

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Basic electrical requirements, which are specifically applicable to all Division 26 Sections, in addition to the requirements of Division 1 - General Requirements.

1.2 SUBMITTALS

- A. Provide submittals in accordance with Section 013300 - Submittal Procedures.
- B. Submittal data containing manufacturer's data shall be sent to the Architect, Engineer and Owner for review.
- C. Electronic submittal data shall be assembled in Adobe Acrobat's Portable Data Format (PDF) for review.
- D. Electronic submittal data shall be assembled in one (1) complete PDF file and shall include an index sheet (TOC) listing each submittal item by specification number and its content. Each file shall also be organized with "Bookmarks" of each section. Submittals that do not have each submittal item referenced by "Bookmarks" shall be rejected.
- E. All electronic submittal data for a trade shall be submitted at one time except as noted herein.
- F. Data not submitted shall have a statement explaining why the data was not submitted.
- G. Submittals not conforming to any of the above requirements shall be rejected.
- H. The contractor shall go to each specification section to determine all technical information/data required and organize information/data using tabs for major headings as follows:
 - 1. Section 260519 - Low-Voltage Electrical Power Conductors and Cables
 - a. Building wire and cable (600 volts and less)
 - b. Connectors, splices and terminations (600 volts and less)
 - c. Sleeves
 - 2. Section 260529 - Hangers and Supports for Electrical Systems
 - a. Steel slotted support systems
 - b. Non-metallic slotted support systems
 - c. Fastening hardware
 - d. Plywood backboards
 - e. Sleeves
 - 3. Section 260533 - Raceways and Boxes for Electrical Systems
 - a. Rigid steel conduit
 - b. IMC
 - c. PVC coated steel conduit.
 - d. EMT
 - e. Flexible metal conduit
 - f. Liquidtight flexible metal conduit
 - g. Nonmetal conduit
 - h. Conduit fittings and bodies
 - i. Surface metal raceway
 - j. Two compartment raceway
 - k. Surface raceway fittings
 - l. Outlet boxes
 - m. Junction boxes
 - n. Floor boxes
 - o. Hinged cover enclosures
 - p. Cabinets
 - q. Handholes

- r. Sleeves
- 4. Section 260537 - Cable Hooks Support System
 - a. J-Hooks
 - b. Brackets and fittings
- 5. Section 260553– Identification for Electrical Systems
 - a. Product Data
 - b. Identification Schedule
 - c. Samples
- 6. Section 260941 – Digital Lighting Controls
 - a. Product data
 - b. Shop Drawings
 - c. Qualification Data
 - d. Certification
 - e. Field Quality Control Test Reports
- 7. Section 260943 – Building Lighting Controls
 - a. Product data
 - b. Shop Drawings
 - c. Qualification Data
 - d. Certification
 - e. Field Quality Control Test Reports
- 8. Section 262416 – Panelboards
 - a. Product data
 - b. Shop drawings
- 9. Section 262726 – Wiring Devices
 - a. Convenience receptacles
 - b. Isolated ground receptacles
 - c. GFCI receptacles
 - d. Twist locking receptacles.
 - e. Pendent cord receptacles
 - f. Cord & Plug sets.
 - g. Light switches
 - h. Pilot light switches
 - i. Key operated switches
 - j. Key operated momentary contact switch
 - k. Wall plates
- 10. Section 262813 – Fuses
 - a. Product data
 - b. Shop drawings
- 11. Section 262816 - Enclosed Switches and Circuit Breakers
 - a. Product data
 - b. Shop drawings
- 12. Section 263213 – Engine Generators
 - a. Rated capacities (data)
 - b. Operating characteristics (data)
 - c. Overall dimensions (shop drawings)
 - d. Weight (shop drawings)
 - e. Required clearances (shop drawings)
 - f. Location of connectors (shop drawings)
 - g. Wiring diagrams (shop drawings)
 - h. Warranty

13. Section 263600 – Transfer Switches
 - a. Product data
 - b. Shop drawings
14. Section 265100 – Interior Lighting
 - a. Product data
 - b. Coordination drawings
 - c. Qualification data
 - d. Warranties
- I. Manufacturer's data sheets shall be marked to clearly indicate the manufacturer, model number, size, color, accessories, required clearances, field connection details, weight loading, electrical characteristics, capacities, etc. being submitted. Variations from specifications shall be explained. Submittal preparer's name and telephone number shall be listed on the index sheet.
- J. Only manufacturers listed in specifications or addendums will be considered.
- K. Review, corrections, or comments made on the submittals do not relieve the Contractor from compliance with the requirements of the Drawings, Specifications and Addendums (Contract Documents). By entering into this Contract, the Contractor agrees that the purpose of submittals is to demonstrate to the Engineer that the Contractor understands the design concept and that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and use. Review of shop drawing will be general only for basic conformance with the design concept. The review of such drawings, schedules or cuts shall not relieve the Contractor from the responsibility for correcting all errors of any sort contained in the submittals. The Contractor is responsible for confirming and correlating all quantities and dimensions; selecting proper fabrication processes, construction methods and installation techniques; coordinating this work with that of all other trades; and performing all work in a safe, workmanlike and satisfactory manner.
- L. Below are the submittal item codes that will be used when reviewing the submittal data. These codes show up on the "Submittal Review" sheet. Only one copy of the submittal review sheet is returned upon completion of the submittal review.
 1. RNE - Reviewed, No Exceptions Noted
 - a. Indicates the information provided has been reviewed and no exceptions are taken. Contractor must still comply with the contract documents.
 - b. No corrective action required at this time.
 2. FNC - Furnish with Noted Corrections
 - a. Indicates the contractor shall ensure that all necessary or noted corrections are incorporated into equipment furnished to the project.
 - b. Contractor shall incorporate items requested in review comments, but re-submittal not required.
 3. RES - Revise and Resubmit
 - a. Indicates item is not presently acceptable as submitted, but may be accepted provided additional information and/or changes are made.
 - b. Contractor shall revise and resubmit item to Engineer with additional information indicating compliance with Contract Documents prior to proceeding with work.
 4. PSD - Provide Submittal Data
 - a. Indicates submittal data was not provided for this item or section.
 - b. Contractor shall provide submittal data meeting the explicit requirements of the plans, specifications, and all addenda.

- M. Shop drawings and data submittals for materials requiring extra long delivery time shall be submitted for approval as soon as possible after execution of contract. All sleeves must be precast in concrete or concrete block and accordingly provided to the mason in a timely manner. Accordingly, all items such as these shall be submitted for approval in a timely manner (prior to other submittals if necessary) so they may be properly incorporated in the building's structure. Allow a minimum of three weeks for review. No substitutions of materials or extensions of contract time will be allowed for Contractor's failure to submit or order such materials sufficiently in advance of the work. See Architectural specification section for additional requirements for submittals.

1.3 REGULATORY REQUIREMENTS

- A. All work installed under Division 26 shall conform to the current adopted Edition of Building/Electrical Codes and their appropriate amendments:
1. NFPA 70 2023 National Electrical Code
 2. Life Safety Code, NFPA 101
 3. Requirements of the State of Georgia Fire Marshall's Office.
 4. GA State Energy Code.
 5. Standard Building Code
 6. Standard Mechanical Code (Georgia Edition)
 7. Standard for Health Care Facilities, NFPA 99
 8. National Fire Alarm Code NFPA 72
 9. Standard for Emergency and Standby Power Systems NFPA110
 10. City of McDonough and Henry County Codes
- B. Obtain and pay for all permits, and request inspections from all authorities having jurisdiction, in a timely manner.
- C. Materials and Equipment included in Underwriter's Label Service shall bear that label. Electrical equipment shall be UL approved as installed, and bear the UL label, unless noted otherwise herein.
- D. Where requirements of these specifications differ from specified codes and ordinances, conform to the more stringent requirements.

1.4 CONTRACTOR GUARANTEE

- A. All equipment and materials furnished and all work performed under these specifications, shall be guaranteed to be free of defective materials and workmanship for a period of one year (unless a longer period is specified elsewhere) after Architect's Final Certificate. Upon notice of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.

1.5 OPERATING AND MAINTENANCE (O&M) MANUALS

- A. One bound and indexed Operating and Maintenance Manuals and one electronic copy (PDF format) shall be prepared by the Contractor and be submitted for approval prior to delivery to operating personnel. Binders shall be 3-ring commercial grade, complete with inside storage pockets, sheet protectors, spine and front cover labels.
- B. Operating and maintenance manuals shall also comply with Division 1 Section "Operation and Maintenance Data."

1.6 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on Drawings, unless prevented by project conditions. Shift or relocate equipment or systems to avoid conflicts with other trades. Modifications to the work required to accommodate project conditions encountered in the field shall be made at no additional cost to the contract.

- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.
- C. Install items so that there are no obstructions (e.g., pipes, conduits, etc.) blocking service panels of the equipment, or preventing the removal of the equipment.
- D. Electrical items are shown on drawings in approximate locations unless dimensioned. Install at location required to serve intended purpose. Include installation within ten (10) feet of location shown.

1.7 SEQUENCING AND SCHEDULING

- A. Contractor shall coordinate work so as to avoid conflicts with other work in progress.
- B. Work shall progress in a manner that will not interfere with other trades. The Division 26 Contractor shall have coordination meetings with all other Contractors to ensure that all systems installed in "share areas" (e.g., ceiling plenums, mechanical rooms, etc.) are coordinated and installed to ensure proper fit and access. All costs required for the coordination of the work between trades shall be borne solely by the Contractor.
- C. Contractor shall provide confirmation letters from the factory (not from the contractor) to the Owner that long lead items have been ordered. Long lead items are defined as items having longer than six-week fabrication schedules. See Section 01100 - Summary for additional requirements.

1.8 ACCEPTABLE PRODUCTS

- A. Where a manufacturer has been listed as being acceptable in the various specification sections hereinafter for a certain product, it shall be understood that the manufacturer has been approved as being capable of producing this product. This does not necessarily constitute approval of his standard product. His product shall still comply with all of the requirements and standards of this specification and not necessarily his standard specification, to the extent that it might require special manufacture to meet the requirement and standards of this specification.
- B. Prior Approval: Substitutions of specified items and prior approvals of other manufacturers will not be considered.
- C. Addenda: If the substitution is allowed, such approval will be set forth in an Addendum.
- D. Costs: All costs incurred by the acceptance of substitutions shall be borne by the contractor.

1.9 DRAWINGS

- A. General: Both the drawings and specifications shall be considered supplemental to one another so that materials and labor required by one but not the other shall be supplied and installed as though specifically called for by both. Where drawings and specification conflict, Contractor shall conform to the more stringent or costly of the two requirements.
- B. Scaling: The drawings are diagrammatic only and show generally the location of the equipment, ducts and pipes but are not to be scaled. All dimensions shall be verified at the building site. Prefabrication of work from the drawings shall be at the Contractor's risk.
- C. Existing Conditions: It shall be the Contractor's responsibility to visit the site prior to bidding the project and prior to beginning work to make himself familiar with existing conditions.

1.10 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Delivery, Storage and Handling: Deliver products to site in factory-fabricated protective containers, with (where appropriate) factory-installed shipping skids and lifting lugs. Store in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- B. Prior to Final Construction Review: All materials and equipment shall be cleaned. Chipped or scraped paint shall be retouched to match.

- C. Equipment Painting: Equipment which has been damaged beyond the point of retouching or has been retouched not to match the original finish shall be repainted in accordance with the Architectural painting section.

1.11 CLEANING

- A. The Contractor shall maintain the site reasonably clean and free of excessive debris and leftover materials at all times. All trash and debris shall be hauled from the job site on a daily basis for disposal. Prior to testing and adjusting, equipment shall be clean and free of any construction debris and litter.
- B. Contractor shall meet all contractual requirements as related to site cleanliness including dust control.

1.12 ROOM NUMBERS

- A. The room numbers indicated on the Contract Documents were provided by the Architect to assist in identifying spaces during construction. These room numbers may not necessarily be the Owner's final choice of room numbers. The contractor shall obtain from the Owner the final choice of room numbers and shall use these numbers wherever required. (For example, room numbers are used in programming of fire alarm systems and intercom system, and shall match the Owner's final choice.)

END OF SECTION 260500

SECTION 260501 - ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Demolition of existing facilities shall consist of, but is not limited to, the removal of cable and wiring, conduit, fixtures and outlets, and associated abandoned or removed equipment.
- B. Visual Appearance: Demolition shall be accomplished so as to not degrade the visual appearance and structural soundness of the facility.
- C. Surfaces exposed by the removal of equipment and equipment connections shall be restored to match existing adjacent surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.
- C. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- B. Existing Electrical Services: Maintain existing systems in service during construction. Disable systems only to make connections and change-over to new service. Obtain permission from Owner at least 14 days before partially or completely disabling any existing system. Minimize outage duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing electrical installations which remain active.
- H. Extend existing installations using materials and methods as specified.
- I. If circuit serves only the device or equipment to be removed, then remove conductors back to supplying panel and remove all accessible conduit.
- J. If circuit serves some devices or equipment to be removed and some devices or equipment to remain, remove conductors back to nearest junction box or equipment to remain and rework remaining conductors to maintain power to devices to remain. Remove accessible conduit to same box or equipment. Plug all openings in box or equipment.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.

3.5 INSTALLATION

- A. Install relocated materials and equipment, as noted on drawings, under the provisions of Division 26.

END OF SECTION 260501

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 27 Section "Voice and Data Communication Cabling and Network Equipment" for cabling used for voice and data circuits.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.5 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- B. Determine required separation between this and other work.
- C. Determine routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Only products of domestic manufacturer will be accepted.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
 - 6. Allied
 - 7. Carol.
 - 8. Pirelli.
 - 9. Rome.
 - 10. Triangle.
- C. Copper Conductors: Comply with NEMA WC 70.
- D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
 - 6. Burndy Hydent.
 - 7. Ilsco.
 - 8. Thomas and Betts.
 - 9. Ideal.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
 - 1. Solderless Pressure Connectors: 3M Skotch-loks, T & B Freespring, or Ideal Wing Nut for 10 AWG and smaller.
 - 2. Compression Connectors: Burndy Hydent, Ilsco or Thomas and Betts, Color-Keyed for 8 AWG and larger.
 - 3. Terminal Lugs: Thomas and Betts STA-KON for 10 AWG and smaller; Thomas and Betts Color-Keyed for 8 AWG and larger. Equal product as manufactured by Burndy or Ilsco are acceptable.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway and ductbank.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway,
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- G. Class 1 Control Circuits: Type THHN-THWN, in raceway.

- H. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- I. Insulation: ANSI/NFPA 70; Type XHHW insulation for circuits 6AWG and larger; Type THHN/THWN insulation for circuits 8 AWG and smaller. At the contractors option, type THHN/THWN insulation may be utilized throughout for all feeders and branch circuits.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."
- E. Install products in accordance with manufacturers' instructions.
- F. Use conductor not smaller than 12 AWG for power and lighting circuits.
- G. Pull all conductors into raceway at same time.
- H. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- I. Neatly train and lace wiring inside boxes, equipment, and panelboards using nylon cable ties by Thomas and Betts, Panduit or Ideal.

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 and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Clean conductor surfaces before installing lugs and connectors.
- E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- F. Where compression connectors are used for conductor splices and taps; tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- G. Use terminal lugs for connecting all stranded conductors and for all multiple connections to terminals.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both wall surfaces.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 7 Section "Joint Sealants."
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 7 Section "Through-Penetration Firestop Systems."
- L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

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 Division 7 Section "Through-Penetration Firestop Systems."

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - a. Verify continuity of each branch circuit.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY

- A. Power system grounding.
- B. Communication system grounding.
- C. Electrical equipment and raceway grounding and bonding.

1.3 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory 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. Exothermic Connections: Exothermic connections shall be suitable for direct burial without degradation over the lifetime of the grounding system. Manufacturers of exothermic connections shall be National Lightning Protection "Powerweld", Lightning and Grounding Systems "Therm-o-weld" or Erico "Cadweld".

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4-inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Ground the electrical service system neutral at service entrance equipment to building steel, water main and to supplementary grounding electrodes.

- B. Ground each separately-derived system neutral to building steel.
- C. Provide communications, computer and other low voltage distribution system grounding conductor and connect to the inter-building grounding bus in the main electrical room. Use code minimum No. 6 AWG copper conductor. Leave six feet slack conductor at terminal board.
- D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, and receptacle ground connections.
- E. Provide a separate grounding conductor in all conduits, no exceptions. Connect outlet boxes to grounding conductors with screw fastened bonding jumper.
- F. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- G. 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.
- H. Grounding Bus: Install in electrical and data network equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
- I. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors.
 - 3. Connections to Ground Rods: Welded connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 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 Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. 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.
- 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 so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, 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.
- E. Supplementary Grounding Electrode: Use driven ground rods on exterior of building.
- F. Where multiple grounding electrodes are required or where other grounding electrodes are located within 6 feet each grounding electrode shall be interconnected below grade using code size bare copper conductor, minimum 6 AWG.

3.3 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Conduit and equipment supports.
- B. Fastening hardware.
- C. Plywood backboards.
- D. Housekeeping pads and curbs.
- E. Sleeves

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted metallic support systems.
 - 2. Fastening hardware.
 - 3. Plywood backboards.
 - 4. Sleeves
- B. Indicate hanger and support framing and attachment methods.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.
- C. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate with Division 23 contractor to route conduit concealed within curb of rooftop mounted HVAC equipment.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- 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. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. 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 in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 4. Toggle Bolts: All-steel springhead type.
 5. Hanger Rods: Threaded steel.
- F. Plywood: Exterior glue, type AC.
- G. Do not use powder-actuated anchors.

2.2 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: Structural steel or steel channel rigidly welded or bolted to present a neat appearance.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 3/8inch in diameter.
- C. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

- D. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Provide 3/4-inch plywood backboards with angle iron frame for all surface mounted equipment and as noted or specified.

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, as permitted in 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 Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 5. To Light Steel: Sheet metal screws.
 - 6. 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.
- E. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.
- C. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts or double nuts jammed tight.

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.
- C. Anchor equipment to concrete base.
 - 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.
- D. Install free standing equipment atop concrete housekeeping pads, minimum 4 inches.
- E. Provide concrete housekeeping curbs, minimum 4 inches, to surround exposed conduit below surface mounted equipment and backboards.

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 9 painting Sections 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.

3.6 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Section 260526 – Grounding and Bonding
 - 3. Section 260529 – Hangers and Supports
 - 4. Section 260553 – Identification

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.

1.4 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.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.

2. Alfex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
 10. Anaconda
 11. Triangle
 12. LTV
- C. Rigid Steel Conduit: ANSI C80.1.
- D. IMC: ANSI C80.6.
- E. EMT: ANSI C80.3.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings for Conduit (Including all Types and Flexible and Liquidtight) and EMT: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Fittings for EMT: Compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Arnco Corporation.
 2. Endot Industries Inc.
 3. IPEX Inc.
 4. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
 2. Hoffman.

- 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. 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.
- D. Wireway Covers: Screw-cover type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
 - 14. Steel City
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover. Provided threaded hubs.
- D. Metal Floor Boxes: Cast metal for on grade and Sheet metal for above grade Cast or sheet metal, fully adjustable, rectangular.
- E. Nonmetallic Floor Boxes: Nonadjustable, round.
- F. Floor Boxes
 - 1. Floor Boxes: Fully adjustable, multi-service recessed floor box.
 - 2. Material: Cast iron for on grade installation and Steel base with PVC housing for above grade installation.
 - 3. Shape: Rectangular.
 - 4. Activations: Recessed activation complete with brushed aluminum carpet or wood trim plate and wire management blocks.
 - 5. Manufacturer: Basis of design - Wiremold RFB4-CI and RFB4-4DB, or equal by Steel City, Hubbell, or FSR.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, galvanized steel.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: 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.

J. 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.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceway: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
1. Basis of Design: Wiremold V2000 Series.
 2. Finish: Ivory enamel. Beige finish is unacceptable.
 3. Fittings: Couplings, elbows, and connectors designed for use with raceway systems.
 4. Boxes and Extension Rings: Designed for use with raceway systems.
 5. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
- B. Two Compartment Aluminum Raceway
1. Surface Metal Raceway: Decorative, low profile, twin cover, two compartment (50/50) multi-outlet raceway system.
 2. Material: Extruded aluminum #6063-T5 alloy with minimum wall thickness meeting UL requirements.
 3. Finish: Brushed aluminum, clear anodized.
 4. Fittings: Covers, couplings, elbows, end caps, etc. designed for use with raceway system.
- C. Manufacturers: Wiremold AL4320 or equal by Mono-Systems SWA 2200 Series and Airey-Thompson #AT-522 Series

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: Gray.
 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, as indicated for each service.
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.

- b. Carson Industries LLC.
- c. CDR Systems Corporation.
- d. NewBasis.

2.8 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 - 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.
 - 6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - 7. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, less than or equal to 11/4": EMT.
 - 2. Exposed, greater than 11/4": IMC.
 - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: Rigid steel conduit.
 - 7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
 - 8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
 - 9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Plenum-type, optical fiber/communications cable raceway.
 - 10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 1/2-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.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
 - 3. Electrical metal Tubing:
 - a. Description: ANSI C80.3; galvanized tubing.
 - b. Fittings and Conduit Bodies: ANSI/NEMA FB 1; insulated throat steel compression type. Set screw or indenter type are unacceptable.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.

3.2 CONDUIT INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- C. 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.
- D. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway 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.
- E. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- F. Do not pull wiring into conduit until building is dried-in and conduit systems are complete.
- G. Install nonmetallic conduit in accordance with manufacturer's instructions and as specified herein.
 - 1. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- H. All conduit shall be routed concealed where possible.
- I. Arrange supports to prevent misalignment during wiring installation.
- J. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- K. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
- L. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.

- M. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- N. Do not attach conduit to ceiling support wires.
- O. Arrange conduit to maintain headroom and present neat appearance.
- P. Route exposed conduit parallel and perpendicular to walls.
- Q. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- R. Route conduit under slab from point-to-point.
- S. Do not install conduits in slab.
- T. Nonmetallic conduit will be allowed to penetrate floor slab, in on-grade construction, provided all of the following criteria are met:
 - 1. Conduit will be concealed within wall construction.
 - 2. Conduit terminates in an outlet at no more than 18 inches above finished floor. Otherwise, a transition to specified materials shall be made within this region.
 - 3. Conduit stubs are inspected by Architect following concrete pour. Damaged stubs shall be replaced in accordance with Architect's instructions at no additional cost.
- U. Maintain adequate clearance between conduit and piping.
- V. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
- W. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- X. Bring conduit to shoulder of fittings; fasten securely.
- Y. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Z. Install no more than equivalent of four 90-degree bends between boxes. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2 inch size.
- AA. Provide sealing fittings on all conduit runs which penetrate exterior walls and refrigerated spaces to prevent circulation of air and/or condensation.
- BB. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- CC. Provide insulating bushings on all RGS and IMC conduits entering wireways, pullboxes, cabinets, panelboards, etc.
- DD. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
- EE. Provide Thomas Jet-Line Polyolefin pull cord, minimum 500 lbs., in each empty conduit except sleeves and nipples.
- FF. Use "Push-Pennies" to protect installed conduit against entrance of dirt and moisture.
- GG. Ground and bond conduit under provisions of Section 260533.
- HH. Identify conduit under provisions of Section 260553.
- II. Where connections to free-standing equipment in excess of 18" from structure are required, a vertical, minimum size 3/4", rigid conduit secured to ceiling and floor shall be utilized with wiring into this conduit by means of a rigid connection to a conduit body and wiring from this conduit by means of a conduit body with a flexible conduit connection to equipment.
- JJ. Flexible conduit shall not exceed 2'-0" in length unless specified otherwise.

- KK. Route conduit through roof openings for piping and ductwork or through "PCA" series roof curb as manufactured by Pate or equal. Pitch pockets are unacceptable. This contractor shall provide curbs where required to roofing contractor for installation and coordination of installed locations.

3.3 INSTALLATION OF SURFACE METAL RACEWAY

- A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
- B. Maintain grounding continuity between raceway components. Provide a code size grounding conductor within raceway.
- C. Multi-outlet surface raceway systems shall contain power and communications outlets as shown on drawings. Receptacles shall be duplex devices as specified in Section 262726. All power and communication wiring and devices shall be field installed.
- D. All services to and from surface raceways shall be concealed. Exposed routings are unacceptable.
- E. Install all device covers, blank covers, connectors, elbows, and end caps as required for a complete system. Use suitable insulating bushings and inserts at connections of surface metal raceway to outlets and corner fittings.
- F. Route surface metal raceway in such manner as to provide maximum "concealment". (i.e. Vertical routings shall be made in corners at wall intersections or adjacent structural components. Horizontal routings shall be along top of baseboards.)

3.4 INSTALLATION OF BOXES

- A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Mounting heights as specified in other sections shall be to the bottom of the outlet.
- C. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. Install boxes to preserve fire resistance rating of partitions and other elements.
- F. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- G. Use flush mounting outlet boxes in finished areas.
- H. Secure flush mounting box to interior wall. Accurately position to allow for surface finish thickness.
- I. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- J. Use adjustable steel channel fasteners for hung ceiling outlet box.
- K. Do not fasten boxes to ceiling support wires.
- L. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- M. Use gang box where more than one line voltage device is mounted together. Do not use sectional box.
- N. Use separate boxes for low voltage systems. Do not install line voltage and low voltage devices within same outlet.
- O. Use 4-inch square box with plaster ring for single device outlets.
- P. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- Q. Set floor boxes level.
- R. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

- S. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes. Orient all outlets in like manner.
- T. Coordinate locations of all floor outlets with Architectural furniture lay-outs.
- U. Position outlet boxes to locate luminaries as shown on Architectural reflected ceiling plan.
- V. Position outlet boxes which serve electric water coolers such that box, device and coverplate will be entirely concealed within equipment cabinet.
- W. Position outlet boxes at markerboards in accordance with elevations on Drawings.
- X. Adjust floor box flush with finish flooring material.
- Y. Adjust flush-mounting outlets to make front flush with finished wall material.
- Z. Install knockout closure in unused box opening.

3.5 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 Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 2 Section "Earthwork."
 - 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 Division 2 Section "Earthwork."
 - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - 6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.6 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 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 the enclosure.

- 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.

3.7 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using 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.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.8 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.9 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

- B. Install conduit to preserve fire resistance rating of partitions and other elements in accordance with Section 07841. Seal penetrations with Flame-Safe FS900 series firestop compounds as manufactured by International Protective Coatings Corporation (800-334-8796) or equal by 3M or Hilti. Verification of these requirements shall be the responsibility of this Contractor.

3.10 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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SECTION 260537 - CABLE HOOK SUPPORT SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

- A. ASTM B633 - Specification for Electro-deposited Coatings of Zinc on Iron and Steel.
- B. ASTM A653 - Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.
- C. ANSI/ TIA/ EIA 568A - Commercial Building Telecommunications Cabling Standard
- D. ANSI/ TIA/ EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces
- E. NFPA 70, National Electrical Code

1.2 QUALITY ASSURANCE

- A. Cable hooks shall be listed and labeled by Underwriters Laboratories (UL).
- B. Cable hooks shall have the manufacturers name and part number stamped in the part itself for identification.

1.3 SUBMITTALS

- A. Submit product data on cable hook devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with these specifications, cable hook support systems shall be as manufactured by Cooper B-Line, Inc., Erico, Hubbell, or Walker.

2.2 CABLE HOOK SYSTEMS

- A. Cable hooks shall have a flat bottom and provide a minimum of 4-inch cable bearing surface.
- B. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.
- C. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.
- D. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.
- E. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.
- F. Cable hooks shall be B-Line series BCH64-2S or engineer approved equal by Erico, Hubbell, or Walker.

2.3 FINISHES

- A. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

PART 3 - EXECUTION

3.1 CABLE HOOK CAPACITY AND LOAD RATING

- A. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- B. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of 3 where extra strength is required.
- C. Follow manufacturer's recommendations for allowable fill capacity for each size of cable hook.

3.2 INSTALLATION

- A. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.

END OF SECTION 260537

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.
 - 8. Panelboard directories.
 - 9. Equipment backboards color coding.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.
- E. The room numbers indicated on the Contract Documents were provided by the Architect to assist in identifying spaces during construction. These room numbers may not necessarily be the Owner's final choice of room numbers. The contractor shall obtain from the Owner the final choice of room numbers, and shall use these numbers wherever required. (For example, room numbers are used in programming of fire alarm systems and intercom system, and shall match the Owner's final choice.)

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION MATERIALS

- A. Paint conduit striped every ten feet. All junction boxes shall also be painted.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. For building wire and cables in sizes 8 AWG and smaller provide with factory insulation to correspond to color code; in sizes 6 AWG and larger provide 3/4" colored tape bands in lieu of colored insulation.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than (6 inches) wide by (4 mils) thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR (36 INCHES)."

2.5 INSTRUCTION SIGNS

- A. Engraved laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Two Layer Acrylic: Adhesive backed, with black letters on white background.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: (3/16 inch).
 - 2. Tensile Strength: (50 lb), minimum.
 - 3. Temperature Range: (Minus 40 to plus 185 deg F).
 - 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
- C. 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 APPLICATION

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl tape applied in bands.
- B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 - 1. Fire Alarm System: Red.
 - 2. Security System: Blue and yellow.
 - 3. Mechanical and Electrical Supervisory System: Green and blue.
 - 4. Telecommunication System: Green and yellow.
 - 5. Intercommunication and Program Clock System: Blue.
 - 6. Television System: Yellow.

7. Computer System: Green.
8. Video Surveillance System: White
- C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
- E. Conductors to Be Extended in the Future: Attach to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
- G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and optical fiber cable.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 1. 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.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- J. Instruction Signs:
 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum (3/8-inch-) high letters for emergency instructions at equipment used for power transfer.
- K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with (1/2-inch) high letters on (1-1/2-inch) high label; where 2 lines of text are required, use labels (2 inches) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.

- c. Electrical switchgear and switchboards.
- d. Transformers.
- e. Emergency system boxes and enclosures.
- f. Motor-control centers.
- g. Disconnect switches.
- h. Enclosed circuit breakers.
- i. Motor starters.
- j. Push-button stations.
- k. Power transfer equipment.
- l. Contactors.
- m. Remote-controlled switches, dimmer modules, and control devices.
- n. Power-generating units.
- o. Voice and data cable terminal equipment.
- p. Master clock and program equipment.
- q. Intercommunication and call system master and staff stations.
- r. Television/audio components, racks, and controls.
- s. Fire-alarm control panel and annunciators.
- t. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- u. Monitoring and control equipment.
- v. Uninterruptible power supply equipment.
- w. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands 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.
- G. For building wire and cables in sizes 8 AWG and smaller provide with factory insulation to correspond to color code; in sizes 6 AWG and larger provide 3/4" colored tape bands in lieu of colored insulation.
 - 1. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 2. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.

3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of (6 inches) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line 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.
- J. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.
- K. For all panelboards, provide neatly typewritten directory of each device usage including building room numbers (e.g. Convenience Outlets Room A101).
- L. Locate directory inside panelboard door. Protect directory with clear plastic.
- M. Electrical Equipment Backboards: Medium grey.
- N. Telephone and Computer Equipment Backboards: White with medium grey frame.

END OF SECTION 260553

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SECTION 260941 - DIGITAL LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. The lighting control system specified in this section shall provide sensor-based and manual lighting control.
- B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed)
- C. All system devices shall be networked together enabling digital communication and shall be individually addressable.
- D. The system architecture shall be capable of enabling stand-alone groups (zones) of devices to function in some default capacity even if network connectivity to the greater system is lost.
- E. The system architecture shall facilitate remote operation via a computer connection.
- F. The system shall not require any centrally hardwired switching equipment.
- G. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

1.2 SUBMITTALS

- A. Product Datasheets (general device descriptions, dimensions, wiring details, nomenclature)
- B. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)
- C. Other Diagrams – as needed for special operation or interaction with other system(s)
- D. Factory Startup/Commissioning Worksheet – must be completed prior to factory start-up.
- E. Hardware and Operation Manuals
- F. Other operational descriptions as needed.

1.3 QUALITY ASSURANCE

- A. All steps in sensor manufacturing process shall occur in the USA, including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
- B. All components and the manufacturing facility where product was manufactured must be ROHS compliant.
- C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40-degree Fahrenheit (and Celsius) operation.
- D. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.4 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
- B. Coordinate lighting controls with BAS either through IP based intercommunication of system or hardwired auxiliary relay outputs.
- C. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.5 WARRANTY

- A. All devices in lighting control system shall have a 5-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. This specification is based on the nLight® Network Control System an Acuity Brands Company. Equals by Wattstopper, Greengate, or Current.

2.2 SYSTEM REQUIREMENTS

- A. System shall have an architecture that is based upon two main concepts: 1) intelligent lighting control devices 2) standalone lighting control zones.
- B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
- C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches.
- D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
- E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.
- F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
- I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.
- J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
- K. System shall have one or more primary wall mounted network control devices that are capable of accessing and controlling connected system devices.
- L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
- M. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
- N. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to the utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.
 - 1. Auto-On / Auto-Off (via occupancy/vacancy sensors)
 - a. Zones with occupancy/vacancy sensors automatically turn lights on when occupant is detected.
 - b. Zones with occupancy/vacancy sensors turn lights off when vacancy is detected.

- c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic functionality.
 - d. Coordinate auto on or vacancy setting preference with owner.
- O. System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Networked System Occupancy Sensors

1. "Dual" technology occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions.
3. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants.
4. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
5. Sensors shall be available with two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, and ¼ HP motor. Relays shall be dry contacts.
6. Sensors shall be available with two occupancy "poles", each of which provides a programmable time delay.
7. Sensors shall be available in multiple lens options which are customized for specific applications.
8. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
9. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
10. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
11. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
12. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
13. Network system shall also have ceiling, recessed, & corner mounted sensors available.
14. Fixture mount sensors shall be capable of powering themselves via a line power feed.
15. Sensors shall have dimming control and low temperature/high humidity operation.
16. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).
17. Sensors shall be the following Sensor Switch model numbers, with device options as indicated on the drawings.
 - a. CM PDT 10 R

B. Networked System Power (Relay) Packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC, be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Power Packs and Power Supplies shall be available that are WiFi enabled.
8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.
9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.
15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
19. Power (Relay) Packs and Supplies shall be the following Sensor Switch model Series:
 - a. nPP16 (Power Pack w/ 16A relay)
 - b. nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
 - c. nPS 80/150/250 (Auxiliary Bus Power Supply)

C. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.

2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
 3. Panel shall provide one 0-10VDC dimming output paired with each relay.
 4. Panel shall power itself from an integrated 120/277 VAC supply.
 5. Panel shall be capable of operating as either two networked devices or as one.
 6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
 7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.
 8. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:
 - a. nPANEL 4 (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
- D. Networked Auxiliary Input / Output (I/O) Devices
1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
 2. Devices shall have two RJ-45 ports.
 3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
 5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
 6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output.
 7. Auxiliary Input/Output Devices shall be the following Sensor Switch model numbers:
 - a. nI/O D (I/O device with 0-10 dimming output)
- E. Networked System Wall Switches & Dimmers
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
 2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 3. All devices shall have two RJ-45 ports.
 4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
 5. Devices shall be Gray in color.
 6. Devices with mechanical pushbuttons shall provide tactile and LED user feedback.
 7. Devices with mechanical pushbuttons shall be made available with custom button labeling.
 8. Devices with a single "on" button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
 9. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:
 - a. **nPODM** (single on/off, pushbuttons, LED user feedback)
 - b. **nPODM DX** (single on/off, single dimming raise/lower, pushbuttons, LED user feedback)
 - c. **nPODM 2P** (dual on/off, pushbuttons, LED user feedback)
 - d. **nPODM 2P DX** (dual on/off, dual dimming raise/lower, pushbuttons, LED user feedback)
 - e. **nPODM 4P** (quad on/off, pushbuttons, LED user feedback)
 - f. **nPODM 4P DX** (quad on/off, quad dimming raise-lower, pushbuttons, LED user feedback)

F. Networked System Scene Controllers

1. Device shall have two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Devices shall be Gray in color.
3. Device shall recess into single-gang switch box and fit a standard GFI opening.
4. Devices shall provide LED user feedback.
5. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
6. All devices shall have two RJ-45 ports.
7. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
8. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
9. Device shall have LEDs indicating current selection.
10. Scene Selector device shall be the following nLight model number:
 - a. **nPODM 2S** (2 Scene, push-button)
 - b. **nPODM 4S** (4 Scene, push-button)
 - c. **nPODM 4S DX** (4 Scene, push-button, On/Off/Raise/Lower)
 - d. **nPODM 2L** (2 Adjustable Preset Levels, push-button, On/Off)
 - e. **nPODM 2L AB** (2 Scene, push-button, On/Off/High/Low)
 - f. **nPODM 4L DX** (4 Adjustable Preset Levels, push-button, On/Off/Raise/Lower)

PART 3 - EXECUTION

3.1 START-UP & SUPPORT FEATURES

- A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied.
- C. System shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.
- F. Provide 4-hours of manufacturer certified training and programming for the system, in order to meet the system programming requirements required by the Owner.

END OF SECTION 260941

SECTION 260943 - BUILDING LIGHTING CONTROLS

PART 1 - GENERAL

1.1 INTRODUCTION

- A. The intent of this specification is to provide for furnishing, installing, testing and placing into operation, a complete and functional lighting control system with provision for integrated switching and dimming control of the indicated lighting.

1.2 DESCRIPTION OF WORK

- A. Extent of lighting control system work is indicated by drawings and by the requirements of this section. It is defined to include lighting control panels, control stations and other user interface devices, wiring, and ancillary programming equipment. Type of lighting control equipment and wiring specified in this section includes the following:
 - 1. Programmable relay/dimmer panels
 - 2. Over-ride switch stations
 - 3. Breaker panels with Programmable relays
 - 4. Preset dimming control stations
- B. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways, electrical boxes and fittings required for installation of the lighting control system, which are not part of this section.

1.3 QUALITY ASSURANCE

- A. Independent Testing Laboratory - The control panels shall be tested and listed under the UL 916 Energy Management Equipment standards.
- B. Factory Programming – The system shall be turned over to the owner fully programmed and ready for immediate operation. It shall be the responsibility of the contractor to coordinate with the owner and supply the necessary “as-installed” information and desired schedules to the manufacturer in a timely manner.
- C. Manufacturer experience - To insure a uniform installation and single responsibility, all switching and dimming equipment described herein shall be supplied by a single manufacturer. Manufacturer shall have a minimum of 10 years experience in lighting control systems.
- D. Manufacturer shall be Synergy Lighting Controls, Wattstopper, Hubbell, or Lutron. Basis of design is Synergy Lighting Control System.

1.4 CODES AND STANDARDS

- A. Network - ANSI 875.1, ARCNET®
- B. Protocol - ASHRAE 135 – 1995, BACnet®
- C. IEEE Std 2000.1-1998
- D. UL 916 Energy Management Equipment
- E. California Energy Commission

1.5 SUBMITTALS

- A. Prior to fabrication manufacture shall submit the following materials for approval.
- B. Manufacturer’s published catalog data sheets for all equipment and components of the lighting control system.
- C. Shop Drawings - Submit detailed drawings and documentation of lighting control system components and interconnection. As a minimum, the shop drawings shall include the following:
 - 1. One-line schematic diagram with wire type details
 - 2. Network wiring details
 - 3. Lighting control panel load schedules
 - 4. Input and output wiring details

5. Programming worksheets for system configurations
6. A complete BACnet *Protocol Implementation Conformance Statement* (PICS).

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. The lighting control system shall provide seamless control and monitoring of all lighting included in the scope of work regardless of whether it is relay switched or dimmed. All relay and dimmer panels, unless otherwise noted, shall be interconnected by a communication bus making possible the sharing of control functions and status system wide. Control inputs shall be transferable over the network to affect lighting control patterns and zones regardless of to which relay or dimmer panel the loads are connected. Overrides for after hour use or cleaning shall be accomplished via pushbutton switch. lighting control panels shall provide a user interface and display permitting local set-up, override, monitoring and diagnostics.

2.2 HARDWARE

- A. Enclosures
 1. Shall be NEMA 1 rated, code gage steel cabinet. Enclosure and contents shall be designed to operate in interior spaces with temperatures of 32°-104° F (0°-40° C) and, 0-90% non-condensing humidity. Enclosure shall be available with optional recessed mounting hardware. See drawings for mounting requirements.
 2. Enclosure Dimensions:
 - a. Small - 21" (533mm) H X 20" (508mm) W X 6" (152mm) two power modules maximum.
 - b. Medium - 34.5" (876mm) H X 20" (508mm) W X 6" (152mm) four power modules maximum.
 3. Multi-tapped Transformer - The enclosure shall be supplied with multi-tapped transformer and shall not require specification of voltage for each control location. Provide a dedicated power feed of 277, 60 Hz, 225 VA. for each enclosure.
 4. Modular Design - The power modules and system controller shall be modular and designed for ease of field service or upgrade.
- B. Relay Power Modules
 1. Mechanical - All Relay Power Module components shall be mounted to heavy steel back plane. Module shall install into enclosure with keyed tab and slot hardware, secured in place with heavy duty screws.
 2. Relay Power Module shall provide eight relay outputs designed for the control of lighting circuits. The Power Module shall be operable without the system controller installed for direct operation of lighting loads or with the system controller for programmable input to output mapping. Terminal block shall accept two (2) #8 AWG maximum wire(s).
 3. Relay Certification – Relays shall be Underwriters Lab (UL) and (CUL) listed.
 4. Relay Status Indicators - The system shall provide LED status indicators for all relay outputs.
 5. Relay Ratings - Relays shall be SPST, mechanically latching, individually replaceable with enclosed contacts. Relays shall be rated to at least 18K SCCR, 30 amps at 277 VAC electronic or HID ballast, 15 amps 120VAC tungsten, 20A at 347V. A limited 3-year warranty shall be provided on the individual relays.
 6. Relay Response - Relays shall be individually settable to respond as normally open, normally closed, momentary on, momentary off, Inteliswitch, or for Sweep Switch operation through the System Controller.
 7. Standard Inputs – The Relay Power Module shall provide:
 - a. Remote override switch input shall be provided to accept a dry contact closure from a remote-control device such as an A/V system, building automation system, fire alarm panel or other similar device to force all relays on or off. Terminal block shall be removable. Whenever active, the On or Off override condition shall be visually and audibly annunciated via the UIP on the System Controller.

8. Input/Output Expansion Module - The I/O expansion module shall connect directly to the Relay Power Module and provide:
 - a. Eight (8), programmable dry contact low voltage switch/occupancy sensor inputs with removable terminal blocks. Momentary or maintained contacts shall be supported as 3-wire momentary, 2-wire momentary, alternate action or 2-wire maintained contact. 24VDC power shall be provided to power occupancy sensors. Inputs shall be dry contact and internally sourced. Inputs shall be linkable to any number of relays for override control.
 - b. Two (2) inputs per module shall be capable of monitoring external analog sensing devices such as a photocell. It shall be possible to control the output relays in response to analog input values with 100 steps of analog control resolution. Terminal block shall be removable.
 - c. Eight (8), pilot light outputs with removable terminal blocks. Pilot light output voltages shall be jumper selectable for 5V, 20V or 24V.
 - d. Eight (8), 0-10vdc analog outputs for dimming control of 0-10vdc dimmable ballasts.
 9. Fade Time – The system shall support an adjustable fade rate from 0 to 99 minutes with a 1 sec resolution when changing from a preset level to another preset level.
 10. Removable Low Voltage Terminal Blocks – All low voltage terminal blocks shall be removable to provide the capability for the installer to remove the connector from the header when terminating wire. Systems that do not provide removable low voltage terminal blocks shall not be acceptable.
 11. BACnet integration – Provide the capability for relays/analog outputs, dry contact low voltage switch inputs, and analog inputs to be accessible from BACnet network when used with a networked System Controller.
- C. System Controller
1. Mechanical - The system controller shall be supplied as a modular chassis consisting of the user interface panel, system control electronics, and provision for installation of up to four industry standard half-length ISA accessory boards. The system controller shall plug into the enclosure as an assembly for ease of installation, service, or upgrade. All system controllers shall be installed into the enclosures only after the rough-in phase of installation is complete.
 2. User Interface Panel (UIP) - The user interface shall provide a simple means to set-up, program, and monitor the lighting control system. Provide as a minimum the following features:
 - a. Multi-lingual operation in English, Spanish or French
 - b. Four line, eighty-character LCD display with back light
 - c. Four multi-function menu selection keys graphically associated with the LCD display
 - d. A twelve key, numeric keypad with Enter and Back functions
 - e. A four-key menu navigation and selection keypad with Up, Down, plus (+) and minus (-) function keys
 - f. LED status indicators for Network, DMX512 input and Local input/output bus.
 3. Capacity - The system controller shall have the capacity to operate up to 12 power modules in two enclosures, permitting up to 96 points of control from each system controller.
 4. RS232 Port - Provide a front mounted DB9 serial connector for connection of a personal computer or other external serial device. Provide a second DB9 serial connector within the enclosure for permanent connection of serial devices. Option to add up to an additional 4 more serial ports
 5. RS485 ARCNET port – Provide a removable terminal block connection for the network bus wire connection.
 6. Ethernet Port – Provide an Ethernet port for connection to a Local Area Network.
 7. RS485 Control Station port – Provide a removable terminal block connection for the dimming control station and/or addressable network button station bus.

8. Program Back-up - The user program shall be stored in non-volatile memory. The system shall utilize a memory back-up device that is system integrated, maintenance free and not require batteries for retention of memory.
 9. Modem for Remote Access – The System Controller shall be provided with a modem for remote access to program and trouble shoot the system.
 - a. Off-line programming - It shall be possible to program the system off-line via personal computer or laptop located at a remote site.
 - b. On-line monitoring and control - It shall be possible to monitor and override the status of the system in real time via personal computer located at a remote site. This shall include the current status of individual loads, input status, event log, relay run time/start counters, and graphic screen operation as a minimum.
 - c. System programming via email – Provide the capability for emailing as an attachment the owner's system programming database to factory support such that the factory personnel can open the programming database to modify the programming and operating problems and email the corrected database back to the owner for upload into "System" via Configuration Software listed in this section.
 - d. Factory support - Provide free remote dial-in factory support capability for the life of the system such that factory personnel can assist the owner with the diagnosis and resolution or programming and operation problems. It shall be possible for the factory to read the software version currently installed at the site and download an updated version to the site if required without interruption of the user program.
- D. Network
1. Communication - System controllers shall be capable of panel-to-panel communications over a high-speed 156Kbps, hard-wired data network or Ethernet LAN.
 2. Wire - Network wire shall be twisted and shielded pair, installed in a daisy chain configuration, and rated for EIA-485 data communication. Network wire type and installation shall be per the lighting control system manufacturer's requirements without exception. For Ethernet LAN applications, wire shall be Cat 5 cable.
 3. Protocol - Network protocol shall be BACnet® over ARCNET® (ANSI 878.1) token passing or BACnet IP. Systems utilizing proprietary networking schemes shall not be acceptable
- E. Networked Preset Dimming Control Stations
1. Capacity – Preset control stations shall provide 6 presets, master raise/lower, individual raise/lower, and OFF control for 4, 8, 12, or 16 control channels as indicated from the front of the control station.
 2. Finish - Faceplates shall attach to mounting frame without visible screws and, when in place, shall provide a clean architectural appearance. Full-length piano hinge shall allow faceplate to fold down flat against wall when open. Faceplate finish shall be brushed stainless steel or as otherwise directed by the architect.
 3. Presets – Control stations shall be capable of storing and recalling a total of 16 presets, each with fade time set-able as 5, 10, 15, 30, 45 seconds or 1, 5, 10, 30, 60 minutes.
 4. Level Indication - Each channel shall have an associated 10 segment LED bar graph which shall indicate the intensity of the lighting.
 5. Master - Master raise/lower function shall adjust intensity of all control channels simultaneously. Channels set as non-dim shall be excluded from master raise/lower operation.
 6. Exclusion from Presets – It shall be possible to individually exclude channels from saved presets.
 7. Tamper Proofing – Provide a hidden switch on each control station to disable the preset save function to prevent unauthorized or accidental overwriting of scenes.

- F. Networked Override Switch Control Station
 1. Finish – Faceplates shall attach to the mounting frame without visible screws and, when in place, shall provide a clean architectural appearance. Faceplate finish shall be brushed stainless steel or as otherwise directed by the architect.
 2. Buttons – Stations shall support up nine programmable buttons per station with associated status LED indicators. Each button shall be individually programmable for function and load controlled. Stations shall support the following button function types:
 - a. ON (for afterhours use)
- G. Networked Touch Screen Control Station
 1. 3.5" color screen with configurable color schemes
 2. Resistive touch screen interface is compatible with gloves and prosthetic limbs.
 3. Capacity – Provides up to 16 Presets and 32 channels, with number of presets and channels configurable via the SYSW CONFIG software or SYSC MLS / MLX controller.
 4. Finish – No visible screws. Provides a clean architectural appearance.
 5. Presets – Capable of storing and recalling a maximum of 16 presets, each with fade time set-able as 0, 5, 10, 15, 30 and 45 seconds, or 1, 5, 10, 30 and 60 minutes.
 6. Preset lighting levels can be modified and saved from the SYGS station.
 7. Adjustable channel intensity using raise/lower buttons.
 8. Level Indication - Each channel provides an associated bar graph which indicates the intensity of the lighting in 1% increments.
 9. Master - Master raise/lower function adjusts intensity of all dimmed control channels simultaneously.
 10. User defined alphanumeric labels for all channel and preset buttons. Labels may be edited in the SYSW CONFIG software or on the SYGS station.
 11. Password protection options for multiple levels of access.
 12. Customizable 'logo screen' provides ability for customers to display their own logo or other picture on the station screen when not in use.
- H. Control Station LAN Network – Control stations shall be connected to the system via a four-wire digital communication bus network wire. The system shall support one control station LAN for each system controller. Each control station LAN shall support a maximum of sixty stations.
- I. Emergency Lighting:
 1. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF/DIMMING control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Dimmed circuits shall be driven to 100% output.
 2. Features include:
 - a. 120/277 volts, 50/60 Hz., 20-amp ballast rating
 - b. 0-10V Dimmer override to 100%
 - c. Auxiliary contact for remote test or fire alarm system interface
 3. Hubbell Product Number: UL924BRLN (1)(2). Equals by Functional Devices Inc., LVS Inc.

2.3 FIRMWARE FEATURES

- A. Open Protocol Networking - To insure interoperability with other building systems, the lighting control panels shall communicate using the BACnet® (ASHRAE 135- 1995) communication standard. As a minimum, all relays, dimmers, switches, groups and analog inputs shall be represented as standard BACnet objects and shall support read/write services. Systems requiring a gateway device for BACnet communications shall provide at least one BACnet gateway point for each lighting control relay, dimmer, switch input and analog input on the project. It shall be the sole responsibility of the lighting control system supplier to map all proprietary lighting control points through the gateway and supply complete written documentation cross referencing the lighting zones to the BACnet points. This documentation

shall clearly indicate which BACnet properties and services are provided by the gateway and which properties and services are actually supported by the proprietary lighting control devices to which the gateway is connected. All lighting control devices conforming to the BACnet protocol shall have a Protocol Implementation Conformance Statement (PICS) that identifies all of the portions of BACnet that are implemented.

- B. Groups - It shall be possible to associate output relays and dimmers into logical control zone groups. Groups shall be assign-able to schedule events, switch inputs, analog inputs, control station channel, presets, DMX output, or telephone override. It shall not be necessary to program functions or schedules individually for each output. Groups shall be network visible to other building systems as standard BACnet objects.
- C. Astronomic Clock - The system clock shall of the astronomical type and be capable of calculating the correct time for sunrise and sunset at the installed location. It shall be possible to set control functions to occur at or up to 99 minutes before or after sunrise or sunset.
- D. Daylight Savings Time - The system shall automatically adjust for daylight savings time. It shall be possible to disable this function.
- E. Schedules - The system shall support up to 99 unique lighting control schedules. The quantity of time schedule events contained in the schedules shall be limited only by the available system memory and shall be dynamically allocated to the schedules such as to not limit the capacity of any single schedule.
- F. Schedule Assignment - Unique schedules may be assigned to each day of the week facilitating a rotating Monday through Sunday weekly operating scenario. A unique holiday schedule shall automatically supercede assigned weekday schedules based on a list of holiday dates. Additionally, schedules may be assigned to specific calendar dates. A schedule assigned to a calendar date shall have priority over a schedule assigned to a Monday through Sunday upon which the calendar date occurs such that only one schedule runs on any given day.
- G. Overrides - It shall be possible to override schedule operation and force outputs to an ON state for afterhours use. Overrides shall be initiated from digital wall stations.
- H. System override shall be available:
 - 1. Priority Normal - Under normal time clock operation, a group can be overridden ON by any available corridor mounted digital wall station. The system will remain in the overridden condition for two hours. System shall flash lights to warn occupants of upcoming OFF condition. System can be continually overridden in 2-hour increments by using corridor mounted wall stations.
- I. Inter-Panel Control - Each system controller input and output shall include provision to annunciate actuation over the network making events available for use by all controllers connected to the network. This function shall be set-able via the UIP on the system controller and not require the use of a personal computer for inter-panel operation over the network.
- J. Flash to Find - It shall be possible to set any output to continuously flash on and off to facilitate easy location of undocumented loads. The flash to find function shall automatically cancel after two minutes.
- K. Status - Each system controller shall be capable of displaying the current real time status of all inputs and outputs associated with the controller.
 - 1. Input Status – The current state of each input shall be displayed as ON or OFF for switch inputs or as a value for analog inputs.
 - 2. Output Status – The current state of each output shall be displayed as ON or OFF for relay outputs or as a percentage value for dimmed outputs.
 - 3. Network Status – The network status display shall indicate that the system controller is actively communicating on the local input/output bus and the network by displaying network message traffic expressed as a percentage of capacity. This display shall also indicate the currently available system RAM and flash disk memory.

- L. Logging - The system controller shall automatically retain a record of system control events and run times and shall make this information available to the user via the UIP on the system controller.
 - 1. Event Log - The system shall automatically log in memory key actions performed by the system controller. Each log entry shall be time and date stamped. It shall be possible to view or print the event log via the UIP or PC software. A minimum of 2000 system events shall be saved before the system begins to overwrite the oldest data. Logged actions shall include but not be limited to:
 - a. Power up
 - b. Power down
 - c. Input change of state
 - d. Output change of state
 - e. Manual override
 - f. Network event
 - g. New script
 - h. Alarms
 - 2. Relay Run Time - A cumulative "ON" time record shall be accumulated for each output. It shall be possible to view and reset the run-time for each output via the UIP or PC software.
 - 3. Relay Starts - A counter shall track the quantity of starts for each output. It shall be possible to view or reset the number of starts for each output from the UIP or PC software.
- M. Script File - All system parameters and user programming shall be stored within the system controller in the form of an editable text file. It shall be possible to upload and download the file between the system controller and a personal computer.
- N. Script Logic - The system controller logic shall support the creation of customized logical control scenarios. Scenarios shall be created off line using the optional Windows® based configuration software package. As a minimum, the system shall understand and process "basic" IF, AND, OR, THEN, ELSE, = (equal), < (less than), and > (greater than) logical statements. Commands and operations to be tested and/or acted upon shall include as a minimum: DAY, DATE, TIME, INPUT, OUTPUT, TIMER, INC COUNTER # (increment counter #), DEC COUNTER (decrement counter #), and RESET COUNTER.
- O. Room Partition Control – It shall be possible to configure the system to accommodate areas where movable partitions are used to sub-divide a large room into several smaller rooms. The system shall provide for a dimensional array of possible room combination scenarios making possible the re-mapping of the channel to preset relationships in situations where the architectural relationship of the lighting changes with the reconfiguration of the room. It shall be possible to provide a unique set of presets for each possible room combine scenario. Systems that simply overlap the channels of combined rooms in a one to one relationship are not acceptable.
 - 1. Provide SYA IR Partition photoelectric sensor for partition between spaces.

2.4 CONFIGURATION SOFTWARE

- A. Provide PC software for off-line programming and editing of lighting control panel script files. The application shall run on any personal computer using the Windows XP/Vista/Windows 7 32bit operating system and shall support the BACnet file transfer services allowing co-installation and network operation with other BACnet building automation workstations.
- B. It shall be possible to upload, edit, and download user program and log data through a direct connection to the lighting control system network or remotely through the use a telephone modem.
- C. The configuration software shall have the ability to "learn" the hardware components that are present in the system and automatically configure a script file using default values which may then be edited by the user.

- D. The system shall support the simultaneous use of multiple personal computers.
- E. The application shall be BACnet compliant and designed to co-reside on a PC workstation running other BACnet building control applications.
- F. The configuration software shall utilize a local database to store all system parameters. The programming database shall be capable of being Emailed to the lighting control manufacture for review, editing and technical support, then Emailed back to the customer for upload into the lighting control system.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND DOCUMENTATION

- A. Installation - The control system shall be installed and connected as shown on the plans and as directed by the manufacturer. The contractor shall complete all electrical connections to all control circuits, network terminations, RS-232 connections, sensors and override wiring.
- B. Documentation - The contractor shall provide accurate "as built" drawings to the owner indicating the correct and latest program in each controller. The "as-built drawings" shall clearly indicate the lighting control panel identification, the load controlled by each relay, and the device connected to each input.
- C. Operation and Service Manuals – Provide operation and service manuals for all system components as indicated in the General Provisions.

3.2 PRODUCT SUPPORT AND SERVICE

- A. System Start-up
 - 1. Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:
 - a. The control system has been fully installed in accordance with manufacturer's installation instructions.
 - b. Low voltage wiring for overrides and sensors is completed.
 - c. Accurate "as-built" load schedules have been prepared for each lighting control panel.
 - d. Proper notification of the impending start-up has been provided to the owner's representative.
 - 2. A Start-up Request form must be completed by the contractor and submitted to the Lighting Control Manufacture prior to scheduling a Start-up.
- B. Factory Support: Factory telephone support shall be available at no cost to the owner for the life of the system. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll-free number for technical support.

3.3 WARRANTY

- A. Manufacturer shall provide a three (3) limited warranty on the lighting control system and software.

END OF SECTION 260943

SECTION 262410 - SERVICE ENTRANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes arrangement with utility company for permanent electric services, underground service entrance and concrete transformer pads.
- B. Related Sections include the following:
 - 1. Section 260519 - Low Voltage Electrical Power Conductors and Cables
 - 2. Section 260533 - Raceways and Boxes for Electrical Systems

1.2 SYSTEM DESCRIPTION

- A. System Voltage Main Building: 120/208 volts, three phase, four wire, 60 Hertz.

PART 2 - PRODUCTS

2.1 METERING EQUIPMENT

- A. Metering Equipment: As required by the utility company and as shown on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make arrangements with Utility Company to obtain permanent electric service to the Project.
- B. All costs related to permanent electric service shall be borne by the electrical contractor.
- C. Underground: Install service entrances from Utility Company's pad-mounted transformer to building service entrance equipment. Utility Company will connect service lateral conductors to transformer secondaries.
- D. Provide concrete pads for transformer installations. Pads shall conform to any and all requirements of the Electric Utility.
- E. Provide 1-1/4" conduit to the meter bases as required by utility.

END OF SECTION 262410

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Transient voltage suppression panelboards.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Panelboard Schedules: For installation in panelboards.
- D. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures and Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- 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 NEMA PB 1.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.6 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.7 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. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Protection Div.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D.
 - 2. Transient Voltage Suppression Panelboards:
 - a. Liebert Corporation.
 - b. Advance Protection Technologies (APT)
 - c. Emerson

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints."
- B. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations: NEMA 250, Type 1.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide with standard flush door and lock, all keyed alike.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 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. Finish: Manufacturer's standard grey enamel finish over corrosion-resistant treatment or primer coat.
7. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- C. Phase and Ground Buses:
 1. Material: Tin-plated aluminum.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box. Provide in all panelboards.
 3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Provide where 5-wire configuration is indicated.
- D. Conductor Connectors: Suitable for use with conductor material.
 1. Main and Neutral Lugs: Mechanical type.
 2. Ground Lugs and Bus Configured Terminators: Compression type.
 3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- B. Minimum Integrated Short Circuit Rating: 14,000 amperes rms symmetrical for 480 volt panelboards or 10,000 amperes rms symmetrical for 208 volt panelboards, unless noted otherwise on Drawings.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breaker.
- C. Branch Overcurrent Protective Devices:
 1. Molded Case Circuit Breakers: NEMA AB 1; bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Circuit breakers shall be listed as suitable for use with 75 degrees C conductor.
 2. Bolt-on circuit breakers shall be replaceable without disturbing adjacent units.

2.5 TRANSIENT VOLTAGE SUPPRESSION

- A. Transient control systems: where noted on drawings, provide Emerson SolaHD SPD200K10YMOD transient control systems Liebert "Hybrid Advantage@ or equal by Transtector. Install adjacent (within 10 feet) to applicable panelboards. Provide conduit and conductors as schedules for interconnection.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: 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.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
4. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

2.7 CONTROLLERS

- A. Controller Disconnect Switches: integrally mounted and interlocked with controller. Provide coil clearing contacts.
 1. Auxiliary Contacts: Integral with disconnect switches to de-energize external control-power source.
- B. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.
 1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 2. Coil(s) Voltage 120 volts, 60 hertz, from separate source.
 3. Switched Poles: Three (3).
 4. Contact Rating: As scheduled on Drawings.
 5. Contactor shall be furnished where applicable, in factory assembled panelboard enclosures. Provide line-side lugs to receive incoming feeder(s).

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Provide filler plates for unused spaces in panelboards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- C. Top of Panel Height: Panelboards with box dimensions of 53 inches or less in height shall be installed with top of panel at 6 ft.-6 in. Panels with box dimensions in excess of 53 inches in height shall be installed such that the operating handle of the uppermost device is 72 inches above finished floor.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Install drip shields on all panels per detail on drawings.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, and lugs.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Isolated-ground receptacles.
 - 4. Snap switches and wall-box dimmers.
 - 5. 0-10V LED lighting dimmers, controllers, and switches.
 - 6. Occupancy switches.
 - 7. Pendant cord-connector devices.
 - 8. Cord and plug sets.

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Provide manufacturer's catalog information showing dimensions, colors and configurations.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- 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.

1.5 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

- B. The above manufacturers are tentatively approved for the wiring devices. It should be noted that in the list of approvals where a manufacturer has been approved for a certain product, it is understood that the manufacturer has been approved as being capable of producing this product. This does not necessarily constitute approval of his standard product. His product must still comply with all requirements and standards of the specification and not necessarily his standard specifications.

2.2 STRAIGHT BLADE RECEPTACLES

- A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, Tamper Resistant, NEMA WD 6 configuration 5-20R, and UL 498. Heavy duty specification grade.
1. Basis of Design: Pass & Seymour; 5361 (single), 5362 (duplex).
 2. Equal products by the following manufacturer's are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
- B. Duplex Convenience Receptacles with USB Charger, 125 V, 20 A: Comply with Fed Spec WC596, configuration 5-20R, and UL 498, UL 1310. Heavy duty specification grade.
1. Basis of Design: Pass & Seymour; TR5362USB.
 2. Equal products by the following manufacturers are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
- C. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Basis of Design: Pass & Seymour; IG5361 (single), IG6300 (duplex).
 2. Equal products by the following manufacturer's are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 3. Description: Straight blade; equipment grounding contacts shall be connected only to the 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.
- D. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Hospital grade.
1. Basis of Design: Pass & Seymour; TR63-H (duplex).
 2. Equal products by the following manufacturers are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 3. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

2.4 TWIST-LOCKING RECEPTACLES

- A. Single Receptacles: Comply with NEMA WD 1, NEMA WD 6, and UL 498. NEMA type as noted on drawings.
 - 1. Acceptable Manufacturers:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 - d. Pass & Seymour

2.5 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking type plug and receptacle body connector; NEMA WD 6 configurations, as noted on drawings, heavy-duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. 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.
 - 3. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.6 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Basis of Design: Pass & Seymour; PS20AC.
 - 2. Equal products by the following manufacturers are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 - 3. Description: Single and three pole switches.
- C. Pilot Light Switches: 120/277V, 20A:
 - 1. Basis of Design: Pass & Seymour; PS20AC-RPL.
 - 2. Equal products by the following manufacturers are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 - 3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Basis of Design: Pass & Seymour; PS20AC-L.

2. Equal products by the following manufacturers are acceptable:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
3. Description: Single pole and three pole, with factory-supplied key in lieu of switch handle.

2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. LED Dimmers: 120 V.
 1. Lutron Nova T-Star Series, 1500 watt, grey plastic full-range slider style dimmer with mating brushed aluminum coverplate. Equals by Lithonia or Lightolier are acceptable.

2.9 WALL PLATES

- A. Decorative Cover Plate: Jumbo-oversize, type 302 stainless steel with stain finish, no equal.
- B. Exposed Cover Plate: Galvanized steel.
- C. Weatherproof Cover Plate: Type 302 stainless steel with spring hinged gasketed device cover, unless noted otherwise.
- D. Manufacturer: Mulberry, Leviton, Cooper or Pass and Seymour.

2.10 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 1. Wiring Devices Connected to Normal Power System: Gray, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 1. Take steps to ensure that devices and their boxes are protected. 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 the 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.
 5. Verify outlet boxes are installed at proper height.
 6. Verify wall openings are neatly cut and will be completely covered by wall plates.
- C. Conductors:
 1. Do not strip insulation from conductors until just 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.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

- D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they 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. Connect wiring devices by wrapping solid conductor around screw terminal or by means of integral screw tensioned clamp, where applicable. Under no circumstances is "back wiring" of devices by a spring tensioned means acceptable.
 6. Use a torque screwdriver when a torque is recommended or required by the 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.
 10. Install devices plumb and level.
 11. Install switches with OFF position down.
 12. Do not cascade convenience receptacles on the "load" side of GFCI devices, unless specifically noted otherwise.
 13. Connect wiring device grounding terminal to equipment grounding conductor.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates:
1. Install decorative plates on switch, receptacle, and outlets in finished areas.
 2. Install carpet flanges and coverplates on all floor boxes.
 3. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
 4. Install weatherproof plates on outlets exposed to the elements and as noted.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Install 0-10V conductors on controls side of dimmers according to manufacturers' device listing conditions in the written instructions.
 3. Do not install dimmer switches in ganged installations with other devices. Provide separate outlets. Where dimmers are shown in ganged installations, install in accordance with manufacturer's instructions to maintain full rated capacity of each device and cover with one faceplate.
 4. Provide LED lighting controller/power pack for 0-10V dimming.
- 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, multi-gang wall plates. Adjust devices and wall plates to be level.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- J. Interface with Other Products:
1. Coordinate locations of outlet boxes provided under Section 16130 to obtain mounting heights specified and indicated on Drawings.
 2. Install wall switch 48 inches above finished floor.
 3. Install convenience receptacle 16 inches above finished floor, unless noted otherwise.

4. Install convenience receptacle 6 inches above backsplash of counter.
 5. Install dimmer 48 inches above finished floor.
- K. All convenience receptacles which are located within 6 feet of a sink, basin, tub, shower, etc. shall be ground fault protected, regardless of indication. Verification of these requirements shall be responsibility of this Contractor.

3.2 IDENTIFICATION

- A. Comply with Division 16 Section "Electrical Identification."

3.3 FIELD QUALITY CONTROL

- A. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 20-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
 7. Inspect each wiring device for defects.
 8. Operate each wall switch with circuit energized and verify proper operation.
 9. Verify that each receptacle device is energized.
 10. Test each receptacle device for proper polarity.
 11. Test each GFCI receptacle for proper operation.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches.

1.2 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- 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 NEMA FU 1.
- D. Comply with NFPA 70.

1.4 PROJECT 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.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.6 EXTRA MATERIALS

- A. Fuses: Furnish three of each size and type to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSES

- A. Fuses 600 Amperes and Less: ANSI/UL 198E, Class RK1; dual element, current limiting, time delay, 250 or 600 volt fuse as applicable.

- B. Interrupting Rating: 200,000 rms amperes.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare fuse cabinet on plywood backboard within buildings main electrical room.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers.
 - 4. Motor Controllers.
 - 5. Enclosures.

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. HD: Heavy duty.
- C. RMS: Root mean square.
- D. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. UL listing for series rating of installed devices.
 - 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.4 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. Product Selection for Restricted Space: Drawings for enclosed switches and circuit breakers are not to scale. Contractor is responsible for maintaining code clearances between enclosures, and adjacent surfaces and other items. Installations shall comply with Article 110 of NFPA 70.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.6 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, 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.

1.7 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. Spares: For the following:
 - a. Fuses for Fusible Switches: Three (3)
 - 2. Fuse Puller: Furnish one fuse puller to Owner.
 - 3. Storage Cabinet: Furnish one fuse storage cabinet (by fuse manufacturer) to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.
- B. Fusible Switch Assemblies: NEMA KS 1; heavy-duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Cover interlock shall be defeatable. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class R fuses.
- C. Nonfusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Cover interlock shall be defeatable. Handle lockable in OFF position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Moeller Electric Corporation.
 - 4. Siemens Energy & Automation, Inc.
 - 5. Square D/Group Schneider.
- B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents. Minimum 25 kAIC.
 - 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.

- C. Molded-Case Circuit-Breaker Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 4. Handle Lock: Include provisions for padlocking.

2.4 MOTOR-CONTROLLERS

- A. Enclosures: NEMA 250, Type 1(indoor "dry" locations), unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
- B. Controller Disconnecting Means:
 - 1. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes. Provide auxiliary contact for disconnection of starter control circuit(s).
 - 2. Combination Motor Starters: Combine motor starters with motor circuit protector disconnect in common enclosure.
- C. Across-The-Line Controllers:
 - 1. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated 2-pole, full-voltage controller for fractional horsepower induction motors, without thermal overload unit. Provide in NEMA 1 lockable enclosure.
 - 2. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, for induction motors rated in horsepower.
 - 3. Control Circuit: 120 V.
 - 4. Overload Relay: NEMA ICS 2; solid-state electronic overload protection.
- D. Multispeed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
 - 1. Compelling relay to ensure that motor will start only at low speed.
 - 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
 - 3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.5 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover of all combination starters.
 - 1. In addition to HAND/OFF/AUTO selector switch, two speed combination starters shall be furnished with a HIGH/LOW selector in front cover.
- C. Control Relays: Auxiliary and adjustable time-delay relays.
- D. Auxiliary Contacts: NEMA ICS 2; two normally open field convertible contacts in addition to "latching" contact.
- E. Indicating lights: NEMA ICS 2; LED pilot device with GREEN "motor run" in front cover.
- F. Overload Reset: Externally operable in front cover.
- G. Single-Phase Protective Relay: Provide a single-phase protective relay for all poly-phase magnetic motor starters.

2.6 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible disconnect switches. Fuses shall be installed in such a way that ratings can be clearly read.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components.
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Electrical Identification."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
 - 5. Inspect visually and perform several mechanical ON-OFF operations on each circuit breaker.
 - 6. Verify circuit continuity on each pole in closed position.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors. Do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Gas engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Performance requirements for sensitive loads.
 - 5. Outdoor enclosure.
- B. Related Sections include the following:
 - 1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

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.
- B. LP: Liquid petroleum.

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. Time-current characteristic curves for generator protective device.
- 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. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 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.
- D. Warranty: Special warranty specified in this Section.

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 two hours' normal travel time from Installer's place of business to Project site.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 180 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

- D. 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.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. 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 Architect no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Architect'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: Minus 15 to plus 40 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet.

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 3.
- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Division 7 Section "Roof Accessories."

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: One (1) year from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

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. Kohler Co.; Generator Division.
 - 3. Onan Power Generation; Industrial Business Group.
 - 4. MTU Onsite Energy.
 - 5. Generac.

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: Nominal ratings as indicated.
 - a. Minimum Rating: 30kW, 37.5kVA at 0.8 power factor, 208Y/120 volts, 60 Hz.
 - 2. Output Connections: Three-phase, four wire.
 - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
 - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within two seconds.
 - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 - 8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Natural gas.
- 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. Natural Gas (Vapor-Withdrawal) System:
 - a. Carburetor.
 - b. Secondary Gas Regulators: One.
 - c. Fuel-Shutoff Solenoid Valves: One.
 - d. Flexible Fuel Connectors: One.
- 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. 1,000 watts, 120 volts AC.
- 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 maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Residential 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 18 dB at 500 Hz.
 - 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 95 dBA or less.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

- K. Starting System: 12-V 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: 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 indicated. 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. Constructed to contain spillage of electrolyte.
 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. Locate charger within genset housing.

2.4 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. 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.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, and the following:
1. AC voltmeter.
 2. AC ammeter.

3. AC frequency meter (45 – 65 Hz range).
 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. Start-stop switch.
 11. Overspeed shutdown device.
 12. Coolant high-temperature shutdown device.
 13. Coolant low-level shutdown device.
 14. Oil low-pressure shutdown device.
 15. Generator overload.
 16. Lamp test switch.
 17. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:
 - a. Frequency Meter: 45-65 Hz range, 3-1/2-inch dial.
 - b. AC Output Voltmeter: 3-1/2-inch dial, 2 percent accuracy, with phase selector switch.
 - c. AC Output Ammeter: 3-1/2-inch dial, 2 percent accuracy, with phase selector switch.
 - d. Output voltage adjustment.
 - e. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
 - f. Engine start/stop selector switch.
 - g. Engine running time meter.
 - h. Oil pressure gage.
 - i. Water temperature gage.
 - j. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
- D. 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.
- E. 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.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Rating: Matched to generator rating.
 3. Mounting: Adjacent to or integrated with control and monitoring panel.

2.6 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: Drip proof.
- 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. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

2.8 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene.
 - 2. Durometer Rating: 50.
 - 3. Number of Layers: Three.

2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in 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 elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- 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 15 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. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according to Division 15 Section "Mechanical Identification" and Division 16 Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. 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.
 - 2. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
- C. 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.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. 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. Describe loads connected to emergency system.
- B. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes transfer switches rated 600 V and less including the following:
 - 1. Automatic transfer switches.
 - 2. Remote annunciation systems.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches and remote annunciators through one source from a single manufacturer.
- C. 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.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.4 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:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Architect's written permission.

1.5 COORDINATION

- A. Coordinate size and location of switch with other trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Contactor Transfer Switches:
 - a. Caterpillar; Engine Div.
 - b. Kohler Power Systems; Generator Division.
 - c. Onan/Cummins Power Generation; Industrial Business Group.
 - d. MTU On-Site Power.
 - e. Generac.

2.2 RATINGS

- A. Ratings: NEMA ICS 2; as follows:
- B. Voltage: 208/120 volts, three phase, four wire, 60 Hz.
- C. Switched Poles: 4.
- D. Continuous Ratings: ATS at minimum 150 amperes.
- E. Interrupting Capacity: 100 percent of continuous rating.
- F. Withstand Current Rating: 25,000 rms symmetrical amperes when used with circuit breakers (480V).

2.3 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. 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.
- B. Tested Fault-Current Closing and Withstand 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.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- H. 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.
- I. 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.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 16 Section "Electrical Identification."
 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.
- K. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.4 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. 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.
- D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. Automatic Transfer-Switch Features:
 1. Undervoltage Sensing for Each Phase of Normal 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 is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 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 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under-voltage 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 automatic 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: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
- 12. 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.
- 13. 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 are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - 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 not available.

2.5 REMOTE ANNUNCIATOR

- A. 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 flush-mounting type to suit mounting conditions indicated. The following alarm conditions shall be annunciated at a minimum:
 - 1. Engine high-temperature shutdown.
 - 2. Lube-oil, low-pressure shutdown.
 - 3. Overspeed shutdown.
 - 4. Engine high-temperature pre-alarm.
 - 5. Lube-oil, low-pressure pre-alarm.
 - 6. Overcrank shutdown.
 - 7. Coolant low-temperature alarm.
 - 8. Control switch not in auto position.
 - 9. Battery-charger malfunction alarm.
 - 10. Battery low-voltage alarm

2.6 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 16 Section "Electrical Supports and Seismic Restraints."
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Division 16 Section "Electrical Identification."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Verify that surfaces are ready to receive work.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to 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.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Coordinate tests with generator tests and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.

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 as specified below. Refer to Division 1 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

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SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. Related Sections include the following: Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.2 DEFINITIONS

- A. CRI: Color-rendering index.
- B. CU: Coefficient of utilization.
- C. LER: Luminaire efficacy rating.
- D. Luminaire: Complete lighting fixture, including driver housing if provided.
- E. RCR: Room cavity ratio.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Driver.
 - 4. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
- B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. Include replacement parts list.
- C. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.5 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.

1.6 WARRANTY

- A. Special Warranty for LED fixtures: Manufacturer's standard form in which LED fixture manufacturer agrees to repair or replace fixtures that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for LED Fixtures: Five years from date of Substantial Completion.

1.7 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection.
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 2. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. LED Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- 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.
- G. Plastic Diffusers, Covers, and Globes:
 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- H. Air-Handling Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."
 1. Heat Removal Units: Air path leads through lamp cavity.
 2. Combination Heat Removal and Air Supply Unit: Heat is removed through cavity at both ends of the fixture door with air return accomplished through louvered door assembly.
 3. Dampers: Operable from outside fixture for control of return-air volume.

2.3 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2.4 LED LAMPS

- A. LED Lamps: Color temperature 4000 K.

2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Electrical Supports" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, aircraft cable.
- C. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- D. Install clips to secure recessed grid-supported luminaires in place.
- E. Provide hanger wire from structure to each corner of fixtures.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture. Secure to prohibit movement.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use cord or stem for wiring at one point and distribute wiring through fixtures via manufacturer installed plugs at each end.
- D. Air-Handling Lighting Fixtures: Install with dampers open and ready for adjustment.
- E. Adjust aimable lighting fixtures to provide required light intensities.
- F. Connect wiring according to Division 26 Section "Conductors and Cables."
- G. Fixtures in areas defined by the "Lighting Standards for Georgia Public Schools" shall comply with paragraph G.2.b of standard.
- H. Install in accordance with manufacturer's instructions.
- I. Locate recessed ceiling luminaires as indicated on architectural reflected ceiling plan.
- J. Install recessed luminaires to permit removal from below.
- K. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating. Verification of these requirements shall be the responsibility of the Contractor.
- L. Install wall mounted luminaires, at height as indicated on Drawings.
 - 1. Fixtures located above mirrors at lavatories shall be installed 6 inches above top edge of mirror. Coordination through General Contractor is required to determine this elevation.
- M. Install accessories furnished with each luminaire.
- N. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

- O. Bond products and metal accessories to branch circuit equipment grounding conductor.
- P. Install specified lamps in each luminaire.
- Q. Connect grid troffers to branch circuit utilizing "fixture whips" maximum 6 feet in length.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery/generator and retransfer to normal.

3.3 ADJUSTING:

- A. Relamp luminaires that have failed lamps prior to Owner's acceptance.

3.4 CLEANING:

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosure.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

END OF SECTION 265100