



Project Manual

SOUTHWEST TRANSIT EV CHARGING

**14405 West 62nd Street
Eden Prairie, Minnesota
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DA Project #0425099-00



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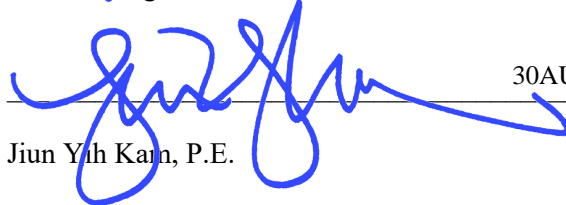
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I hereby certify that this Specification, Division 26, was prepared by me or under my direct supervision and that I am a duly licensed Engineer under the laws of the State of Minnesota.



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Reg. No. 51923

DIVISION 26 – ELECTRICAL

260500	COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS
260519	LOW-VOLTAGE POWER CONDUCTORS AND CABLES
260523	CONTROL VOLTAGE ELECTRICAL CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260544	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
262416	PANELBOARDS
262813	FUSES
262816	ENCLOSED SAFETY SWITCHES
263600	TRANSFER SWITCHES

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work included in this section of the specifications consists of furnishing labor, equipment, supplies, and materials, unless otherwise specified, and in performing operations necessary for the installation of electrical work as listed in the Instruction to Bidders and as required by these specifications and shown on the drawings. These are subject to the terms and conditions of the contract. The work includes the completion of details of electrical work not mentioned or shown which are necessary for the successful operation of electrical systems described on the drawings or required by these specifications.
- B. Furnish and install all equipment described herein, and as shown on the plans, to provide complete and operating systems for the project. All necessary cabling for connection to active equipment shall be provided for a complete and working system. Unless noted otherwise, junction boxes, back-boxes, and conduit rough-in for devices will be provided by the Division 26 subcontractor as defined in the specifications of Division 26. Include the following paragraph for electronic safety and security systems designed and provided by others. It is difficult to continually coordinate with other systems. The engineer strives for coordination, however, there will be scenarios where outside vendors and designers do not submit documents in a timely manner. The following will place responsibility on the contractor to review and coordinate.
- C. Section Includes:
 - 1. Definitions
 - 2. Substitutions
 - 3. Shop Drawings
 - 4. Project Record Drawings
 - 5. Operating and Maintenance Manuals
 - 6. Project Conditions
 - 7. Permits
 - 8. Authority Having Jurisdiction Inspections
 - 9. Insurance
 - 10. Guarantee/Warranty
 - 11. Common requirements for Electrical Installation
 - 12. Penetration Firestopping
 - 13. Refinishing and Touchup painting
 - 14. Cleaning and Protection
 - 15. Equipment Furnishing by Owner

16. Interruption of Existing Electric Service
17. Building Structure Penetrations
18. Final Tests and Adjustments

1.3 DEFINITIONS

A. Basic Contract definitions are as follows:

1. Provide: The term "provide" means "to furnish and install, ready for the intended use and in complete operating condition."
2. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.
4. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications and requests, is limited to the Engineer's duties and responsibilities as stated in the Conditions of the Contracts.
5. Indicated: The term "indicated" refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
6. Contractor: The term "Contractor" shall carry the same meaning as "Electrical Contractor" or "Division 26 Contractor"
7. Or Equal: The term "Or equal" shall carry the same meaning as "approved as equal by the Engineer".
8. Shall: The term "shall" carries the same meanings as "must".
9. Owner: All references here-in and on drawings to "Owner" shall be the same as "Southwest Transit".

B. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Standards Dictionary

1.4 QUALITY ASSURANCE

- A. Materials, products, devices, fixtures, forms or types of construction included in this specification shall meet or exceed the requirements of National Electrical Code (NEC), American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineers (IEEE) and National Electrical Manufacturers Association (NEMA), Building Industry Consulting Service, Inc. (BICSI), Electronics Industries Alliance/Telecommunications Industry Association (EIA/TIA), and the applicable local Codes.
- 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. Submit certification required to install equipment components systems packages.

- C. All Electrical workers on this project shall be thoroughly knowledgeable of all applicable codes related to all electrical systems for this project. All installations shall be performed by skilled electrician tradesmen fully aware of the latest techniques, practices, and standards of the industry. Haphazard or poor installation practice as determined by the or Engineer will be cause for rejection of work.
- D. Good workmanship and appearance shall be required. Carefully lay out all work in advance to install in a neat and good workmanship-like manner all in accordance with recognized practices and standards of the industry.

1.5 COORDINATION

- A. All drawings, specifications and documents for this project shall be taken as a whole. Prior to installation, the Contractor shall be familiar with this project by carefully reviewing and comparing all documents that pertain to this project.
- B. In preparation of the contract documents, a reasonable effort has been made to provide layouts and connections based on selected and specified manufacturer's equipment. Since physical space, electrical connections, equipment arrangements and other requirements may vary according to each manufacturer, the final responsibility for connections, initial access and proper fit is the responsibility of the Contractor.
- C. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Sleeves through fire rated floors and walls shall be non-combustible.
- D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- E. Prior to roughing in for electrical equipment furnished by others, verify the voltage and current characteristics and control connections of this equipment. Notify the Engineer where equipment connection requirements do not match the provisions indicated on the documents.
- F. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- G. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- H. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, complete installation of these items prior to ceiling tile installation.
- I. The drawings indicate only the approximate locations of rough-ins and may not indicate complete connection requirements. Prior to proceeding with any work or rough-ins the Contractor shall obtain all equipment rough-in requirements and information from the equipment supplier, manufacturer or from the respective trades furnishing the equipment, to complete the installation in a neat and workmanship-like manner.

- J. Scaled and calculated locations are approximate only. Before proceeding with work, carefully check and verify with building dimensions and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- K. Drawings are essentially diagrammatic and indicate the general arrangement of equipment. Many offsets, bends, pull boxes, special fittings, etc. will be required which are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, conduit routes, building obstructions, etc., to install apparatus and equipment. Install apparatus and equipment in manner and locations to avoid obstructions, preserve headroom, maintain code required clearances, and keep openings and passageways clear.
- L. Where outlet boxes are located adjacent and opposite side of the same wall, the outlet boxes shall not be placed back to back, nor shall extension rings be used in place of double boxes, all to limit sound transmission between rooms. Provide short horizontal nipple between adjacent outlet boxes, which shall have depth sufficient to maintain wall coverage in rear by masonry material.
- M. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. Such that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
 - 5. To maintain access to user serviceable equipment.
- N. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- O. Where outlet boxes are not provided with a device, whether new or existing, contractor shall provide a covering faceplate. Provide a covering faceplate for every outlet box.

1.6 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Sections.
- B. Substitutions:
 - 1. Submittal dates: For a period of up to ten (10) days prior to bid date, Engineer will consider written requests from bidders, manufacturers, and suppliers for substitution of products.
 - 2. Submission: Submit a separate request for each product, supported with descriptions, drawings and samples as appropriate, including:
 - a. Comparison of the qualities of the proposed substitution with that specified. Standard features and options of the proposed substitution shall be clearly identified on the submittal.
 - b. Changes required in other elements of the work because of the substitution.

- c. Availability of maintenance service, and source of replacement materials.
 3. Substitution request constitutes a representation that bidder submitting request:
 - a. Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified.
 - b. Will provide the same warranties or bonds for the substitution as for the product specified.
 - c. Will coordinate the installation of an accepted substitution into the Work, and make such other changes as may be required to make the Work complete in all respects.
 - d. Waives all claims for additional costs, under his responsibility which may subsequently become apparent.
 4. Engineer Review: The Engineer will review requests for substitutions with reasonable promptness to judge the acceptability of the proposed substitution, and notify bidders by addendum the decision to accept the requested substitution.
 5. Late Request for Substitutions: Requests for substitution received after bidding will not be considered except in such cases where it is necessary to make a substitution due to strikes, lockouts, bankruptcy, discontinuing of a product, etc. Requests for such substitutions of materials after award of contract shall be made in writing to Engineer and shall be made within ten days of date that Contractor ascertains he cannot obtain material or equipment specified.
 6. Engineer's Acceptance: Engineer's acceptance of a substituted item applies only to the general quality and arrangement of the items substituted. Substituted items are still subject to the shop drawing review process.
- C. Shop Drawings:
1. Before ordering any equipment, stamp with approval, and submit to the Engineer the electronic copy required for the contractor's and retained by the Engineer.
 2. The review of shop drawings by the Engineer shall not constitute agreement of any deviations from the plans and specifications and shall not relieve the Contractor from responsibility for errors or omissions.
 3. Shop drawings shall be electronic copy format as follows:
 - a. A digital copy of shop drawings (Portable Document Format (*.pdf) or AutoCAD 2010 is the preferred content format).
 4. Refer to drawings for the additional required equipment that is to be submitted as part of the shop drawing submittals.
 5. Allow a minimum of fourteen (14) calendar days for the Engineer to review the shop drawings. Time is from the receipt of drawings in the engineer's office until they are shipped out of the office.
- D. Project Record Documents:
1. As work progresses: Record changes or deviations from the contract drawings as follows:
 - a. Record location and elevation of underground conduits and direct burial wiring.

- b. Record as-built changes for electrical work within the building that occur during the progress of construction and before the work is concealed. Record shall include such changes as:
 - c. Relocation of devices to avoid obstacles.
 - d. Routing of conduit from outlet to outlet.
 - e. Routing of conduit under floor, overhead, in walls or exposed.
 - f. Combining of circuits into common conduit.
 - g. Sizes of conduits and conductors.
 - h. Revisions to circuit breaker quantity or arrangement in panelboards.
2. Location: The record drawings shall be maintained at the job site and be subject to review by the Owner or Engineer during the construction period. This record keeping requirement shall not be construed as authorization for the Contractor to make changes in the layout without definite instructions by the Engineer in each case.
3. Submission: Upon completion of the work, submit a set of drawings showing changes as noted on the record set of prints to the Owner.

E. Operating and Maintenance Manuals:

Submittal: At the completion of the contract submit to the Engineer 2 sets of operating and maintenance manuals including parts lists bound into hard covered manuals for the electrical equipment. Each manual to include an electronic data disk of the entire operating and maintenance manual with folder structure and naming to match tabs in the manual. Label manuals with the local supplier's name and address. Cross out or delete from the submission information not definitely applying to these particular pieces of equipment. Provide information for equipment with shop drawings.

1. Content:
2. Approved shop drawings or product data sheets alone are not acceptable maintenance material. Most shipped items of equipment include installation/maintenance sheets in the shipping package that shall also be included into the maintenance manual.
3. Include all special warranties.
4. All test and commissioning data of every system as called out herein, after Engineer review.
5. Programming: Instructions for programmable systems.
6. Hazardous Materials: Disposal Certificates.

1.7 PROJECT CONDITIONS

- A. Exterior Environmental Conditions: Electrical systems shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: Temperature ranges at the Project location as determined by the U.S. Weather Bureau.
 2. Altitude: Elevation of the Project locations.
- B. Interior Environmental Conditions: Electrical systems shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 72 to 75 deg F (conditioned spaces), 55 deg F to ambient (unconditioned spaces).
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Elevation of the Project locations feet.

C. Interruption of Existing Electric: Do not interrupt electric service(s) to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service(s) according to requirements indicated:

1. Notify Owner/Owner's Representative no fewer than 15 working days in advance of proposed interruption of service.
2. Do not proceed with interruption of service(s) without Owner/Owner's Representative's written permission.

1.8 PERMITS

A. Obtain and pay fees for all licenses, required permits, and charges for use of outside services (i.e. inspecting agencies or delivery services) and use of property other than the site of the Work for storage of materials or other purposes.

1.9 AUTHORITY HAVING JURISDICTION INSPECTIONS

A. Secure regular inspections as required by State and local regulations. Pay charges by regulating agencies for Drawings, Specifications, review of Drawings and Specifications, and the inspections of installations.

1.10 INSURANCE

A. Procure and maintain such insurance required by law and additional insurance as required by owner.

1.11 GUARANTEE/WARRANTY

A. The electrical system installed under this contract shall be left in proper working order. Replace, without additional charge, new work or material which develops defects from ordinary use within one year unless a longer period is specified elsewhere, from date of acceptance by the Owner, except materials not furnished by the Contractor, or unless specified otherwise in Sub-Sections as Special Warranties.

B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished on special equipment.

1.12 MAINTENANCE

A. Maintenance Service: During warranty period for defective workmanship and material.

1. Emergency Service: Provide immediate, 24-hour response.

2. Normal Service: Non-emergency service may be performed during normal working hours.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Owner for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

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

3.2 PENETRATION 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 07 Sections.
- B. General Requirements:
 1. Provide penetration fire stopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration fire stopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

2. Penetrations in Fire-Resistance-Rated Walls: Provide penetration fire stopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - a. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls, and fire partitions.
 - b. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
3. Penetrations in Horizontal Assemblies: Provide penetration fire stopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - a. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
 - b. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.T-rating in subparagraph below indicates resistance to excessive thermal transmission.
 - c. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
4. Penetrations in Smoke Barriers: Provide penetration fire stopping with ratings determined per UL 1479.
5. Accessories: Provide components for each penetration fire stopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration fire stopping manufacturer and approved by qualified testing and inspecting agency for fire stopping indicated.
 - a. Permanent forming/damming/backing materials, including the following:
 - 1) Slag-wool-fiber or rock-wool-fiber insulation.
 - 2) Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - 3) Fire-rated form board.
 - 4) Fillers for sealants.
 - b. Temporary forming materials.
 - c. Substrate primers.
 - d. Collars.
 - e. Steel sleeves.

C. Fill Materials:

1. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
2. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
3. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

4. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
5. Intumescent Putties: Non-hardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
6. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
7. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
8. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
9. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
10. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

D. Mixing:

1. For those products requiring mixing before application, comply with penetration fire stopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

E. Installation:

1. General: Install penetration fire stopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
2. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - a. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
3. Install fill materials for fire stopping by proven techniques to produce the following results:
 - a. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - b. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

4. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.3 REFINISHING AND TOUCHUP PAINTING

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.
- B. Refinish and touch up paint:
 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
 5. Paint exposed conduits to match painted surfaces.

3.4 CLEANING AND PROTECTION

- A. Progress Cleaning:
 1. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - a. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - b. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 - c. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations. Use containers intended for holding waste materials of type to be stored.
 - d. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
 2. Site: Maintain Project site free of waste materials and debris.
 3. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - a. Remove liquid spills promptly.
 - b. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
 4. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended,

use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

5. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
6. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
7. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Sections.
8. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
9. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
10. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

B. Final Cleaning:

1. Thoroughly clean electrical materials, equipment and apparatus to be free of dust, dirt, rust, and foreign materials before acceptance at Substantial Completion.
2. Clean electrical materials in conformance with manufacturer's instructions.
3. Clean panelboards, switchboards, motor controls, etc. Take special care to remove dirt, mortar, wire scraps, etc., from equipment interiors.
4. Clean accessible elements of disconnecting and protective devices of equipment, coils of dry type transformers, etc.) and vacuum clean enclosure prior to being energized.
5. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
6. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.5 EQUIPMENT FURNISHED BY THE OWNER

A. Contractor Requirement:

1. Inspect in presence of the Owner's Representative, and report in writing, any damage.
2. Assume responsibility for receiving, storing, protecting, installing, and connecting owner furnished equipment.

B. List of Owner furnished equipment and equipment as indicated on the drawings.

1. EV Charging Equipment
2. EV Charge Management System

3.6 INTERRUPTION OF EXISTING ELECTRIC SERVICE

- A. The existing building will be in use during construction. Schedule and carry out the Work in such a manner as to cause the Owner a minimum of inconvenience due to service interruption. Temporary services (feeder, branch circuit and signal systems) shall be installed if one area or phase of construction disrupts service to another area of the building(s) or if equipment, conduits, or feeders have to be relocated to allow construction to progress. Service interruptions shall be confined to the smallest area possible at any one time and interruptions shall be scheduled in advance with the Owner's site representative. All interruptions shall be conducted and shall be limited to after-hours, weekends, or as directed by the Owner. After service has been restored following an interruption, inspect areas affected by the interruption and be responsible for returning automatically controlled equipment to the same operating condition which existed prior to the interruption.
- B. Notify the Owner a minimum of 15 working days prior to service interruption.

3.7 BUILDING STRUCTURE PENETRATIONS

- A. Where existing or temporary raceway systems are being demolished, which leave openings in the existing building structure, the building structure shall be patched to match the existing construction and maintain the existing building fire ratings.

3.8 FINAL TESTS AND ADJUSTMENTS

- A. Provide personnel for initial start-up and operation of the electrical equipment and for a trial run of the equipment to demonstrate that the equipment and associated systems are properly installed and operating as intended before the date of substantial completion.
- B. Upon completion, subject the work to such tests as are required under industry standards and/or specified herein. Acceptance of the work by Owner shall be contingent upon satisfactory completion of these tests.
- C. Subject the work to a careful and thorough visual inspection to detect erroneous or loose connections, damaged components, presence of foreign objects or materials, poor workmanship, incorrect ratings of overcurrent protective devices, or other abnormal conditions.
- D. Perform tests to demonstrate proper functioning of lighting equipment, controls, proper rotation, etc. Proper operation of permanently connected meters and metering equipment shall be demonstrated, and the accuracy thereof established to a reasonable degree.
- E. Overcurrent protective devices shall be properly coordinated, and as the equipment is put into service, necessary final adjustments shall be made to equipment within the scope of work under this contract to make the electrical system operative throughout.
- F. Should any operating condition be encountered which would require abnormal or unsafe settings of protective devices, this fact shall be brought to the attention of the Engineer immediately. Tests shall be recorded and the reports submitted to the Engineer.
- G. Perform specific testing as may be required to comply with installation requirements of the National Fire Protection Association (NFPA). Reporting of these tests shall be submitted to the Engineer and to Authority Having Jurisdiction as defined by the code.

3.9 INSTRUCTION OF OWNERS EMPLOYEES

- A. Provide the services of competent instructors, who will give full instructions in the care, adjustment, and operation of parts of the electrical system and equipment to the Owner's employees who are to have charge of the equipment.
- B. Each instructor shall be thoroughly familiar with parts of the installation on which he is to give instructions and shall have full knowledge of the operating theory and practical operation-maintenance work. Factory trained instructors shall be employed wherever they are available.
- C. Instructions shall be given during the regular work week after the building has been accepted and turned over to the Owner for regular operation. In addition to the time indicated in other Division 26 sections, provide one man-day (8 hours) of instructions, broken into two (4 hour) sessions for general systems.
- D. The instructions shall be given within three months after the work has been accepted and turned over to the Owner at a time mutually agreed on with the Owner.

3.10 Notify the Engineer in writing when such instruction has been completed.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Section 260500 “Common Work Results for Electrical, Communications, and Electronic Safety and Security.”

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600 V or less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Section 260523 “Control-Voltage Electrical Cables” for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

- A. RoHS: Restriction of Hazardous Substances.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire Company.
 - 2. American Bare Conductor.
 - 3. Belden Inc.
 - 4. Cerro Wire LLC.
 - 5. Encore Wire Corporation.
 - 6. General Cable Technologies Corporation.
 - 7. Okonite Company (The).
 - 8. Service Wire Co.
 - 9. Southwire Company.
 - 10. WESCO.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type RHH and Type RHW-2: Comply with UL 44.
 - 2. Type USE-2 and Type SE: Comply with UL 854.
 - 3. Type THHN and Type THWN-2: Comply with UL 83.
 - 4. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 5. Type UF: Comply with UL 83 and UL 493.
 - 6. Type XHHW-2: Comply with UL 44.
 - 7. Low Leakage Type: Cross-linked Polyethylene Insulation, XHHW-2, VW1, wire in accordance with UL requirements. 600 volts with conductor temperatures of 90°C. Wire must be designed to reduce capacitive and resistive leakage to a dielectric constant 3.5. <55uA leakage current at 120-volt over 100 feet. Minimum insulation wall thickness: 40-mil.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M Electrical Products.
 - 2. ABB (Electrification Products Division).
 - 3. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.
 - 4. Atkore International (AFC Cable Systems).
 - 5. Gardner Bender.
 - 6. Hubbell Incorporated, Power Systems.
 - 7. Ideal Industries, Inc.
 - 8. ILSCO.
 - 9. NSi Industries LLC.
 - 10. Service Wire Co.
 - 11. TE Connectivity Ltd.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid; stranded for No. 8 AWG and larger. Pre-manufactured equipment raceway and conductors are exempt from this requirement.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway; Type XHHW-2, single conductors in raceway.
- B. Exposed Wet Location and Exterior Feeders not exposed to direct sunlight: Type THHN/THWN-2, single conductors in raceway; XHHW-2, single conductors in raceway.
- C. Exterior Feeders exposed to direct sunlight: XHHW-2, single conductors in raceways.

- D. Feeders Concealed in Dry Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN, single conductors in raceway; THHN/THWN-2, single conductors in raceway; XHHW, single conductors in raceway; XHHW-2, single conductors in raceway.
- E. Exposed Branch Circuit Raceway, Including in Dry Crawlspace: Type THHN/THWN, single conductors in raceway; type THHN/THWN-2, single conductors in raceway; type XHHW, single conductors in raceway; XHHW-2, single conductors in raceway.
- F. Branch Circuits Concealed in Dry Ceilings, Walls, and Partitions: Type THHN/THWN, single conductors in raceway; type THHN/THWN-2, single conductors in raceway; type XHHW, single conductors in raceway; type XHHW-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal raceways in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 “Raceways and Boxes for Electrical Systems” prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install surface mounted raceways parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- A. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack. Provide terminal type ring connector if branch circuit conductors are stranded. Stranded conductors shall not be directly connected to wiring device.
- B. Splices or taps in handholes, manholes, or other in-ground enclosures for conductors size No. 6 AWG and smaller:
 - 1. “King Safety Sealed” connectors; taped and then coated with a waterproofing product

equal to 3M “ScotchKote Electrical Coating”.

- C. Splices or taps in handholes, manholes, or other in-ground enclosures for conductors larger than size No. 6 AWG:
 - 1. “King Safety Sealed” connectors; taped and then coated with a waterproofing product equal to 3M Scotchcast “Resin Splice Kits”.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 “Identification for Electrical Systems.”

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of floor and exterior wall assemblies. Comply with requirements in Section 260544 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling.”

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 260500 “Common Work Results for Electrical, Communications, and Electronic Safety and Security Systems.”

3.8

3.9 FIELD QUALITY CONTROL

- A. Test wiring rated 600 volt and less to verify that no short circuit or accidental grounds exist. Perform insulation resistance tests on wiring No.6AWG and larger, using instruments which applies voltage of approximately 500 volts to provide a direct reading of resistance. Minimum resistance: 250,000 ohms.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Category 6 balanced twisted pair cable.
 - 2. Category 6a balanced twisted pair cable.
 - 3. Balanced twisted pair cabling hardware.
 - 4. Low-voltage control cabling.
 - 5. Control-circuit conductors.
 - 6. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: **60 inches (1520 mm)** or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.

3. Average Optical Smoke Density: 0.15 or less.

- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Cabling shall match existing cabling on site. Verify in field.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum.
- G. Jacket: Color as selected by the owner, thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B. Cabling shall match existing cabling on site. Verify in field.
- C. General Requirements for Balanced Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standards:
 - a. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.

- b. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
- 4. Marked to indicate transmission performance.
- E. Legend:
 - 1. Machine printed, in the field, using adhesive-tape label.
 - 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.4 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway, Type XHHW-2, complying with UL 44 in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway, Type XHHW-2, complying with UL 44 in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway, Type XHHW-2, complying with UL 44 in raceway

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
 - 2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by 1-1/2 inches (38 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
 - 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.

3. Do not untwist balanced twisted pair cables more than **1/2 inch (12 mm)** at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

F. not identified with a tag for future use.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

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

3.5 FIRESTOPPING

- A. Comply with TIA-569-D, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping" Chapter.

3.6 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Section 260500 – Common Work Results for Electrical

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.3 DEFINITIONS

- A. EGB: Electrical Grounding Busbar
- B. BCT: Bonding Conductor For Telecommunications.
- C. TGB: Telecommunications Grounding Busbar.
- D. TMGB: Telecommunications Main Grounding Busbar

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning & Grounding.
7. ILSCO.
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Robbins Lightning, Inc.
10. Thomas & Betts Corporation, A Member of the ABB Group.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Sizes and types of conductors in four subparagraphs below are typical examples. 28-kcmil bonding cable in "Bonding Cable" Subparagraph below is slightly larger than No. 6 AWG.
 - a. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - b. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - c. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - d. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.4 GROUNDING BUSBARS

- A. Grounding Bus: Provide as follows unless indicated otherwise. Predrilled rectangular bars of annealed copper
 1. 1/4 by 2 by 24 inches with 9/32-inch holes spaced 1-1/8 inches apart for electrical rooms.

- B. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Phenolic, Lexan or PVC, impulse tested at 5000 V. Grounding bus shall be listed by a Nationally Recognized Testing Laboratory.

2.5 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- E. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. 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.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 24 inches above finished floor unless otherwise indicated.
- D. Conductor Terminations and Connections:
 - 1. Pipe: Bolted connectors
 - 2. Equipment Grounding Conductor Terminations: Bolted connectors and irreversible connectors.
 - 3. Underground Connections: Welded and irreversible connectors except at test wells and as otherwise indicated.

4. Connections to Ground Rods at Test Wells: Bolted and irreversible connectors.
5. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Ground all separately derived systems in accordance with the requirements of National Electrical Code and as indicated on the drawings.
 1. Interior Transformers: Make connection to the grounding electrode system at the nearest steel beam or column of the building structural steel system.
 2. Exterior Generators: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor, reinforcing steel in the concrete pad, and to the frame of the generator.
 3. Interior Generators: Connect to the building service grounding electrode system.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
Receptacle circuits.
 3. Single-phase motor and appliance branch circuits. In addition, motors over 150 volt to ground shall be bonded to the conduit system with a separate ground wire
 4. Three-phase motor and appliance branch circuits. In addition, motors shall be bonded to the conduit system with a separate ground wire
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from

panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.4 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. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- C. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- F. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
 - 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches from building's foundation.
- G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.

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

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

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

END OF SECTION 260526

SECTION 260529 – HANGERS, SUPPORTS, AND CONCRETE BASES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Hangers and supports for electrical equipment and systems.

1.3 ACTION SUBMITTALS

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70, National Electrical Code®.

PART 2 - PRODUCTS

2.1 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.
- C. Engage a qualified professional engineer to design hanger and support system.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.

- b. B-Line; an Eaton Business.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation.
 - e. Unistrut
 - f. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) B-Line; an Eaton Business.

- 2) 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.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

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 unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article. Use the more stringent requirement if there are conflicts between the documents.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMTs, IMCs, and RMCs may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27) complying with MSS SP-69, or Spring-tension clamps.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ENT: Electrical Nonmetallic Tubing.
- B. FMC: Flexible Metallic Conduit.
- C. GRC: Galvanized Rigid Steel Conduit.
- D. HDPE: High Density Polyethylene Conduit.
- E. IMC: Intermediate Metal Conduit.
- F. LFMC: Liquid Tight Flexible Metallic Tubing.
- G. LFNC: Liquid Tight Flexible Nonmetallic Tubing.
- H. PVC: Polyvinyl Chloride Conduit.
- I. RMC: Rigid Metal Conduit.
- J. RNC: Rigid Nonmetallic Conduit.
- K. RTRC: Reinforced Thermosetting Resin Conduit.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems; a part of Atkore International.
 2. Allied Tube & Conduit; a part of Atkore International.
 3. Anamet Electrical, Inc.
 4. Electri-Flex Company.
 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
 6. Picoma Industries, Inc.
 7. Republic Conduit.
 8. Robroy Industries.
 9. Southwire Company.
 10. Thomas & Betts Corporation, A Member of the ABB Group.
 11. Western Tube and Conduit Corporation.
 12. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- G. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. MonoSystems, Inc.
 - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Adalet.
 - 2. Crouse-Hinds, an Eaton business.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a brand of Pentair Equipment Protection.
 - 7. Hubbell Incorporated.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. MonoSystems, Inc.
 - 11. Oldcastle Enclosure Solutions.
 - 12. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 13. RACO; Hubbell.
 - 14. Robroy Industries.
 - 15. Spring City Electrical Manufacturing Company.
 - 16. Thomas & Betts Corporation, A Member of the ABB Group.
 - 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC or IMC.
 - 2. Concealed Conduit, Aboveground: GRC, IMC, or EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC, or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size:

1. ¾-inch (21-mm) trade size for branch circuits.
2. ¾-inch (21-mm) trade size for home runs.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. 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.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- U. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- Y. Locate boxes so that cover or plate will not span different building finishes.

- Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- BB. Set metal floor boxes level and flush with finished floor surface.
- CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-*SEAL* INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Section 260500 “Common Work Results for Electrical”.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for Raceway and Cable Penetration of Non-Fire-Rated Construction Walls and Floors.
- B. Related requirements:
 - 1. Refer to Section 260500, Part 3 “Penetration Firestopping” Paragraph for firestopping requirements.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw fastening the sleeve to the board.
- B. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- C. Molded-PVC Sleeves, with nailing flange for attaching to wooden forms.
- D. Molded-PE or –PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- E. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches thickness shall be 0.052 inch
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inch thickness shall be 0.138 inch.

2.2 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi/34.5-MPa, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve or core-drilled hole and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

- b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations, unless core-drilled holes are approved by Structural Engineer. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved openings.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Section 260500 “Common Work Results for Electrical, Communications, and Electronic Safety and Security”.

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels, including arc-flash warning labels.

1.3 PRECEDENCE

- A. Where identification requirements are specified on the Drawings, those requirements shall take precedence of the requirements of Section 260553.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Self-Adhesive Labels:

1. Preprinted, 3-mil-thick, flexible label with acrylic pressure-sensitive adhesive.
 - a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the cable diameter, such that the clear shield overlaps the entire printed legend.
2. Thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 - a. Nominal Size: 3.5-by-5-inch.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 Tags

A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory screened or printed permanent designations; punched for use with self-locking cable tie fastener.

B. Write-On Tags:

1. Polyester Tags: **0.010 inch** thick, with corrosion-resistant grommet and cable tie for attachment to raceway, conductor, or cable.
2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 Signs

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. inches, minimum 1/16-inch.
 - b. For signs larger than 20 sq. inches, 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners or Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- E. Apply identification devices to surfaces that require finish after completing finish work.

- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.3 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "POWER."
 - 2. Identification of Communications, Electronics Safety and Security Systems.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. 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.
 - 1. Branch Circuit Identification:
 - a. In outlet boxes.
 - 1) Full wrap self-adhesive wire markers to indicate panelboard circuit number (i.e.: "L1-2").
 - 2) Inside of the box marked either on the side or back of the box, with a black indelible "magic marker" to indicate the panelboard and circuit numbers of the conductors contained in the box (i.e.: "H4, 2, 6").
 - b. In junction boxes and pullboxes, branch circuit conductors:

- 1) Full wrap self-adhesive wire markers to indicate panelboard and circuit number (i.e.: “L1-2”).
 - 1) Inside of the box marked with a black indelible “magic marker” to indicate circuit numbers of the conductors contained in the box (i.e.: “H2, 4, 6”). Marking for conduits placed next to the location where conduit enters the box.
 - 2) Tag attached by string to each group of conductors that enter the pull box or junction box (i.e.: one tag per conduit). Tags marked with a black indelible felt tip pen to indicate the circuit numbers of the conductors (i.e.: “L1-2, 4, 6”).
- c. In panelboards and other electrical enclosures:
- 1) Tags attached to the conductors by strings. Tags marked with a black indelible felt tip pen to indicate the load served by that conductor (i.e.: “Vestibule #103 Lights”).
- C. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags or nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags, self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- E. Conductors To Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker-tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.

- H. Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.
 - 1. Comply with NFPA 70E and ANSI Z535.4.
 - 2. Comply with Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
- I. Operating Instruction Signs: 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.
- J. 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 unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
 - b. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment To Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Switchboards.
 - d. Enclosed switches.
 - e. Power-transfer equipment.
 - f. Monitoring and control equipment.
 - 3. Labeling Examples:
 - a. Motor or heater control devices, manual motors switches, motor toggle switches, pushbuttons, thermostats, etc. Identified with nameplate. Nameplate inscriptions shall indicate the equipment being controlled, i.e. "Toilet Exh, Range Hood Exh, Heater, A.C. Unit #1, H.W. Pump #2, etc. as described in the Motor Starter and Control Schedule, and the branch circuit source, i.e. "Panel L1-2".
 - b. Motor or heater disconnects and starters, safety switch, toggle switch, or starter. Identified with nameplate. Nameplate inscriptions shall indicate the equipment being controlled, its motor number as listed in the Motor Starter and Control Schedule and its motor number as listed in the appropriate schedule on the mechanical drawings, i.e. "Toilet Exh (Mot #4, PRV – 1), Heater (Mot #7, UH-3),

- A.C. Unit #1 (Mot #12, RTU-2)", etc. and the branch circuit source, i.e. "Panel L1-2".
- c. Switchboards, Motor Control Centers and Panelboards – Identified with nameplate provided on the outside of each panelboard in mechanical and electrical equipment rooms and on the inside of the door of each panelboard located in other finished areas. Inscriptions shall indicate the panel name, voltage, phase, wires, feeder size, and feeder source, i.e.: "Panel L1, 120/208-3PH-4W, 2 inches – 3#2 & 1#8 GRD THHN, fed from panel H1."
 - d. Disconnect switch or circuit breaker in switchboards or motor control centers, or individually mounted. Identified with nameplate. Inscriptions shall indicate the device served, i.e. "Panel L1, HVAC Unit #1, Capacitors", etc.
- K. Panelboard Directories: Install as follows:
- 1. Typewritten.
 - 2. Indicating each branch circuit load served.
 - 3. Replacement directories installed where circuits have been modified, added or deleted. (Turn over the old directory to the Owner).
 - 4. Indicates date that directory was installed.
- L. Arc Flash: Label on the exterior of each panelboard, switchboard and Motor Control Center with indications in accordance with NEC 110.16.

END OF SECTION 260553

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Section 260500 “Common Work Results for Electrical, Communications, and Electronic Safety and Security”.

1.2 SUMMARY

- A. Section Includes:
 - 1. Panelboards – circuit breaker type.
 - 2. Panelboards – fusible type.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protection Device (Formerly TVSS)
- C. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Transient Voltage Suppression equipment performance.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: in addition to Section 260550 requirements, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards.
- B. Handle and prepare panelboards for installation according to .

1.8 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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 SPECIAL WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Products by one of the following:
 - 1. ABB/GE www.geindustrial.com
 - 2. Square D; a brand of Schneider Electric
 - 3. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 - 4. Siemens Energy & Automation, Inc.
- B. Source Limitations: Obtain each panel from single source from single manufacturer.

2.2 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. NEMA PB1 Type for panelboards.
- B. UL 67 Standard for load centers.
- C. Enclosures: Flush- and surface-mounted cabinets as indicated on the drawings.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1 unless indicated otherwise on the drawings.
 - b. Outdoor Locations: NEMA 250, Type 3R unless indicated otherwise on the drawings.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover where indicated on the Drawings: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
 - 5. Finishes:
 - a. Panels and Trim: Steel or galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 6. Directory Card: Inside panelboard door, mounted in transparent card holder or metal frame with transparent protective cover.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Where indicated on the drawings, adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Where indicated on the drawings, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs where indicated on the drawings: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs where indicated on the drawings: Mechanical type suitable for use with conductor material.
6. Gutter-Tap Lugs where indicated on the drawings: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs where indicated on the drawings: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
8. Provide 75 degree F rated lugs for all equipment and devices.

2.3 OVERCURRENT DEVICES

- A. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- B. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- C. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- D. Provide 75 degree F rated lugs for all equipment and devices.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Mains: Circuit breaker, fuses, or lugs only as indicated on the drawings. Main circuit breaker must not be mounted in branch circuit breaker pole spaces.
- B. Branch Overcurrent Protective Devices: bolt-on circuit breakers or fuses as indicated on the drawings (plug-in only circuit breakers for load centers).
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489 to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers sizes 225A and smaller: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

2. Adjustable Instantaneous-Trip Circuit Breaker sizes 250A and larger: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Ground Fault Personnel Protection GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 6. Molded-Case Circuit-Breaker (MCCB) Features:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 7. Molded-Case Circuit-Breaker (MCCB) Accessories where indicated on the Drawings provide the following accessories:
 - a. Ground-Fault Protection: Integrally mounted or Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - b. Communication Capability: Circuit-breaker-mounted, Universal-mounted, Integral or Din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - c. Shunt Trip: Trip coil energized from separate circuit, set to trip at 75 percent of rated voltage (55 percent for 120V).
 - d. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - e. Auxiliary Contacts: SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - f. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - h. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- E. Provide 75 degree F rated lugs for all equipment and devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB1.1 or NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to industry standards.
- B. Floor Mounting: Where indicated on the Drawings install panelboards on concrete bases, 4-inch/100-mm nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports and Concrete Bases for Electrical Systems."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount panelboard such that top most overcurrent protection device is no more than 79 inches above finished floor, to the center, unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation:
 - 1. Where required by code, provide overcurrent protection devices and types based on the application (GFCI, AFCI, SWD, HACR, etc) per National Electrical Code and other standards.
 - 2. Set field-adjustable switches and circuit-breaker trip ranges.
 - 3. Program relay and settings per intended sequence of operations and based on engineering study. Install filler plates in unused spaces.

- G. Stub four 1-inch empty conduits from recess mounted 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. Comply with NECA 1.
- J. Ensure circuit breakers and equipment front panel are aligned and there are no exposed energized parts. Contractor is responsible for adjusting and coordinating with equipment manufacturer to ensure alignment.

3.3 IDENTIFICATION

- A. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

END OF SECTION 262416

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Section 260500 “Common Work Results for Electrical, Communications, and Electronic Safety and Security”.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Include the following for each fuse type included in the Project:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

1.4 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish one set of spare fuses for each size and type installed for the project.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.

- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses (Cooper Bussman fuse types given for reference):
 - 1. Feeders (switchboards, panelboards): 600A or smaller, 600 Vac-Class RK1.

2. (LPS-RK or LPJ for 101A-200A size fuse where fuse will not fit into switch such as in switchboards with “twin-switches”).
3. Feeders (Switchboards, Panelboards): 600A or smaller, 250 Vac-Class RK1.
4. (LPN-RK or LPJ for 101A-200A size fuse where fuse will not fit into switch such as in switchboards with “twin-switches”).
5. Motor Branch Circuits: 600A or smaller, 600Vac-Class RK1 (LPS-RK) or Class J (LPJ) for 101A-200A size fuse where fuse will not fit into switch such as in switch boards with “twin-switches”).
6. Motor Branch Circuits: 600A or smaller, 250Vac-Class RK1 (LPN-RK) or Class J (LPJ) for 101A-200A size fuse where fuse will not fit into switch such as in switchboards with “twin-switches”).
7. Other Branch Circuits: Larger than 600A, 600Vac-Class L time delay (KRP-C).
8. Other Branch Circuits: Larger than 600A, 250Vac-Class L time delay (KRP-C).
9. Other Branch Circuits: 600A or smaller, 600Vac-Class RK1 (LPS-RK) or Class J (LPJ) for 101A-200A size fuse where fuse will not fit into switch such as in switchboards with “twin-switches”).
10. Other Branch Circuits: 600A or smaller, 250Vac-Class RK1 (LPN-RK) or Class J (LPJ) for 101A-200A size fuse where fuse will not fit into switch such as in switchboards with “twin-switches”).

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 “Identification for Electrical Systems” and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SAFETY SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Section 260500 "Common Work Results for Electrical".

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible safety switches.
 - 2. Nonfusible safety switches.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation and maintenance manuals.
 - 1. Copies of Shop Drawings.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SAFETY SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position. Handle must be lockable to closed and open position.
- C. Accessories when indicated on the Drawings:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6. Lugs: Suitable for number, size, and conductor material.
 - 7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SAFETY SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position. Handle must be lockable to closed and open position.
- C. Accessories when indicated on the Drawings:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 6. Lugs: Suitable for number, size, and conductor material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted safety switches and enclosed circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 “Identification for Electrical Systems.”
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Enclosed safety switches and enclosed circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262816

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Section 260500 “Common Work Results for Electrical, Communications, and Electronic Safety and Security”.

1.2 SUMMARY

- A. Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Manuals: In addition to the Section 260500 requirements, include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relay; provide relay-setting and calibration instructions, including software, where applicable.

1.5 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 twenty-four hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches from a single manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- 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.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.
- D. Comply with NFPA 99.
- E. Comply with NFPA 110.

2.2 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 260529 "Hangers, Supports and Concrete Bases for Electrical Systems."

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Contractor Transfer Switches:
 - a. ASCO Power Technologies, LP.
 - b. ABB Zenith Controls

2.4 TRANSFER-SWITCH TYPE ELECTRICAL CHARACTERISTICS AND OPTIONS

- A. Manual, Automatic, Open-Transition, Closed-Transition, or Bypass/Isolation type as indicated on the Drawings.

2.5 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.
 - 2. Short-time withstand capability:
 - a. Three cycles, minimum for all equipment under 600 amperes.
 - b. 15 cycles, minimum for all equipment 600 amperes or greater.
- 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 nonfused, 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.
- G. Heater when indicated on the Drawings: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- H. 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.
- I. 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 Section 260553 "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- J. Enclosures: General-purpose NEMA 250, Type 1 unless indicated otherwise on the Drawings, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

- K. Metering display (MD): when indicated on the Drawings, provide metering displayed on the face of the switch to indicate the following:
 - 1. Frequency
 - 2. Ammeter with phase selector switch
 - 3. Voltage with phase selector switch

2.6 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 no-load. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. When indicated on the drawings, provide a relay with a set of normally open and normally closed dry contacts for each of the following. When not indicated, provide a relay with an open and closed dry contact, at minimum.
 - 1. Elevator/Escalator Control Contacts (ECC or ESR): Where indicated on the Drawings, provide contacts for connection to elevator controllers, one closed when automatic transfer switch is connected to the normal source, and one closed when automatic transfer switch is connected to the emergency source.
 - 2. Motor Disconnect Relay (MDR): Where indicated on the Drawings, provide a relay to disconnect one or more motor via their motor starters before transfer, and reconnect the motors, after an adjustable time interval, after transfer. Adjustable timing period of 1 to 60 seconds. One N.C. and N.O. contact rated at for the control circuit in rush and seal currents of the application.
 - 3. Sequential Motor Disconnect Relay (SMDR): Where indicated on the plans, provide a relay system to disconnect more than one motor via their motor starters before transfer, and reconnect the motors in sequence after, an adjustable time interval, after transfer. Adjustable timely period of 1 to 60 seconds between restart of each motor. One N.C. and one N.O. contact for each motor contacts rated for the control circuit inrush and seal currents of the application.
- E. Load Shed Feature (LSR): Where indicated on the Drawings, ATS must be able to accept a contact closure signal from the customer, generator, paralleling switchboard, or other control equipment to shed optional standby load. Provide required auxiliary contacts and interface optional branch ATS with load shed relay being provided on the output of the Generator such that the option branch ATS is de-energized under a Generator Overload condition.
- F. In-Phase Monitor (IPM): Where indicated on the drawings provide a monitor that will compare the phase angle of the normal and generator sources, and prevent transfer until the two phase angles are approximately in phase (within a self-adjusting range). One N.C. and one N.O. contact rated for the control circuit inrush and seal current of the application.
- G. Power Manager (PM): When indicated on the drawings provide a Power Manager with the following features and functions:

1. Furnish Power Managers at location shown to monitor all functions specified below.
2. Listed to UL 3111-1, CSA, CE Mark, and industrially rated for an operating temperature range of -20°C to 60°C.
3. Accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).
4. Capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32VDC.
5. Capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.
6. Accept inputs from industry standard instrument transformers (120 VAC secondary PTs and 5A secondary CTs). Direct phase voltage connections, 600 VAC and under, shall be possible without the use of PTs.
7. Applied in single, 3-phase, or three & four wire circuits. A fourth CT input shall measure neutral or ground current.
8. All setup parameters shall be stored in non-volatile memory and retained in the event of a control power interruption.
9. The following metered readings shall be communicated via serial communication module:
 - a. Current, per phase RMS and neutral (if applicable)
 - b. Current Unbalance %
 - c. Voltage, phase-to-phase and phase-to-neutral
 - d. Voltage Unbalance %
 - e. Real power (KW), per phase and 3-phase total
 - f. Apparent power (KVA), per phase and 3-phase total
 - g. Reactive power (KVAR), per phase and 3-phase total
 - h. Power factor, 3-phase total & per phase
 - i. Frequency
 - j. Accumulated Energy
 - 1) Accumulated real energy KWH
 - 2) Accumulated reactive energy KVAH
 - 3) Accumulated apparent energy KVARH
10. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
 - a. Event Logging
 - 1) Date and time and reason for transfer normal to emergency.
 - 2) Date and time and reason for transfer emergency to normal.
 - 3) Date and time and reason for engine start.
 - 4) Date and time engine stopped.
 - 5) Date and time emergency source available.
 - 6) Date and time emergency source not available.
 - b. Statistical Data
 - 1) Total number of transfers.

- 2) Total number of transfers due to source failure.
 - 3) Total number of days controller is energized.
 - 4) Total number of hours both normal and emergency sources are available.
11. Input/Output Options.
 - a. Provide (8) solid state status inputs.
 - b. Provide four (4) relay output contacts.
 12. The power Manager shall flush mount to an enclosure.
 13. Equipped with a continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities:
 - a. Current, per phase RMS and neutral
 - b. Current Unbalance %
 - c. Voltage, phase-to-phase and phase-to-neutral
 - d. Voltage Unbalance %
 - e. Real power, per phase and 3-phase total
 - f. Apparent power, per phase and 3-phase total
 - g. Reactive power, per phase and 3-phase total
 - h. Power factor, 3-phase total & per phase
 - i. Frequency
 - j. Accumulated Energy (KWH, VAH, VARH)
 14. Reset of the following electrical parameters from the front of the Power Manager:
 - a. Real energy (MWH), apparent energy (MVAH) and reactive energy (MVARH).
 15. Means for protection against unauthorized/accidental changes for setup and reset function.
- H. Communications Options:
1. Ethernet Communications module (ECM): Provide Ethernet based communications module that allows Ethernet connectivity from the Transfer Switch network to an Enterprise Local Area Network (LAN) over a single IP address. Coordinate with the Division 27 Communications contractor for installation of cabling required for communications connection to the Enterprise network.
 - a. Email notification capabilities
 - b. Remote monitoring by Building Automation Systems using Modbus TCP/IP protocol.
 - c. Status indication of generator(s), Utility, and Transfer Switch, Alarms and Alerts, and statistical activity data.
 - d. Ethernet module shall support Modbus, SNMP, and advanced Encryption security standards.
 - e. Controller power supply – power supply must be capable of providing 10 second ride through power upon loss of power and during transfer.
- I. Additional 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 200 percent of nominal. Factory set for pickup at 95 percent.
4. Tim 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 of sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sending 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: Once isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods 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.

2.7 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. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated
- B. Identify components according to Section 260553 "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- D. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring to Remote Components and Controlling Generator(s): 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. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Provide conductors, cables and raceways between the transfer switch and remote locations, for all options when indicated on the drawings, as follows:
 1. Elevator Control Contacts (ECC)
 2. Elevator/Escalator Pre-signal Relay (ESR)
 3. Load Shed Feature (LSR)
 4. Motor Disconnect Relay (MDR)
 5. Sequential Motor Disconnect Relays (SMDR), conductors and raceway to each motor
 6. Serial Communication
 7. Remote Annunciator System (RAS)

8. Remote Annunciator and Control System (RACS)
 9. Between electric utility protective relaying in transfer switch and associated shunt trip circuit breakers or switches.
 10. Between transfer switch and associated generator for start function.
Coordinate termination of cables and conductors with contractors responsible for controlled equipment.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. 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. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
- C. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 1. Check for electrical continuity of circuits and for short circuits.
 2. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 3. Verify that manual transfer warnings are properly placed.
 4. Perform manual transfer operation.
- E. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 1. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 2. Simulate loss of phase-to-ground voltage for each phase of normal source.
 3. Verify time-delay settings.
 4. Verify pickup and dropout voltages by data readout or inspection of control settings.
 5. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 6. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- F. Coordinate tests with tests of generator and run them concurrently.

- G. 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.
- H. 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.
- B. Coordinate this training with that for generator equipment.

END OF SECTION 263600