarks shall be applicable for live video and recorded video:
      a. Ability to create quick or detailed bookmarks to facilitate incident review and documentation.

b. Ability to edit and delete bookmarks and to use filtering to find bookmarked video.

9. Secure Connection: Connect to mobile server through trusted CA certificates for HTTPS encryption..
10. Supported Browsers:
    a. Microsoft Edge
    b. Safari
    c. Google Chrome
    d. Mozilla Firefox
11. Browser Plug-Ins or Extensions: No plug-ins or extensions to be installed.

B. Mobile Client
1. Provide the following native-app mobile client capabilities:
    a. User Authentication:
        1) Require only user name and password.
        2) Enable basic users to change password during login.
        3) User authentication and authorization is handled by mobile server.
2. Multiple Server Profiles: Select between multiple server profiles to facilitate easily switching between sites or different connection addresses.
3. Views and View Groups: Automatically obtain the user's private and shared views from the system to be used as camera lists.
    a. View Groups: Views shall be organized in view group folders. View groups shall also have the capability of organizing subordinate view groups.
    b. All-Camera View: Automatically generate a view for all cameras when no views are set up.
4. Full-Screen View: Display cameras in full screen to take better advantage of the mobile device's screen, with camera view navigation in full screen by swiping left or right.
5. Pinch-To-Zoom: Digital pinch-to-zoom shall enable mobile users to enlarge a part of the image for closer review and conduct detailed investigation of video.
6. Picture-In-Picture: Provide the following functionality for Picture-In-Picture:
    a. Display a live picture-in-picture frame of the same camera when in playback mode.
    b. The picture-in-picture shall be movable by dragging.
    c. Double-tapping and will return to live view.
    d. Hide live picture-in-picture frame.
7. Search: Search function to find cameras, types of camera, cameras with related microphones, cameras with related speakers, and camera views.
8. Navigation: Ability to navigate recorded video using a time picker and to adjust the start time by dragging a timeline scroller.
9. Bookmarks: Bookmarks shall be applicable for live video and recorded video.
    a. Ability to create quick or detailed bookmarks to facilitate incident review and documentation.
    b. Ability to edit and delete bookmarks and to use filtering to find bookmarked video.
10. Mobile Video Push: Provide mobile client capability for mobile device users to use their mobile device cameras as cameras in the VMS, including the following characteristics.
    a. No Mobile Setup: No mobile device setup shall be required for mobile video push. Provide central server-side configuration.

b. Metadata Support: Mobile users shall be able to include metadata in the video submitted.
c. Audio: Mobile users shall be able to include audio in the video submitted.
11. Investigation: Provide access to investigations created in the web client.
12. Secure Connection: Connect to XProtect Mobile server through trusted CA certificates for HTTPS encryption.
13. Supported Mobile Operating Systems:
a. Android.
b. iOS.

2.13 LICENSING

A. Provide all system licensing as required.

B. VMS shall offer easy-to-use automatic or manual online activation via the Internet and alternatively, offline activation via email and web for closed surveillance networks.

C. Server Base License:
1. Require one mandatory server base license for installing the product.
2. Server base license shall permit the following deployments within the legal entity purchasing the base license:
a. Unrestricted number of management servers.
b. Unrestricted number of recording servers.
c. Unrestricted number of full viewing client, web client and mobile client applications.

D. Hardware Device License:
1. Require one license per hardware IP address to connect:
a. Cameras.
b. Audio devices.
c. Video encoders.
d. Other devices.

2.14 RECORDING SERVER

A. Provide VMS system recording server(s), where indicated on Drawings.

B. Hon-Dah WWTP Recording Server - BP3
1. Due to offsite location and WAN connectivity to IHS network, contractor to provide dedicated NVR and shall install in the Hon-dah Wastewater Treatment Plant IDF for local recording capabilities. Contractor to coordinate directly with IHS IT and Security personnel for connectivity between the two sites for monitoring capabilities from the security control room located in the main hospital

C. General Criteria:
1. Provide all associated hardware, software, and licensing as required.
2. Meet or exceed minimum technical requirements as recommended by VMS manufacturer.
3. Be sized and configured to manage and record video for all cameras, as indicated on the Drawings, and be capable of modular expansion.
4. Be rack mount server; coordinate final rack location in equipment room with owner IT.
5. Basis-of-Design Server:
a. Rack mount server, manufacturer branded.

b. Be procured directly from the VMS manufacturer.
c. Minimum technical specifications, as recommended by manufacturer.
d. Supplied with software, configuration, and licensing, specific to the Project.

D. Back-Up Power:
1. Provide rack mount, dedicated security UPS unit to support the recording server.
2. Sized to provide eight-hour runtime at normal load. Runtime can be reduced to 30 minutes if line voltage power is supplied by back-up emergency generator.
3. Basis-of-Design Product:
a. APC Smart-UPS series products.

E. Recording criteria - General:
1. Record all cameras at full resolution at 15 frames per second, using motion-based recording of average 40% motion. Coordinate specific requirements with owner during configuration.
2. Size the recording server such that cameras are recorded and archived for minimum 30-days on the storage device, plus an additional 25% spare storage capacity.
3. As part of shop drawing process, installer shall submit video storage calculations to demonstrate the specified video storage capacity is met.

F. Recording criteria - Pharmacy
1. Record all cameras at full resolution at 15 frames per second without motion and 30 frames per second with motion-based recording with 15 seconds of prevent video (minimum) of average 40% motion. Coordinate specific requirements with owner during configuration.
2. Size the recording server such that cameras are recorded and archived for **minimum 60-days** on the storage device, plus an additional 25% spare storage capacity.
3. As part of shop drawing process, installer shall submit video storage calculations to demonstrate the specified video storage capacity is met.
4. Recorder for the Pharmacy shall be in the IDF that serves the Pharmacy and will be dedicated to support all pharmacy cameras in a raid 10 storage configuration. See overall ICT plans for serving zones.
5. Pharmacy cameras shall be restricted to authorized staff only. Entry-way and customer service areas will be integrated to provide video based on alarm to the security operations center.

2.15 CLIENT WORKSTATIONS

A. Provide VMS system client workstation(s), where indicated on drawings.

B. VMS client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package. Contractor to provide and install KVM as required to facilitate these functional requirements.

C. Hardware shall be one in the same with ACAMS Client Workstation(s), refer to section 281300.

D. General Criteria:
   1. Provide all hardware, software, and licensing as required.
   2. Meet or exceed minimum technical requirements as recommended by ACAMS and VMS manufacturers.
   3. Be tower style workstation; coordinate final location with owner.
   4. Basis-of-Design Workstation:
      a. Minimum technical specifications, as recommended by manufacturer.
      b. Supplied with software, configuration, and licensing, specific to the Project.
      c. Refer to section 281300, Client Workstations.
   5. Display Monitors:
      a. Provide (2) 24" monitors with each client station.
      b. 16:9 aspect ratio; 1920x1080 resolution.
      c. Utilize HDMI or DP video input.
      d. Basis-of-Design Product:
         1) Planar PXN2400.

E. Back-Up Power:
   1. Provide tower style, dedicated security UPS unit to support each workstation.
   2. Sized to provide four-hour runtime at normal load. Runtime can be reduced to 30 minutes if line voltage power is supplied by back-up emergency generator.
   3. Basis-of-Design Product:
      a. APC Smart-UPS series products.

F. Additional ACAMS Monitoring Applications:
   1. Thick client software installed on owner provided PC (meeting manufacturer min spec):
      a. Provide and install client software on up to (2) owner workstations.
   2. System shall be capable to support and provide:
      a. Brower-based (web-based) thin client application.
      b. Mobile device client application.

2.16 VIDEO WALL DISPLAYS

A. Provide VMS large format, commercial grade 24/7 operation video wall displays where indicated on drawings.

B. Video wall displays shall be driven by associated local VMS client workstations. Connect to client stations with appropriate HD video signal cables.

C. Provide VESA low-profile wall mount bracket for each display.

D. Coordinate infrastructure requirements with the GC and EC prior to rough-in.

E. Display minimum criteria:
   1. Screen size 55".
   2. Aspect ratio 16:9.
   3. Resolution 3840x2160 (UHD).
   4. Brightness 500 nits.
   5. Power 120VAC.
   6. Mount VESA 400x400mm.

F. Basis-of-Design Product
1. Bosch UML-554-90.

2.17 INDOOR CAMERAS

A. Description:
1. Wall, ceiling, or pendant mount.
2. Minimum 30 frames per second.
3. Wide dynamic range.
4. Day/night mode.
5. Low-light capable.
6. Varifocal lens.
7. PoE power.
8. ONVIF and NDAA compliant.
9. Provide manufacturers PoE+, PoE++, or Hi-PoE mid-stream injector if required.
10. For any camera with fixed lens, provide optimal lens for owner desired field of view.
11. Provide all mounting hardware appropriate for the installation application.
12. For accessible ceilings, provide recessed mount kit with tile bridge support bracket.

B. Basis-of-Design (BOD) Products:
1. Fixed camera, 2MP:
a. Avigilon 2.0C-H6A-D1.
2. Fixed camera, 4MP:
a. Avigilon 4.0C-H6A-D1.
3. 360-degree fisheye camera:
a. Avigilon 12.0C-H6A-FE.
4. Dual head 2-sensor, 2x3MP:
a. Avigilon 6.0C-H6ADH-DO1-IR.
5. 360-degree multi-sensor, 4x3MP:
a. Avigilon 12C-H5A-4MH - H5A.

2.18 OUTDOOR CAMERAS

A. Description:
1. Wall, pendant, or pole mount.
2. Minimum 30 frames per second.
3. Wide dynamic range.
4. Day/night mode.
5. Low-light capable.
6. Varifocal lens.
7. PoE power.
8. ONVIF and NDAA compliant.
9. Provide manufacturer PoE+, PoE++, or Hi-PoE mid-stream injector if required.
10. For any cameras with fixed lens, provide optimal lens for owner desired field of view.
11. Provide all mounting hardware appropriate for the installation application.

B. Basis-of-Design Products:
1. Fixed camera, 2MP:
a. Avigilon 2.0C-H6A-DO1.

2. Fixed camera, 4MP:
   a. Avigilon 4.0C-H6A-DO1
3. Fixed camera, 8MP:
   a. Avigilon 8.0C-H6A-DO1.
4. 360-degree Fisheye camera:
   a. Avigilon H6A Fisheye, 12.0 MP
5. Dual head 2-sensor, 2x3MP:
   a. Avigilon 6.0C-H6ADH-DO1-IR.
6. 180-degree 3-sensor 9MP panoramic:
   a. Avigilon 9C-H5A-3MH - H5A.
7. 270 / 360-degree multi-sensor, 4x:5.0 MP
   a. Avigilon 20C-H5A-4MH.
8. PTZ camera, 4MP, 30x optical zoom, WDR:
   a. Avigilon 4.0C-H6A-PTZ-DP30
9. IR PTZ camera, 8MP, 40x optical zoom:
   a. Avigilon 8.0C-H5A-IRPTZ-DP36-WP

2.19 IP POE ETHERNET EXTENDERS - PASSIVE

A. Provide passive IP PoE Ethernet extender units (pair) for data circuits which exceed Category cabling 295' maximum length due to routing path or field conditions. Where distances do not permit passive devices, provide a powered IP PoE solution as specified in next section.

B. Provide passive IP PoE Ethernet media converter units (pair) for data circuits which must be transmitted over alternate cable media, such as for coaxial elevator traveler cabling.

C. General Criteria:
   1. Passive IP PoE Ethernet extender units which do not require power may be used where applicable.
   2. Passive IP PoE Ethernet medica converter units which do not require power may be used where applicable.
   3. Where multiple extender unit circuits terminate in a common equipment room, multi-channel, rack mount head-end extender unit is to be used. Coordinate work in equipment rooms with owner IT.
   4. Install head-end equipment and Ethernet extender devices per manufacturer written recommendations.
   5. Basis-of-Design Product:
      a. Nitek products.
      b. Veracity products.

2.20 IP POE ETHERNET EXTENDERS - ACTIVE

A. Provide active/powered IP PoE Ethernet extender solution using powered-fiber cable media, for data circuits which exceed Category cabling 295' maximum length due to routing path or field conditions, and cannot be served with passive IP PoE Ethernet extenders.

B. General Criteria:
   1. Active/powered IP PoE Ethernet extender solution must be used where required, for applications where passive extender units will not comply.
   2. Where multiple extender unit circuits terminate in a common equipment room, the manufacturer solution multi-channel head-end unit is to be rack mounted. Coordinate work in equipment rooms with owner IT.
   3. Install head-end equipment and Ethernet extender devices per manufacturer written recommendations.
   4. Provide and install manufacturer branded powered-fiber cable media, or powered-fiber cable media as recommended by supplied solution manufacturer.
   5. Basis-of-Design Product:
      a. Altronix Netway Spectrum PoE Extender System.
      b. Leviton OneReach PoE Extender System.

2.21 FIBER MEDIA CONVERTERS

A. If required, provide fiber media converters and related equipment for exterior camera locations.

B. OSP OS2 single mode fiber circuits to exterior camera locations to be provided by Division 27 structured cabling contractor. Security installer to coordinate all requirements prior to work.

C. Coordinate media converter locations in equipment room racks with owner IT.

D. Power circuit to NEMA4 enclosure to be provided by electrical contractor.

E. NEMA4 enclosure:
   1. To house related security components.
   2. Integral camera mount, camera bracket mounts to enclosure.
   3. Basis-of-Design Product:
      a. Axis T98A18-VE.

F. Fiber media converter and camera PoE mid-span power injector:
   1. Basis-of-Design Product:
      a. Altronix Netway series products.
      b. Axis Communications products.
      c. As recommended by camera manufacturer.

2.22 CAMERA POLES

A. Provide outdoor camera poles where indicated on drawings, at heights as noted on drawings. Coordinate pole finish with Architect.

B. Turn camera poles over to GC for installation. GC to provision concrete pole base, as recommended by pole manufacturer. Coordinate underground conduit rough-in with GC and EC.

C. Basis-of-Design Products:
   1. Strong Poles.
   2. CameraPoles.org.

2.23 TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICES

A. Provide Transient Voltage Surge Suppression (TVSS) device for each exterior camera connected with copper data cable, or fiber-power hybrid cable, for video transmission. Not required for exterior cameras utilizing fiber optic cabling and fiber optic media converter.

B. Install TVSS device per manufacturer written recommendations, including grounding and bonding.

C. Basis-of-Design Product:
   1. Ditek products.

2.24 TAMPER PROTECTION

A. Tamper Protection:
   1. Provide tamper switches on all control units, cabinets, enclosures, pull boxes, and other susceptible system components.
   2. Tamper switches shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Security monitoring station shall communicate system tamper alarms and identify locations.

2.25 CABLING FOR SECURITY SYSTEMS

A. Provide low voltage security cabling infrastructure to support all security systems and devices indicated on the Drawings and specified herein. All cabling must meet the minimum technical criteria recommended by the associated equipment manufacturer, as supplied for the project.

B. Category data cabling circuits for network connected Ethernet devices will be provided and installed by Division 27 telecom cabling contractor. Security contractor to provide Category patch cords at security device end, which match the installed data cable Category rating.

C. For all installation applications, provide cabling rated for the environment in which it is installed.

D. Comply with Section 280513 Conductors and Cables for Electronic Safety and Security.

E. Comply with NFPA 70.

F. Identification Products:
   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 Worldwide.
      b. Panduit.
      c. HellermannTyton.
   2. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
   3. Comply with requirements in Part 3 "Identification" within this section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other pathway elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for security device cabling conduit systems to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

B. Verify and obtain all necessary licenses and construction permits required to complete the Project scope.

3.3 INSTALLATION

A. During Phase 1 Area 1 installation of the temporary parking area the following tasks shall take place:
   1. Installation of recorders and storage devices to support cameras being installed in this part of construction to be located in existing MDF in location determined by owner.
   2. Installation of cameras associated with this phase of construction.
   3. Installation of video workstation with two (2) 27" monitors and one (1)55" monitor in the existing command center to view and control the aforementioned parking lot cameras.
   4. Cameras installed on the SSB Building as shown on drawings.
   5. Cutover of all cameras located within the admin building and the SSB Building to the new video recording and storage arrays.
   6. Install visual alerts (AI Assisted Event Detection) for all new cameras installed in phase 1.

B. Phasing of the remaining equipment shall follow the applicable project schedule.

C. When the MDF in the new hospital is ready to receive equipment installation the servers and storage arrays installed above shall be relocated to their permanent home, moving of this equipment shall be coordinated with owner.

D. Install cameras, video surveillance equipment, and cabling items to comply with manufacturer's written instructions. Where cutting and fitting are required to install equipment onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim unit with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

F. Mounting Heights:

G. Comply with all state and local ordinances, codes, and regulations.

H. Coordinate all security conduit rough-in requirements with EC and GC prior to work.

I. Coordinate all security equipment installation and IT LAN requirements with owner.

J. All equipment installed shall be maintained with manufacturer's provided software and firmware. At turnover the manufacturer's most current version of both software and firmware shall be installed on all devices inclusive of all patches and updates.

K. VMS Manufacture's professional services shall be subcontracted by security vendor for all planning, programing and integration tasks.

L. All servers, storage arrays, and camera devices shall use the synchronous clock time server as the basis of their time settings. An automated task shall be set to ensure that all servers and cameras remain in sync with this master-time standard.

M. All active devices to include but not limited to servers, cameras, POE extenders, etc. that are field installed shall be reflected on the red line and as-built drawing packages.

N. When a license or software key is required, all servers, software, storage arrays and cameras shall be installed with perpetual (non-expiring) licenses and those licenses shall be registered to the owner. Coordinate with the owner to determine the registration information.

O. Keys: Installation contractor shall turn over a minimum of two keys for each security enclosure and rack installed. The contractor shall turn over a minimum of two security bits for each type of security screw/lock installed.

P. Back-up: VMS server shall be installed with an external solid state hard drive for back-up purposes in the pharmacy. A full back-up of the VMS alarm system log shall be scheduled to be conducted nightly. Contractor shall create a backup sequence to backup hard drives to the IHS Phoenix area data center storage. Contractor shall provide additional physical backups as requested by the Owner.

Q. After installation is complete and accepted a full Backup is required: of all configuration data for both the pharmacy and general VMS, including but not limited to:
1. All system configuration data.
2. Full device configuration data.
3. Maps.
4. Alarm settings and definitions.
5. Software client views.
6. User-defined rules and events. Defined video bookmarks.

R. Restore: The backup shall be tested to ensure that it is complete, and the system could be restored from.

3.4 Integrations

A. Access Control: Integrate video surveillance with access control to provide visual verification of alarm events. System shall allow operators to monitor alarms and link recorded pre-alarm footage followed by live footage to specific access control alarm events and dispatch alerts to security personnel for immediate assessment and response.

B. Intrusion Detection: Video surveillance shall interface with intrusion detection system to automatically display live video from affected zones, record triggered events, and dispatch alerts to security personnel for immediate assessment and response.

C. Emergency Help Points: Integrate video surveillance with emergency help points cameras, enabling cameras to automatically to provide video verification on activated devices, deliver live situational awareness, dispatch alerts to security personnel for immediate assessment and response, and record incident evidence for security review.

D. Security Radios: Configure video surveillance to communicate alarms and unusual activity as alerts to security radios, ensuring timely information distribution and coordination during live or recorded event review.

E. Synchronized Clock Server: Video surveillance shall integrate with a synchronized clock server to provide accurate timestamps on all footage and across all video servers to include storage arrays, supporting efficient incident investigation and event correlation across security platforms.

F. Infant Protection: Integrate video surveillance with infant protection systems to deliver immediate visual confirmation and recording when abduction alerts or unauthorized movements are detected, supporting rapid security response.

G. Duress Alarms: When a duress alarm is activated, nearby cameras will display live video in the control room and create flagged recordings for quick reference.

H. Dashboard Monitors: Display surveillance feeds into the dashboard monitor system, providing authorized users across the hospital to view live camera feeds to provide real-time overview of incidents throughout the facility.

I. Computer-Aided Dispatch (CAD): Integrate video surveillance with CAD to transmit live or recorded footage relevant to dispatched incidents, supporting dispatchers and first responders with contextual visual information during emergencies. Enable officers to attach dispatch metadata to video clips.

J. Watch List: The VMS shall be integrated with the security suite to compare images in an image Watch List to create alerts based on cameras located on the exterior and at entrance points to the hospital.

K. Mapping: VMS shall be integrated with mapping interface and show all devices to aid in investigations, alerts, alarms, status indicators, and dispatch. Mapping shall be at scale with accurate room names and numbers and include all campus buildings to include but not limited to hospitals, parking lots, wastewater treatment plants, pumping stations, residences (structures only), etc. The maps shall have interactive icons depicting where new and existing devices are located, icons shall allow for call up of the device.

L. Lexis-Nexis Adam Program: Work alongside the Motorola Professional Services team to integrate with the Lexis-Nexis Adam program which has partnered with the National Center for Missing & Exploited Children (NCMEC) to create a searchable database to generate alerts based on cameras located on the exterior and at entrance points to the hospital. Note: This is a future offering by Motorola that they are developing and will be available Q4 2026 or Q1 2027.

M. Workflow automation platform: The VMS shall be integrated with workflow automation platform to enable rule-based automation across integrated technologies such as video surveillance, access control, radios, and analytics system.

3.5 WIRING METHODS

A. Routing:
1. Cabling may be installed in accessible ceilings unenclosed, unless otherwise indicated on the Drawings.
2. Install cable and conduit, concealed in accessible ceilings, walls, and floors where possible.
3. Cabling may be installed unenclosed within consoles, cabinets, desks, and counters.
4. In unfinished spaces, install cabling in conduit pathways; concealed in walls for new construction.
5. Where installed within conduit, data circuit conduit size shall be minimum 1 inch.
6. Refer to the Drawings for typical device conduit requirements.
7. Data transmission wiring shall not share conduit with other building wiring systems.
8. Install plenum cable in environmental air spaces, including plenum ceilings.
9. For all installation applications, provide cabling rated for the environment in which it is installed.

B. Wiring within Enclosures:
1. Bundle, lace, and train cables within enclosures.
2. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
3. Provide and use lacing bars and distribution spools.
4. Install conductors parallel with or at right angles to sides and back of enclosure.

C. Grounding: Provide independent-signal circuit grounding if recommended by manufacturer.

D. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

3.6 INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement and routing of primary cabling pathways.

B. Comply with the following Sections:
1. 260533 "Raceways and Boxes for Electrical Systems"
2. 270528 "Pathways for Communications Systems"
3. 270544 "Sleeves and Seals for Communications Pathways and Cabling"

C. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with Phoenix Pharmacy Standard privacy masking requirements in clinical and pharmacy areas.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.7 FIRESTOPPING

A. Comply with Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI TDMM.

3.8 IDENTIFICATION

A. Label all security control panels, enclosures, cabinets, and cabling.

B. Identify system components, wiring, and cabling complying with TIA/EIA-606-C.

C. Comply with labeling requirements of the following Section:
   1. 271500 "Communications Horizontal Cabling", for data cabling.

D. Cable and Wire Identification:
   1. Label each cable within 4 inches of termination, where it is accessible within an enclosure.
   2. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number and identify each cable extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

E. Labels: Must be flexible vinyl or polyester type label, which flexes as cables are bent. Label text must be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color.

F. Cable Schedule: Install a cable schedule within each electronic security enclosure. List incoming and outgoing cables and their designations, origins, and destinations. Protect printed schedule with clear plastic cover. Furnish an electronic copy of all final schedules provided for the Project.

G. All labeling and cable schedules shall be aligned with the submitted closeout security as-built drawings.

3.9 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing servers or workstations that have been powered up shall be locked and secured, as coordinated with owner.

3.10 STARTUP SERVICE

A. Perform system startup and commissioning.
   1. Complete installation and startup checks according to approved procedures that were developed in conjunction with owner in "Preparation" Article and based on manufacturer's written instructions.
   2. Coordinate system startup schedule and logistical requirements with owner prior to work.

3.11 CLEANING

A. Clean installed items using methods and materials recommended by manufacturer.

B. Clean video surveillance system camera housings, servers, workstations, and components as needed.

C. Clean adjacent surfaces soiled by door hardware installation.

D. Pay particular attention to ceiling tiles, utilize gloves or other protective equipment to prevent the soiling or fingerprinting ceiling tiles and access doors. Clean or replace ceiling tiles if they become damaged or uncleanable after installation of equipment.

3.12 DEMONSTRATION

A. Perform 100% pre-testing for all system functionality, and complete initial readiness checklist. Correct and resolve all deficiencies. Update and submit completed readiness checklist identifying corrections, and request for approval of Substantial Completion.

B. Perform final field test in conjunction with owner, demonstrating that all features and functionality are 100% complete and operational to owner's satisfaction.

C. User Acceptance Testing (UAT): Testing shall be conducted using manufacturer-verified templates to ensure reliability. Tested scenarios shall include, but are not limited to:
   1. A person is lying on the ground.
   2. A window is broken or shattered.
   3. A long lineup of people is present.
   4. Fire or flames are present.
   5. A large delivery truck is present near an outdoor entrance.
   6. A person is not wearing a high-visibility vest and a hard hat.
   7. A large group of people is present.
   8. A liquid spill has occurred in an indoor area.
   9. A vehicle is in an accident.

D. When commissioning the VMS security contractor must be present for a full commissioning inspection, refer to section 019113 and 280800.

3.13 VIDEO SURVEILLANCE SCHEDULE

A. The Video Surveillance sets represent the design intent and direction of the owner and architect. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process.

B. At existing locations with new Video Surveillance equipment, the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required.

C. Video Surveillance sets:
   1. Set: 1
      a. Camera Type: Multi-Sensor with Integrated PTZ
      b. BOD Model: 2.0C-H6A-PANOPTZ-IR
      c. Pixel Count: 20.0 Panoramic, 2.0 PTZ
      d. Mount Type: Mount to Help Point camera arm
      e. IR: Yes
      f. Color: Black to match help point color

g. Set: 2
   1) Camera Type: Multi-Sensor with Integrated PTZ
   2) BOD Model: 4.0C-H6A-PANOPTZ-IR
   3) Pixel Count: 20.0 Panoramic, 4.0 PTZ
   4) Mount Type: Corner mount to building, below roof line
   5) IR: Yes
   6) Color: Camera and mounting equipment match color of mounting surface through paint or wrap
h. Set: 3
   1) Camera Type: Fisheye
   2) BOD Model: 8.0C-H6A-FE-DC1
   3) Pixel Count: 8.0
   4) Mount Type: Recessed
   5) IR: no
   6) Color: White
i. Set: 4
   1) Camera Type: Dual Head
   2) BOD Model: 6.0C-H6ADH-DO1-IR
   3) Pixel Count: 2 x 3.0
   4) Mount Type: Ceiling surface mount
   5) IR: Yes
   6) Color: White
j. Set: 5
   1) Camera Type: Fisheye
   2) BOD Model: 12.0C-H6A-FE-DC1
   3) Pixel Count: 12.0
   4) Mount Type: Recessed
   5) IR: No
   6) Color: White
k. Set: 6
   1) Camera Type: Fisheye
   2) BOD Model: 12.0C-H6A-FE-360-DO1-IR
   3) Pixel Count: 12.0
   4) Mount Type: Horizontally to vertical wall
   5) IR: Yes
   6) Color: White
l. Set: 7
   1) Camera Type: Fixed
   2) BOD Model: 8.0C-H6A-D1-IR
   3) Pixel Count: 8.0
   4) Mount Type: Ceiling surface mount
   5) IR: Yes
   6) Color: White
m. Set: 8
   1) Camera Type: Fixed
   2) BOD Model: 8.0C-H6A-D1-IR
   3) Pixel Count: 8.0
   4) Mount Type: Horizontally to vertical wall
   5) IR: Yes

6) Color: Camera and pendant match color of mounting surface through paint or wrap

n. Set 9
1) Camera Type: Fisheye
2) BOD Model: 12.0C-H6A-FE-360-DO1-IR
3) Pixel Count: 12.0
4) Mount Type: Ceiling surface mount
5) IR: Yes
6) Color: White

o. Set: 10
1) Camera Type: Fixed
2) BOD Model: 2.0C-H6A-D1
3) Pixel Count: 2.0
4) Mount Type: Recessed
5) IR: No
6) Color: White

p. Set: 11
1) Camera Type: Dual Head
2) BOD Model: 16.0C-H6ADH-DO1-IR
3) Pixel Count: 16.0
4) Mount Type: Ceiling surface mount
5) IR: Yes
6) Color: White

q. Set: 12
1) Camera Type: Dual
2) BOD Model: 6.0C-H6ADH-DO1-IR
3) Pixel Count: 2 x 3.0
4) Mount Type: Wall mount pendant
5) IR: Yes
6) Color: White

r. Set: 13
1) Camera Type: Fixed
2) BOD Model:2.0C-H6A-D1-IR
3) Pixel Count: 2.0
4) Mount Type: Ceiling surface mount
5) IR: Yes
6) Color: White

s. Set: 14 - Elevators
1) Camera Type: Corner
2) BOD Model: 5.0C-H5A-CR1-IR-SS
3) Pixel Count: 5.0
4) Mount Type: Corner mount
5) IR: Yes
6) Color: Match Cab Finish

t. Set: 15
   1) Camera Type: Fisheye
   2) BOD Model: 8.0C-H6A-FE-360-DO1-IR
   3) Pixel Count: 8.0
   4) Mount Type: Pendant from ceiling
   5) IR: Yes
   6) Color: White
u. Set: 16
   1) Camera Type: Fisheye
   2) BOD Model: 8.0C-H6A-FE-360-DO1
   3) Pixel Count: 8.0
   4) Mount Type: Ceiling surface mount
   5) IR: no
   6) Color: White
v. Set: 17
   1) Camera Type: Fixed
   2) BOD Model: 2.0C-H6A-D1-IR
   3) Pixel Count: 2.0
   4) Mount Type: Ceiling surface mount
   5) IR: Yes
   6) Color: White
w. Set: 18
   1) Camera Type: Fisheye
   2) BOD Model: 12.0C-H6A-FE-360-DO1
   3) Pixel Count: 12.0
   4) Mount Type: Ceiling surface mount
   5) IR: No
   6) Color: White
x. Set: 19
   1) Camera Type: Multi-Sensor
   2) BOD Model: 12C-H5A-4MH-DP1
   3) Pixel Count: 12.0 (4x3.0)
   4) Mount Type: ceiling surface mount
   5) IR: YES
   6) Color: Camera and mount match color of mounting surface
y. Set: 20
   1) Camera Type: PTZ
   2) BOD Model: 4.0C-H6A-PTZ-DP30
   3) Pixel Count: 4.0
   4) Mount Type: Pendant
   5) IR: No
   6) Color: Match building color
z. Set: 21
   1) Camera Type: Multi-Sensor
   2) BOD Model: 12C-H5A-4MH-DP1
   3) Pixel Count: 12.0 (4x3.0)
   4) Mount Type: Corner pendant mount
   5) IR: YES

6) Color: Camera and mounting equipment match color of mounting surface

aa. Set: 22
1) Camera Type: Multi-Sensor
2) BOD Model: 12C-H5A-4MH-DP1
3) Pixel Count: 12.0 (4x3.0)
4) Mount Type: Pendant wall mount
5) IR: YES
6) Color: White

bb. Set: 23
1) Camera Type: Dual Head
2) BOD Model: 16.0C-H6ADH-DO1-IR
3) Pixel Count: 16.0 (2x8.0)
4) Mount Type: Ceiling surface mount
5) IR: Yes
6) Color: White

cc. Set: 24
1) Camera Type: Muti-Sensor
2) BOD Model: 32C-H5A-4MH-DP1
3) Pixel Count: 32.0 (4x8mp)
4) Mount Type: Surface mount
5) IR: YES
6) Color: Camera and mounting equipment match color of mounting surface

dd. Set: 25
1) Camera Type: Fisheye
2) BOD Model: 12.0C-H6A-FE-360-DO1-IR
3) Pixel Count: 12.0
4) Mount Type: Pendant from ceiling
5) IR: Yes
6) Color: White

ee. Set: 26
1) Camera Type: Fixed
2) BOD Model: 8.0C-H6A-D1-IR
3) Pixel Count: 8.0
4) Mount Type: Pendant from ceiling
5) IR: Yes
6) Color: White

ff. Set: 27
1) Camera Type: Fixed
2) BOD Model: 8.0C-H6A-D1-IR
3) Pixel Count: 8.0
4) Mount Type: Pendant wall mount
5) IR: Yes
6) Color: White

gg. Set: 28
1) Camera Type: Dual
2) BOD Model: 6.0C-H6ADH-DO1-IR
3) Pixel Count: 2 x 3.0

4) Mount Type: wall mount pendant
5) IR: Yes
6) Color: Camera and mounting equipment match color of mounting surface

hh. Set: 29
1) Camera Type: Multi-Sensor
2) BOD Model: 12C-H5A-4MH-DP1
3) Pixel Count: 12.0 (4x3.0)
4) Mount Type: Pendant wall mount
5) IR: YES
6) Color: Camera and mounting equipment match color of mounting surface

ii. Set:30
1) Camera Type: Fixed
2) BOD Model: 8.0C-H6A-DO1
3) Pixel Count: 8.0
4) Mount Type: Pendant wall mount
5) IR: No
6) Color: Camera and mounting equipment match color of mounting surface

jj. Set: 31
1) Camera Type: Multi-Sensor with Integrated PTZ
2) BOD Model: 4.0C-H6A-PANOPTZ-IR
3) Pixel Count: 20.0 Panoramic, 4.0 PTZ
4) Mount Type: Wall mount
5) IR: Yes
6) Color: Camera and mounting equipment match color of mounting surface through paint or wrap

kk. Set: 32
1) Camera Type: Corner
2) BOD Model: 5.0C-H5A-CR2-IR
3) Pixel Count: 5.0
4) Mount Type: Corner mount
5) IR: Yes
6) Color: Powder Coat to match finish color of wall.

ll. Set: 33
1) Camera Type: LPR
2) BOD Model: VSF-L6A
3) Pixel Count: 3.0
4) Mount Type: Pole mount
5) IR: Yes
6) Color: Coordinate with architect for color

mm. Set: 34
1) Camera Type: Multi-Sensor with Integrated PTZ
2) BOD Model: 4.0C-H6A-PANOPTZ-IR
3) Pixel Count: 20.0 Panoramic, 4.0 PTZ
4) Mount Type: Pole mount
5) IR: Yes

6) Color: Camera and mounting equipment match color of mounting surface through paint or wrap, Coordinate with architect for color

nn. Set: 35
1) Camera Type: PTZ
2) BOD Model: 8.0C-H5A-IRPTZ-DP36-WP
3) Pixel Count: 8.0 PTZ
4) Mount Type: Corner mount
5) IR: Yes
6) Color: Camera and mounting equipment match color of mounting surface through paint or wrap, Coordinate with architect for color

oo. Set:36
1) Camera Type: Fixed
2) BOD Model: 8.0C-H6X-DO1-IR
3) Pixel Count: 8.0
4) Mount Type: Pendant pole mount exterior
5) IR: Yes
6) Color: Camera and mounting equipment match color of mounting surface

pp. Set: 37
1) Camera Type: Fisheye
2) BOD Model: 8.0C-H6A-FE-360-DO1-IR
3) Pixel Count: 8.0
4) Mount Type: Pendant from ceiling
5) IR: Yes
6) Color: Camera and mounting equipment match color of mounting surface through paint or wrap, Coordinate with architect for color

qq. Set: 38
1) Camera Type: Fisheye
2) BOD Model: 12.0C-H6A-FE-360-DO1
3) Pixel Count: 12.0
4) Mount Type: Pendant from ceiling
5) IR: No
6) Color: Black

rr. Set: 39
1) Camera Type: Fixed
2) BOD Model: 8.0C-H6A-D1-IR
3) Pixel Count: 8.0
4) Mount Type: Pendant from ceiling
5) IR: Yes
6) Color: Black

3.14 TRAINING

A. Provide up to four(4) one(1)hour sessions of user/operator training. The two sessions may be similar (to allow additional staff to be trained) or may cover different topics while going into more depth, as determined and requested by owner. Training shall cover the following basic aspects of the system:
1. Camera configuration and adjustments.
2. System operation and monitoring.
3. Use of Visual Alerts

B. Provide up to two (2) four(4) hour sessions of administrator/operator training. The two sessions may be similar (to allow additional staff to be trained) or may cover different topics while going in more depth, as determined and requested by the owner. Training shall cover the following basic aspects of the system:
   1. Software configuration and administration.
   2. Camera configuration and adjustments.
   3. Advanced operations
      a. Image search
      b. Visual Alerts operation, use, and configuration.
      c. LPR operation, use and configuration
   4. System operation and monitoring.
   5. End-user maintenance.

C. Provide up to one (1) eight-hour session of train-the-trainer. The session may be similar to the user/operator training and the administrator/operator training sessions, as determined and requested by the owner. Training shall cover the aforementioned topics above but will allow the sessions to be recorded by internal IHS staff or their delegates.

D. Training shall be used to provide guidance on installed systems not used to upsell beyond the current capabilities. In the event participants ask questions on features that are not purchased, they should be directed to their leadership for discussion on that topic.

E. Training team shall be comprised of a minimum of four people:
   1. Lead-Trainer: Person who will facilitate training.
   2. Manufacture's professional services representative.
   3. Lead-Installer: person who led the installation of the system.
   4. Role-player: Person who can trigger alarms in the field during training.

F. Training leave-behinds: Training team shall prepare and provide the following before each session to each student and an electronic copy:
   1. Training Agenda
   2. Step-by-step instructions on basic tasks such as searching, viewing recorded video and exporting recorded video

3.15 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose, during these visits the VMS manufacture's professional services representative shall be on site. Tasks shall include, but are not limited to, the following for both the general VMS and the pharmacy VMS:
   1. Verify each camera field-of-view with owner.
   2. Verify proper focus and operation of cameras and lenses.
   3. Verify operation of ACAMS alarm integration with the VMS for automatic camera call-up of associated camera(s).
   4. Check video storage usage and capacity versus specified criteria.
   5. Complete system health check.

6. Update software and firmware (as needed) for any servers, cameras or end devices requiring updates to the latest versions at the time of visit. Update corresponding licenses (as applicable).
7. Tune visual alert and analytics taction zones and thresholds.
8. Recommend changes to cameras, device configuration or programming, to improve Owner's use of the video surveillance system.
9. Provide a written report of adjustments and recommendations.

END OF SECTION

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This work includes designing and providing a new, completely supervised, multiplexed, addressable, intelligent, voice evacuation fire alarm system (devices, components and wiring) as described herein and on the contract drawings for the Project. All fire alarm panels and equipment are to be compatible with existing campus Notifier Onyx panels located in existing campus buildings.

1. Include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, software and programming, acceptance testing and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide equipment with components identical to and bearing the labeling of those approved for intended use by independent testing laboratory.

B. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Device guards.
7. Firefighters' two-way telephone communication service.
8. Magnetic door holders.
9. Remote annunciator.
10. Addressable interface device.
11. Digital alarm communicator transmitter.
12. Radio alarm transmitter.
13. Notification appliance circuit power extender panel (NAC).
14. Network communications.

C. Related Requirements:

1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.
2. Division 07 SectionPenetration Firestopping• • for fire stopping requirements not in this Section.
3. Provisions of Division 26 SectionsCommon Work Results for Electrical• • and Raceways and Boxes for Electrical Systems• • apply to this Section.
4. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

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. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. 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.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. 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.
   9. Include performance parameters and installation details for each detector.
   10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
   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. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
      d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
      e. Locate detectors according to manufacturer's written recommendations.
      f. Show air-sampling detector pipe routing.
   13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
   14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
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: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
1. Provide delegated design submittial for notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria.
   a. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
   b. 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.
   c. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

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 and deliver copies to authorities having jurisdiction:
   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 Documents" Article in the "Documentation" section of the "Fundamentals" 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.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. 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.
i. Manufacturer's required maintenance related to system warranty requirements.
j. 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 magnetic media 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. Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
5. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
6. Keys and Tools: One extra set for access to locked or tamperproofed components.
7. Audible and Visual Notification Appliances: One of each type installed.
8. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Installation shall be by personnel certified by NICET as minimum fire-alarm Level III technician.

B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.8 PROJECT CONDITIONS

A. Perform a full test 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 Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

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: Maintain existing equipment fully operational 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.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

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: Five years from date of final acceptance.

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 Notfier system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/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.

F. All campus buildings are to be networked and report to Control Room SEC-2146 within the hospital.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire-extinguishing system operation.
7. Fire standpipe system.
8. Dry system pressure flow switch.
9. Fire pump running.
10. Preaction systems.

B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances, including voice evacuation notices.
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. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Preaction system.
10. Recall elevators to primary or alternate recall floors.
11. Activate elevator power shunt trip.
12. Activate emergency lighting control.
13. Activate emergency shutoffs for gas and fuel supplies.
14. Record events in the system memory.

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. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.

5. Fire pump running.
6. Fire-pump loss of power.
7. Fire-pump power phase reversal.
8. Independent fire-detection and -suppression systems.
9. User disabling of zones or individual devices.
10. Loss of communication with any panel on the network.

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. Voice signal amplifier failure.

E. System Supervisory Signal Actions:
1. Initiate notification appliances.
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. Record the event on system printer.
4. After a time delay of 200 seconds , transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a registered design professional, as defined in Section 013573 "Delegated Design Requirements and Procedures" to design notification appliances, and smoke and heat detectors.
1. Material properties indicated in this Section shall be considered as minimum properties.

B. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 .
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Notifier.

B. General Requirements for Fire-Alarm Control Unit:

1. Compatible with existing campus Notifier panels.
2. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
    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 FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    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 FACP shall provide a minimum 500-event history log.
3. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
4. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. 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, 80 characters, minimum.
    2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. 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, three line(s) of 80 characters, minimum.
    2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
    1. Pathway Class Designations: NFPA 72, Class B .
    2. Pathway Survivability: Level 3(until circuit reaches zone of notification/signaling, then Level 0).
    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 operation using point ID DACT.
        b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
        c. One USB port for PC configuration.
        d. One RS 232 port for voice evacuation interface.

F. Notification-Appliance Circuit:
   1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
   2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
   3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. 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.
      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 shall shut down elevators associated with the location without time delay.

H. 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.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current 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.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
   1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
      a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
      b. Programmable tone and message sequence selection.
      c. Standard digitally recorded messages for "Evacuation" and "All Clear."
      d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

L. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

M. 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 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.

N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed lead calcium.
2. Secondary power duration: 24 hours minimum.

O. 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.

2.5 PREACTION SYSTEM

A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.6 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Notifier.

B. 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. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key- or wrench-operated switch.

4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.7 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Notifier.

B. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Detectors shall be four -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. Self-Testing: Detectors are to be capable of self testing in accordance with NFPA, in locations where applicable.
   7. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
   8. 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.

C. 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.).

D. Ionization Smoke Detector:

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.).

E. 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.

2.8 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Notifier.

B. General Requirements for Heat Detectors: Comply with UL 521.
1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Wheelock.
2. Federal Signal Corporation.
3. GE UTC Fire & Security; A United Technologies Company.
4. Gentex Corporation.
5. System Sensor.

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. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch- high letters on the lens.
1. Rated Light Output:
a. 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall 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.

D. Voice/Tone Notification Appliances:
1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: surface mounted and bidirectional.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.10 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.

2.11 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: Surface 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.

2.12 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, fire pumps, and emergency generators for monitoring status

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 circuit-breaker shunt trip for power shutdown.
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.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. 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.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.14 NETWORK COMMUNICATIONS

A. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

B. Provide Honeywell Connected Life Safety Services (CLSS) to interconnect all campus buildings on the IHS LAN network.

C. Provide integration gateway using BACnet for connection to building automation system.

D. Notifier client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard, and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package.

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 ELECTRIC POWER

A. Provide primary power for all fire alarm panel equipment from the emergency AC service to the building where shown on the drawings. Power shall be 120 VAC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices. Make the service connection for the fire alarm panel equipment at the junction box labeled "FACP Connection" connected to the emergency distribution panel where shown. The circuit breaker shall be painted red, marked "Fire Alarm Control Circuit" and shall be provided with a lockable handle or cover. All 120 VAC primary power circuits shall be equipped with surge protection devices (SPD).

3.3 SYSTEM FIELD WIRING

A. Wiring within Cabinets, Enclosures, Boxes, Junction Boxes and Fittings:

1. Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure or cabinet.
2. Connect conductors which are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting or junction box, to terminal blocks.
3. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with approved pressure type terminal blocks, which are securely mounted.
4. Wire nuts and similar devices are not acceptable.

B. Provide a terminal cabinet where indicated on the Drawings.
1. Use terminal sizes appropriate for the size of the wiring to be connected.
2. Provide labeling of conductor terminations, and a diagram permanently mounted in the terminal cabinet, showing all conductors, their labels, their circuits and their interconnection.
3. Provide terminal cabinets having 25 percent spare backbox space.

C. Fire Alarm Wiring:
1. Provide fire alarm circuits in accordance with the equipment manufacturer's requirements, NFPA 70 – National Electrical Code, specifically Article 760 and these Specifications. Provide wire size sufficient to prevent voltage drop problems.
2. Circuits operating at 24 VDC shall not operate at less than 21.6 volts.
3. Audio speaker circuits operating at 70.7 VRMS shall be designated to operate at less than 0.5 dB (12.5 percent) loss. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.
4. Install all conductors in minimum electrical-metallic tubing (EMT), with a minimum diameter of 3/4 inch.
5. Use shielded wiring where recommended by the manufacturer. For shielded wiring, the shield shall be grounded at only one point, which shall be in or adjacent to the FACP. Treat the drain or shield wires as a fire alarm conductor, landed on terminal strips. The drain wire shall be sleeved or insulated to within 1 inch of its termination. T-taps are not permitted. Circuits to fan shutdown systems shall terminate in terminal cabinets within 3 feet of the controllers for those systems

D. Wiring Installation:
1. All alarm initiating devices and supervisory initiating devices shall be connected on Style 4 two (2) wire (Class B) Signaling Line Circuits (SLC). Unsupervised wiring (point wires) shall not be permitted. Parallel branch circuit wiring shall be permitted on the addressable SLCs.
2. All alarm indicating devices shall be connected on Style Y two (2) wire electrically supervised circuits and on a minimum of two active circuits.
3. Wiring to initiating and supervisory devices and to fire alarm annunciators shall be with two (2) conductor twisted size 16 solid copper UL listed fire alarm system wire, subject to manufacturer's recommendations.
4. Wiring to alarm indicating devices shall be with two (2) conductors twisted No. 14 AWG solid copper UL listed jacketed fire alarm system wire, subject to manufacturer's recommendations.
5. Power wiring, operating at 120 VAC minimum, shall be No. 12 AWG solid copper, 600 VAC rated THHN/THWN insulation.

6. All other wiring shall be solid copper No. 14 AWG minimum with 600 volt THHN insulation except as specifically noted.
7. No splicing of wires is permitted except on terminal blocks in annunciators, control panels or properly labeled terminal cabinets as shown on the drawings.
8. The use of wire nuts or similar type devices is not permitted.

E. Conductor Terminations:
1. All devices shall have terminals for each wiring connection.
2. No splicing of any type shall be permitted in pull boxes, to include crimp terminals.
3. No specific color coding is required for any circuit; however, labeling of any circuit at terminal blocks in terminal cabinets, FACP, and remote fire alarm control units shall be provided at each conductor connection.
4. Each conductor or cable shall have a permanent label to provide a unique and specific designation.
5. Each terminal cabinet, FACP and remote fire alarm control unit shall contain a laminated drawing which indicates each conductor, its label, circuit and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel or unit so that it does not interfere with the wiring or terminals.
6. All wires shall be labeled at both ends.. Use plastic wire ties and wire tie mounts to ensure a neat quality appearance.

F. Conduit Installation:
1. Conceal all electrical conduits above suspended ceilings and behind walls, except in unfinished areas where conduit may be surface mounted, unless otherwise specified.
2. The use of metal clad (MC) cable is acceptable only in concealed spaces and only as allowed by other Codes, including channeled walls and above suspended ceilings. The MC Cable shall be installed and supported in accordance with NFPA 70-NEC.
3. MC cable is not acceptable for smoke control system wiring.
4. All exposed conduit shall be painted to match adjacent finish.

G. Conduit Size:
1. Both exposed and concealed conduit including risers up to 2 inches in diameter shall utilize compression type steel fittings and connectors.
2. Unless otherwise noted, all conduit provided shall be 3/4 inch minimum trade size.
3. Vertical risers shall be one inch diameter minimum.
4. Limited use of 1/2 inch conduit is permitted on horizontal runs when a reduced diameter is required for better concealment. Where necessary, 1/2 inch diameter flex conduit may be fished or used for concealed work. Provide plenum rated wiring conductors (Type FPLP) when flex conduit is used.

3.4 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. Connect new equipment to existing control panel in existing part 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. Equipment Mounting: Install fire-alarm control unit on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
1. Install seismic bracing. Comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Equipment Mounting: Install fire-alarm control unit on finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

F. 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 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

G. 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. Smooth ceiling spacing shall not exceed 30 feet .

4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. 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.

H. 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.

I. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

K. 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.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Visible Alarm-Indicating Devices: Install weather-proof device at exterior fire department connection. Locate in accordance with local authority having jurisdiction.

N. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.5 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.6 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 087100 "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. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe/pre-action sprinkler system.
9. Supervisory connections at elevator shunt-trip breaker.
10. Data communication circuits for connection to building management system.
11. Data communication circuits for connection to mass notification system.
12. Supervisory connections at fire-extinguisher locations.
13. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
14. Supervisory connections at fire-pump engine control panel.

C. Notifier client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard, and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package.

3.7 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.

3.8 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.

3.9 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   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, Preparation" table in the "Documentation" section of the "Fundamentals" 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" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of final acceptance, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.11 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At final acceptance, update software to latest version. Install and program software upgrades that become available within two years from date of final acceptance. 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.

3.12 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 285000 - SECURITY CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This Section is integral to the overall Division 28 specifications and shall be coordinated with other sections, including but not limited to Sections 28 1300 (Access Control), 28 2300 (Video Surveillance), and 28 1600 (Intrusion Detection).

C. Professional Services
   1. Each bidder shall review the professional services scope of work document, associated costs, and all other relevant sections of this specification that require professional services. This review is a mandatory component of the bid response. To ensure compliance, each bid must include a completed and signed Professional Services Compliance Checklist, attached to this bid document.

1.2 SUMMARY

A. This Section specifies a complete, integrated Security Control System (SCS), including all hardware, software, licenses, and services required for a fully operational system. The SCS shall unify disparate security and operational technologies via a core microservice platform and a web-based user interface.

B. The SCS shall provide a unified graphical user interface (GUI) for control and response of electronic safety and security systems. The system's primary function is to integrate critical communications, video security, access control, and incident management software to enable cohesive operation.

C. The system shall include:
   1. Centralized Security Management Software
   2. Operator Workstations and Control Consoles
   3. Interfaces to other Division 28 systems
   4. Integration with third-party systems as required by the drawings.
   5. All necessary power supplies, network infrastructure, and conduit.

1.3 SYSTEM DESCRIPTION

A. The SCS shall be an open-architecture system capable of integrating various subsystems from various manufacturers.

B. The platform shall eliminate manual information and task transfer within conventional workflows by providing an automated operational layer.

C. System Architecture: The system shall consist of two primary components, architected as a secure, cloud-based interface solution for system configuration and workflow automation. It shall function as a "system of interaction/transactions" rather than a "system of records", minimizing long-term storage of sensitive business data.

D. Core Microservice Platform: This component shall be the engine that processes data from various integrated systems. It shall act as a centralized hub, connecting distinct security and operational technologies to enable the seamless flow of information and execution of automated workflows. This platform shall handle the logic, data processing, and integration with the APIs and data formats of connected systems.

E. User Interface (UI) Layer: The UI shall be a web-based, drag-and-drop workflow automation tool that enables personnel to create and manage rule-based workflows without requiring specialized coding knowledge. The UI shall be intuitive, accessible from any web browser, and provide a holistic view of the security posture.

F. Core Functional Logic: The platform shall be built on a Boolean-style logic engine and based on the "if-this-then-that" principle, where a trigger event initiates a corresponding automated action. This logic shall be powered by the integration of digital business rules. The system shall leverage analytics-driven logic to initiate conditional logic, enabling the platform to provide contextual information to relevant personnel.

G. The system shall not require a dedicated centralized control console for monitoring and controlling all doors, alarms, video feeds, and intercoms, as well as other designated devices. System shall utilize a webpage-based interface. The platform's function is to eliminate manual processes by automating workflows that span multiple technologies.

1.4 QUALITY ASSURANCE

A. The installer shall be a qualified Security Controls System Contractor (SCSC) with a minimum of Number (5) years of experience on projects of similar scope and complexity. The SCSC shall be factory-trained and authorized by the software and hardware manufacturers.

B. Compatibility: All system components shall be fully compatible and by Motorola Solutions in advance to ensure proper interoperability.

1.5 SUBMITTALS

A. Software Data Flow Diagram: Provide a detailed diagram showing the data flow and logical programming for the system.

B. Operator Interface Mockups: Submit mockups or screenshots of the proposed user interface for approval.

C. System Test Plan: Provide a comprehensive plan outlining the procedures for system testing and acceptance.

1.6 WARRANTY

A. The installed SCS and all its components shall be warranted against defects in materials and workmanship for a period of (X) Number years from the date of final acceptance

1.7 OPERATIONAL FUNCTIONALITY

A. The SCS shall automate the security response lifecycle according to the Pinpoint, Inform, Evaluate, and React (P.I.E.R.) framework:
   1. Pinpoint (Detect): The system shall automatically detect events and risks using advanced video analytics and other integrated sensors.

2. Inform (Communicate): The system shall integrate with Motorola Inform, a cloud-based AI platform that enhances Orchestrate workflows through automated event verification, triage, and response. Inform shall use real-time analytics to reduce false alarms, recommend response actions, and execute automated playbooks across integrated systems including Avigilon Unity Video, Unity Access, and Motorola communications. Integration shall provide a unified operational view and enable intelligent, automated decision-making through the existing Orchestrate interface.
3. Evaluate (Analyze): The system shall improve situational awareness by leveraging real-time data to provide contextual actions and alerts based on the specific type of trigger.
4. React (Respond): The system shall automate appropriate, multi-step responses, including, but not limited to, locking/un-locking doors, enabling/disabling access cards, and dispatching response teams.

1.8 SCOPE OF WORK

A. The scope of work for this project shall include the full integration of the following technologies into the Security Control System:

B. Motorola TRBO Radio (ION)

C. Motorola P25 interface (SoC)

D. Motorola RAVE panic integration

E. Motorola RAVE mass notification integration

F. Avigilon Unity Video

G. Avigilon Unity Access

H. Vehicle Manager Enterprise

I. Motorola Inform Command Center Software

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The system shall be from a single, integrated manufacturer or a consortium of manufacturers with a proven history of collaboration.

B. Acceptable manufacturers include: Orchestrate Software Inc., Motorola Solutions.

2.2 SYSTEM COMPONENTS

A. Security Management Software:
1. Platform: Orchestrate
2. Core Platform: Cloud-based microservice platform
3. User Interface: Web-based, drag-and-drop GUI
4. Licenses: Provide all necessary runtime and development licenses.
5. Motorola Edge Nodes as required for radio interoperability.

B. Operator Workstations and Control Consoles:

C. Communication nodes:

1. The Motorola Edge Node is a secure, cloud-connected gateway that bridges a MOTOTRBO radio network to Motorola Solutions' cloud-hosted services and third-party applications. It consolidates several key interfaces onto a single platform that is managed in the cloud.
2. Motorola Network Interface Services (MNIS), the Device Discovery and Mobility Service (DDMS), and the interface to the Motorola Gateway to LMR Network (MGLN), onto a single, cloud-managed platform. This enables enhanced operational efficiency, data-driven insights, and safety by integrating radio systems with digital workflows.

D. Interfaces:
1. Access Control Interface: Provide a pathway for the creation of door lock events based on event triggers.
2. Video Interface: Provide a pathway for the creation of video events (call-ups, push alarms, etc.) based on event triggers.
3. Intercom Interface: Provide a full interface for controlling and annunciating intercom calls.
4. Alarm Interface: Centralize all alarm annunciations from all connected systems, alongside programmable system responses to various alarms.
5. ION Radios Interface: Provide an interface for communications with ION Radios.

E. Network Equipment: Provide all necessary network switches, cables, and ancillary equipment for a complete, secure network for the SCS.

F. Comprehensive Compatibility
1. The platform is designed for integration with a wide range of Motorola Solutions products and technologies to enable automated workflows and a coordinated response.
2. The following table details some of the key compatible products and their functions:

Product	Technology Type	Function
MOTOTRBO Radios	Critical Communications	Digital two-way radios for voice and data communication
WAVE PTX™	Broadband PTT	Push-to-talk across different devices, networks, and locations
Avigilon Unity Video	Video Security	AI-powered video management software with cloud-managed capabilities
Avigilon Unity Access	Access Control	On-premise control server appliance for access control
Rave Alert & Rave Panic Button	Mass Notification & Safety	Smartphone app and mass notification system for emergencies

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install all components in accordance with the manufacturer's instructions, approved shop drawings, and applicable codes.

B. Integration: The SCSC is responsible for the full integration of all Division 28 field devices into the SCS. This includes all wiring, terminations, and configuration.

C. Conduit and Wiring: All wiring shall be run in conduit and labeled clearly.

D. Client workstations are to be located in the IDF indicated on drawings and outputs extended via ethernet KVM to security operations center where they shall be connected to the corresponding monitor, keyboard and mouse. The user shall have the ability to alternate monitors for fire and video as shown in drawing package.

3.2 PROGRAMMING AND CONFIGURATION

A. GUI Development: Develop a user-friendly graphical interface that accurately represents the facility and provides intuitive control of all integrated systems.

B. Control Logic: Implement all specified control logic, including cause-and-effect programming for alarms and events. The platform helps organizations shift from a reactive to a proactive security posture by automating the detection, analysis, and communication, and response cycle.

C. Network Configuration: Configure all devices with static IP addresses on the designated network.

3.3 COMMISSIONING AND ACCEPTANCE

A. System Test: The SCSC shall perform a complete, point-to-point test of the entire system to verify all control logic, interfaces, and annunciations are fully functional.

B. Final Acceptance: The system will be considered accepted upon successful completion of all required tests and the provision of all required documentation.

3.4 TRAINING

A. The SCSC shall provide comprehensive on-site training to the Owner's designated personnel on the operation, administration, and basic troubleshooting of the Security Control System.

B. Provide up to four(4) one(1)hour sessions of user/operator training. The two sessions may be similar (to allow additional staff to be trained) or may cover different topics while going into more depth, as determined and requested by owner. Training shall cover the following basic aspects of the system:
   1. Operation
   2. Basic administration and Troubleshooting

C. Provide up to two (2) two(2) hour sessions of administrator/operator training. The two sessions may be similar (to allow additional staff to be trained) or may cover different topics while going in more depth, as determined and requested by the owner. Training shall cover the following basic aspects of the system:
   1. Software configuration and administration.
   2. Camera configuration and adjustments.
   3. System operation and monitoring.
   4. End-user maintenance and troubleshooting.

D. Provide up to one (1) eight-hour session of train-the-trainer. The session may be similar to the user/operator training and the administrator/operator training sessions, as determined and requested by the owner. Training shall cover the aforementioned topics above but will allow the sessions to be recorded by internal IHS staff or their delegates.

E. Training shall be used to provide guidance on installed systems not used to upsell beyond the current capabilities. In the event participants ask questions on features that are not purchased, they should be directed to their leadership for discussion on that topic.

F. Training team shall be comprised of a minimum of four people:
   1. Lead-Trainer: Person who will facilitate training.
   2. Manufacture's professional services representative.
   3. Lead-Installer: person who led the installation of the system.
   4. Role-player: Person who can trigger alarms in the field during training.

G. Training leave-behinds: Training team shall prepare and provide the following before each session to each student and an electronic copy:
   1. Training Agenda
   2. Step-by-step instructions on basic tasks

3.5 DEPLOYMENT MODEL

A. The solution shall be deployed by certified partners who have reseller agreements for both radio and Avigilon products and have completed the necessary training.

3.6 CYBERSECURITY

A. The platform shall adhere to a systematic cybersecurity approach integrated into all phases of development and integration.

B. This shall include adherence to standards like the Software Development Lifecycle (SDLC) to mitigate cybersecurity risks.

3.7 GENERAL PROFESSIONAL SERVICES

A. The awarded contractor will be required to partner with Motorola Solutions to perform system configuration, programing, system integrations, testing and training.

3.8 SYSTEM & NETWORK INTEGRATION SERVICES

A. The SCS is a complex solution that may require dedicated System & Network Integration Services to ensure seamless deployment and optimal performance.

B. These services shall be available for System Staging to prepare equipment for streamlined deployment and Site Development for the design and construction of mission-critical communication facilities.

C. Expertise in Network Integration shall be provided to properly prepare the client's network for the deployment of the new solution and to address the inherent complexity of integrating open-architecture systems with various third-party technologies.

3.9 MANAGED & SUPPORT SERVICES

A. The installer shall provide a comprehensive suite of Managed & Support Services to ensure the technology investments are optimized, secured, and future-ready.

B. These services shall include continuous, 24/7 monitoring and proactive identification of system incidents, extending to support for devices, networks, and various other systems.

C. This approach shall move beyond a reactive "break-fix" support model to ensure operational resilience and business continuity.

3.10 DAY 2 SERVICES

A. Day 2 services are defined as pre-scheduled visits by Motorola Solutions professional services staff, working in conjunction with the awarded contractor, to optimize the environment by updating any hardware, software, interface links, and system behaviors, as well as programmed alarms and responses.

3.11 PARTNER & CHANNEL ENABLEMENT

A. The SCS deployment model shall be delivered through a scalable, partner-centric approach.

B. Certified "Safety Reimagined Partners" shall be an extension of the business, providing essential professional services on the ground, including installation, basic configuration, and first-line support.