

PART 1 - General

1.1 Intent

A. The electrical specifications are, for convenience, divided into the following sections which contain the requirements applicable to the systems named:

1. 260500 - common work results for electrical
2. 260519 - low voltage electrical power conductors and cables
3. 260523 - control voltage electrical power cables
4. 260526 - grounding and bonding for electrical systems
5. 260529 - hangers and supports for electrical systems
6. 260533 - raceway and boxes for electrical systems
7. 260553 - identification for electrical systems
8. 260923 - lighting control devices
9. 262416 - panel boards
10. 262726 - wiring devices
11. 262813 - fuses
12. 262913 - enclosed controllers
13. 265100 - interior lighting
14. 265600 - exterior lighting

1.2 Scope of Work

- A. Provide all items, articles, materials, operations, labor, equipment and services required for the installation of electrical systems. Refer to electrical drawings, specifications and the drawings and specifications of other trades for the scope of electrical work. Include all electrical work called for or required to facilitate the work and systems indicated on drawings or specified of other trades. Electrical work and details indicated on plan may not be complete in all details but is intended to convey the systems and major scope items required. Electrical contractor shall include all work and incidentals required for complete and operating systems.
- B. The work shall be done in accordance with best practice so as to contribute to efficiency of operation and minimum maintenance and shall be installed with proper accessibility. The materials and equipments, including all necessary accessories, shall be put into proper adjustment so that the component parts function together as a workable system. The electrical contractor shall provide all

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equipment, materials and operations as indicated either on the drawings or contained herein or as may be reasonably implied by either to accomplish a complete electrical system.

- C. Electrical work shall include but shall not be limited to the following:
1. Underground ducts, conduits excavation, backfilling, etc. As required for the electric service.
 2. Transformer pad.
 3. Utility fees and charges.
 4. Metering equipment/provisions except as otherwise provided by the Detroit Edison company, a division of DTE Energy.
 5. Ground mat.
 6. Secondary service entrance cables and conduit.
 7. Secondary service distribution equipment.
 8. Transient voltage surge suppression.
 9. Receptacle panels.
 10. Branch power and lighting circuits.
 11. Lighting fixtures and lamps.
 12. Lighting switches and device plates.
 13. Receptacles, power outlets and plates.
 14. Conduit, conduit fittings, outlet boxes, supports, fuses, wire, cables, connectors insulating bushings, solder, tape, etc. Required for a complete electrical installation.
 15. Wall mounted exterior lighting fixtures.
 16. Exterior lighting control devices.
 17. Single phase starters.
 18. Connections to motors provided by architectural and mechanical trades.
 19. Connect all line voltage electrically operated devices furnished in place by the mechanical contractor.
 20. Complete building and equipment grounding system.
 21. Complete testing of all systems and equipments.
 22. Work, equipment and materials as shown on the drawings, mentioned in the specifications, and as required to make a complete satisfactory job, complete with all code requirements.

1.3 Definitions

- A. The terms "electrical trades", "the contractor", or "this contractor" shall mean the electrical contractor responsible for the electrical systems.
- B. "Provide" shall mean "furnish and install" or "furnish all labor and materials required for the installation of."

1.4 References

A. Provide equipment and materials that conform to the applicable standards of the:

1. American National Standards Institute (ANSI),
2. Institute of Electrical and Electronic Engineers (IEEE),
3. National Electrical Manufacturers Association (NEMA),
4. National Fire Protection Association (NFPA)
5. All Materials and equipment shall be listed and labeled by Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), Met Laboratories (MET) or Canadian Standards Association (CSA).

B. Install equipment and materials in compliance with the:

1. 2008 National Electrical Code (NEC)
2. 2008 NFPA 70e
3. 2006 Michigan building code
5. 2006 Michigan mechanical code
6. State of Michigan department of consumer & industry services, bureau of construction codes and fire safety,
7. Owner's inspection authorities,
8. Manufacturers' instructions

1.5 Document Review

A. Before submitting a proposal, this contractor shall review the documents (plans, and specifications) of all trades in order to arrive at a clear understanding of the project requirements and the work required. The bidder shall have reviewed the documents to arrive at a clear understanding of the work required and the conditions under which work is to be performed. He/she shall be held to have compared the electrical documents and the documents of other trades to have satisfied him/her self as to the interfaces and electrical work and materials required to accommodate systems, equipment, devices, etc. Furnished or furnished and installed by other trades.

B. Prior to submitting the bid, request clarification, in writing, of any ambiguities, questions, uncertainties, etc. Requests shall be made in writing to the construction manager a minimum of ten (10) days before the bid due date.

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- C. Requests for material substitutions or for material consideration as an equal shall be made in writing to the construction manager a minimum of ten (10) days before the bid due date.
- D. No allowances or extra consideration in behalf of the contractor will subsequently be allowed because of error or failure on the part of the contractor to conform to the requirements described herein.

1.6 Drawings and Measurements

- A. The drawings show the general arrangement, general design and location of equipment. The drawings are to be considered diagrammatic and are not intended to be scaled for rough-in measurements, or to serve as shop drawings.
- B. Follow the drawings in laying out the work, consult documents of other trades, to become familiar with all conditions affecting the work. Field measurements shall be taken, where necessary, for ordering materials and fitting the installation to the site conditions.
- C. Where job conditions require reasonable changes in indicated locations or arrangement, such changes shall be made without extra cost to the contract.

1.7 Barrier Free Design

- A. The contractor shall install systems and equipment as required for conformance with the handicapped barrier free regulations and the Americans with Disabilities Act. In particular, mounting heights of outlets and accessibility of controls shall be complied with.

1.8 Submittals

- A. Submit for approval six copies of shop drawings and product literature. Submittals shall include adequate information to prove that the systems, equipment and materials comply with the contract documents. Each copy of the submittals shall be marked to indicate the specific models, sizes, types and options being provided. Submittals not so marked will be rejected.

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- B. Shop drawing shall be submitted for all equipment and materials including that described in individual specification sections including the following:
 - 1. Electrical distribution equipment.
 - 2. Low voltage electrical power conductors and cables
 - 3. Raceway and boxes for electrical systems
 - 4. Lighting control devices
 - 5. Wiring devices
 - 6. Fuses
 - 7. Enclosed controllers
 - 8. Interior lighting
 - 9. Exterior lighting
- C. Shop drawings to include descriptions and/or explanatory notes as may be required to give a clear idea of its arrangement and construction.
- D. No apparatus or equipment shall be shipped from stock or fabricated until shop drawings for same have been reviewed by the engineer and stamped "accepted" or "accepted as noted".
- E. Submit shop drawings with all pertinent data and with identification mark number as specified or scheduled.
- F. Furnish and deliver to the architect a manual of all shop drawings pertaining to this contract when work is completed. The manual shall consist of a standard hard cardboard, cloth covered, three ring binder, letter size, 8-1/2" x 11". Shop drawings shall be folded and punched. All items and/or pages shall be numbered and typewritten, with index inserted at front of manual for ready reference.
- G. Provide four (4) complete operating instructions, operating manuals and repair parts lists for owner's personnel. Instruct owner's personnel in the operation of all systems.

1.9 Record Documents

- A. The contractor shall keep an accurate record of as-built conditions to record any variations from working, engineering, or shop drawings with reference to the work.
- B. Record drawings shall accurately indicate the installed location of all below grade services, conduit, wiring, etc.

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- C. Record drawings shall accurately indicate the final circuiting all lighting fixtures, wiring devices, etc.
- D. Upon completion of the work, the contractor shall deliver to the architect a set of "record" drawings on magnetic media compatible with Autocad release 2004 or higher and two blue line sets of "record" drawings. If requested, the architect will supply a set of contract drawings on magnetic media that the contractor may use as a background for the "record" drawings.

1.10 Operations and Maintenance Manuals

- A. Submit for approval four copies of operations and maintenance manuals as specified in the other division 16 specification sections. Each copy of the manuals shall be marked to indicate the specific models, sizes, types and options of the systems and equipment that were provided. Manuals not so marked will be rejected.

1.11 Training

- A. Arrange for manufacturers to train the owner's maintenance personnel on the operation and maintenance of systems and equipment as specified in the other division 26 specification sections. Training shall not take place until maintenance personnel have been given 2 weeks to review the approved operations and maintenance manuals. Notify the owner's representative 7 working days in advance of training sessions.

1.12 Materials List

- A. Submit a complete list of all materials and equipment and their manufacturers, for approval within two (2) weeks after award of contract, prior to submittal of shop drawings.
- B. Shop drawings will not be reviewed until the materials list has been reviewed and approved by the engineer.

1.13 Approved Manufacturers

- A. Approved manufacturers shall be as indicated herein and in accordance with the requirements of division 26. All manufacturers shall be subject to the approval of the

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engineer. Such approval concerns the manufacturer only and does not, in any way, act to permit any deviation from strict compliance with the requirements of these specifications.

1.14 Alternate Manufacturers

- A. For purposes of evaluating bids, the project shall be priced using the components specified herein. Any deviation from specified components or materials should be presented as a voluntary alternate price. Prices using alternates should not be included in the contractor's base bid price.

1.15 Substitutions

- A. Provide equipment and materials from the manufacturers specified. Substitutions for specified products are acceptable only if proposed and approved in writing at the time of bid.

1.16 Manufacturer's Instructions

- A. Installation of all materials and equipment shall be in accordance with the manufacturers operating instructions, installation instructions, service instructions, etc. If this information is not shipped with the equipment, this contractor shall obtain said information from the manufacturer at this contractor's cost.
- B. All operating instructions, installation instructions, service instructions, parts lists, etc. Shall be retained and on completion of the work, turned over to the engineer for the owner's use. If this information is not shipped with the equipment, this contractor shall obtain said information from the manufacturer at this contractors cost.

1.17 Grade of Materials and/or Equipment

- A. Do not purchase any used or second-hand material of any kind for use on this project.
- B. All items purchased for this contract shall be new, unused material and shall be manufacturer's first or specification grade and meet the approval of the engineer.

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C. In all instances where materials or methods indicate higher quality than the minimum required by codes, the plans and specifications shall govern.

D. All materials and equipment shall be listed by Underwriter Laboratories, Inc., and shall show their label wherever standards have been established.

1.19 Assembly of Equipment

A. The contract drawings and specifications make mention of numerous items to be purchased and installed and are noted by a manufacturer's name, catalog number, series and/or brief description.

B. The catalog number as mentioned may not be complete to designate all the accessory parts and appurtenances required for the particular use or function.

C. It shall be the responsibility of the contractor to provide the equipment complete with all accessories as required for a complete and operable system including all special finishes as indicated.

1.20 Use of Equipment

A. The use of any equipment or any part thereof for purposes other than testing even with the owner's consent shall not be construed to be an acceptance of the work on the part of the owner, nor to be construed to obligate the owner in any way to accept improper work or defective materials.

1.21 Equipment Connections

A. This contractor shall be responsible for final electrical connections to all light fixtures, power distribution equipment, lighting control equipment, security and communications equipment, etc.

B. Final connections shall be made in accordance with equipment shop drawings and rough in measurements furnished by the manufacturer of the particular equipment furnished.

1.22 Setting Drawings and Templates

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- A. Provide all necessary templates, patterns, etc., for installing work. Furnish setting plans and shop details as required. Templates, etc. Shall all be furnished in time to meet all construction schedules.

1.23 Equipment and Wiring Identification and Color Coding

- A. Provide a nameplate indicating the equipment name or number, and its power source.
- B. Nameplates shall be engraved 1/8" thick plastic with black letters on a white background, and letters at least 1/4" high. Nameplates shall be attached with a minimum of two mechanical fasteners such as sheet metal screws or bolts and nuts. Embossed plastic tape labels are not acceptable.
- C. Color code wiring in accordance with 260553 identification of electrical systems.
- D. Identify circuits and feeders, at each junction or pull box, by either writing in indelible ink the circuit number and panel name (when the panel is not adjacent) on the cover of the box, or by installing cable tags on all wires.
- E. Color code conduits and boxes for fire alarm wiring by either painting the box cover red, and/or using red conduit.
- F. Identify wiring devices as noted in 260553 identification of electrical systems.

1.24 Equipment Foundations and Supports

- A. The contractor shall be responsible for the installation and cost of all equipment foundations, supports, etc., required for the installation.
- B. Include all inserts, rods, structural steel, frames, brackets, etc. as required.

1.25 Cleanup

- A. Remove and legally dispose of demolished items, rubbish and debris from the construction site daily, and at the completion of the work. Failure to do so may result in the cleanup being performed by others and all costs thereof being deducted from the contractor's final payment.

1.26 Equipment Protection

- A. Protect equipment and materials during shipment, storage and construction against damage and contamination.
- B. Items that become damaged or contaminated shall be restored to a "like new" condition or replaced at the contractor's expense.

1.27 Work Performance

- A. Locate equipment as close as practical to the locations shown on the drawings. Should field conditions prevent the installation of equipment or materials as indicated on the drawings, make any deviations only with the prior approval of the owner's representative.
- B. Coordinate work with the other trades to ensure completion consistent with the project schedule. Do not unduly delay the startup, testing or turnover of project systems.
- C. Coordinate work with the other trades to ensure a safe working space around electrical equipment and to ensure access to equipment requiring maintenance (including motors, controls, panels, lighting, valves, filters, plumbing). Working space and access shall be sufficient for an adult to perform maintenance tasks safely without straddling or removing obstructions. Electrical work that encroaches on working space or that impedes maintenance shall be relocated at the contractor's expense.
- D. Coordinate work with the other trades to provide access doors to maintainable electrical equipment (including lighting fixture remote ballasts) located behind walls or above permanent ceilings.

1.28 Electronic Documents

- A. Electrical drawings in a cad format will be made available to the electrical contractor for use in preparing layout drawings, shop drawings, as-built drawings, etc. At the cost of \$30.00 per drawing payable to Berbiglia Associates, Inc. (BAI).
- B. The Electrical contractor shall include in his/her bid, costs for electronic drawings which they or their vendors, suppliers, etc. Will require for the project. Drawings will be provided via email or on compact disc, at the contractor preference in the format and version in which they were prepared. Drawings will include all addendums, bulletins or revisions issued as of the date of transmission or transmittal of the electronic media to the contractor. BAI assumes no responsibility for providing the contractor with future revisions or drawing updates in an electronic format. Vendors or suppliers desiring cad documents should request same from the electrical contractor. Because data stored as electronic media can be modified without Berbiglia Associates, Inc. Knowledge, the contractor agrees that BAI will not be held liable for the completeness or correctness of the electronic media after an acceptance period of 10 days after delivery of the electronic files. BAI stands by the accuracy of the hardcopy (prints, etc.) Which are included with documents distributed for the project. Any drawings produced from the electronic file(s) provided by BAI shall not be considered property of BAI, nor will BAI be held liable for such drawings. Contractor in using the electronic documents agrees to this provisions of this section. All drawing produced from the electronic files should be checked against the hard copy supplied to ensure accuracy and consistency. Due to the ever-increasing complexity and growth of electronic media viruses, it is mandatory that the contractor scan any disk or email received from BAI. While BAI takes great strides in trying to keep our system clean of viruses, occasionally one may be passed undetected. If any virus is detected by the contractor on any media received from BAI, please contact us immediately.

1.29 Temporary Facilities

- A. Temporary electric power as required for construction shall be coordinated with and obtained from the Detroit Edison Company.

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- B. Construction power shall be 120/240 volt service and branch wiring per OSHA lighting standard, subpart d, rule 1926.56 (a) and (b) for 120 volt lighting and small tool power.
- C. All construction power shall incorporate GFI (ground fault circuit interrupter protection).
- D. Complete installation shall be in compliance with all applicable codes.
- E. Provide ground fault protection on temporary feeders rated 200 amps and larger.
- F. Temporary feeders shall be limited to the following types:
 - 1. Conductors installed in raceways
 - 2. NEC type mc cable
 - 3. Multi-conductor cable with an overall outer jacket (only where inaccessible to the public and not subject to damage or abuse).
 - 4. NEC recognized hard usage cord or extra hard usage cord (only where inaccessible to the public and not subject to damage or abuse).
- G. Temporary wiring may either be copper or aluminum.

1.30 Warranty

- A. Guarantee work for a period of one year from the date of final acceptance of the project. A manufacturer's warranty beginning upon equipment receipt or startup shall be extended to one year from final project acceptance. A manufacturer's warranty in excess of one year shall remain in effect for its entire time period.

1.31 Certificate of Approval

- A. Upon completion of the building and/or systems, provide owner with certificate of approval from electrical inspection authority and fire marshal.

1.32 Testing, Acceptances and Guarantee

- A. When the systems are completed, the contractor shall operate equipment as required for complete testing. Replace all faulty equipment and make necessary adjustments before final acceptance. Upon final acceptance of work, the contractor shall give the owner a written guarantee that he

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will make good, at his own expense, any defects in materials or workmanship which develop within one (1) year from date of final acceptance.

- B. Tests shall include all installed systems, security equipment, distribution equipment, wiring, controls, etc.
- C. Provide four (4) complete operating instructions, operating manuals and repair parts list for the owner's personnel. Instruct owner's personnel in the operation of all systems.
- D. Perform all tests required by owner, state, city, county and/or other agencies having jurisdiction.
- E. Provide all materials, equipment etc., and labor required for the tests.

1.33 Coordination

A. Coordinate arrangement, mounting, and support of electrical equipment:

- 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
- 3. To allow right of way for piping and conduit installed at required slope.
- 4. So connecting raceways, cables, wireways, will be clear of obstructions and of the working and access space of other equipment.
- 5. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- 6. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in division 08 section "access doors and frames."
- 7. Coordinate sleeve selection and application with selection and application of firestopping specified in division 07 section "penetration firestopping."."

1.41 Rules Of Local Utility Companies

A. Work shall be done in accordance with the rules of local utility company.

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- B. All utility company charges associated with building services and service revisions, or service shutdowns shall be included in this bid.
- C. Coordinate all work with Detroit Edison.
- D. All electric service and metering equipment shall be in accordance with the Detroit Edison Company requirements.

END OF SECTION 260500

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, and XHHW.
- C. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTMA 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Stranded copper.
- B. Branch Circuits: Stranded Copper.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway
- D. Branch circuit wiring , limited to six feet, serving a light fixture from a junction box located in an accessible ceiling space. Type MC cable.
- E. Feeders Concealed below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

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Conductors and Cables

- E. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
 - F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
 - G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 - H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- 3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS
- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
 - B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
 - C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
 - D. Cut sleeves to length for mounting flush with both wall surfaces.
 - E. Extend sleeves installed in floors 2 inches above finished floor level.
 - F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
 - G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
 - H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant

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Conductors and Cables

appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."
- J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

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

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service

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Conductors and Cables

- entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Low-voltage control cabling.
2. Control-circuit conductors.
3. Identification products.

1.2 DEFINITIONS

- A. 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.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.
- C. Maintenance data.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of an NRTL.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry."

2.3 LOW-VOLTAGE CONTROL CABLE

- A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

- B. Provide low voltage cable as recommended by the manufacturer for the application.

2.4 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway power-limited cable, concealed in building finishes, complying with UL 83.

2.5 IDENTIFICATION PRODUCTS

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

1. Brady Corporation.
2. HellermannTyton.

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3. Kroy LLC.
 4. Panduit Corp.
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Pathway 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 room if multiple sheets of plywood are installed around perimeter walls of room.
 2. Install cable trays to route cables if conduits cannot be located in these positions.
 3. Secure conduits to backboard if entering room from overhead.
 4. Extend conduits 3 inches above finished floor.
 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:

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1. Comply with manufacturer's recommendations for the installation of cabling.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
6. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. Separation from EMI Sources:

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

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located in grounded metallic conduits or enclosures shall be as follows:

- a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 - 5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 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.

3.4 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- 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

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

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7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

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

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: All conduits serving wiring that is 120 volt or greater shall be equipped with an insulated green ground wire.
- B. Underground Grounding Conductors: Install barecopper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade.
- C. Conductor Terminations and Connections:
 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 10. Ground all cable tray.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

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- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus, unless otherwise noted on the drawings.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector

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to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. 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.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

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

END OF SECTION 260526

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 1. Trapeze hangers. Include Product Data for components.
 2. Steel slotted channel systems. Include Product Data for components.
 3. Equipment supports.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 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. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored 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 malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

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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, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.

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Hangers and Supports for Electrical Systems

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS
- A. Comply with installation requirements in Division 05 Section "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-PA1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
 - B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, cabinets, floor boxes and poke thru services for electrical wiring.

1.2 SUBMITTALS

- A. Product Data: For raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB1; listed for type and size raceway with which used, and for application and environment in which installed.

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Raceways and Boxes

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, set-screw or compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- B. LFNC: UL 1660.
- C. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- D. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper B-Line, Inc.
 2. Hoffman.
 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise required due to the location indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Nonmetallic Floor Boxes: Nonadjustable, round.

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- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
- I. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.5 FLOOR BOXES/POCKETS, ETC.

- A. The location of floor boxes, pockets, conduits, conduit stub ups, conduit sleeves, etc. indicated on plan are approximate only. The exact location shall be based on dimensioned locations provided by the architectural trades. The electrical contractor shall request dimensioned locations from the architectural trades in sufficient time as required to install the electrical work prior to the pouring of concrete floors or slabs. Do not install floor boxes, pockets, services, conduit stub ups, etc. without the dimensioned location.
- B. Floor conduits or boxes which are required to serve electrical, mechanical, architectural, building or the Owners equipment shall be located based on the conduit entrance location, conduit window location or equipment location indicated on equipment shop drawings, rough-in drawings or lay out drawings for the particular equipment or service. Electrical contractor shall request same from the manufacturer, vendor, supplier, contractor or trade in order to ensure conduits and/or boxes are properly located.
- C. Floor boxes and pockets must provide mounting hardware to mount outlets, jacks, connectors, etc. provided to serve data, telephone, lighting controls, technology, audio systems, visual systems, etc. Coordinate with the trade providing the jack or

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connector and include bracket(s) required to mount the jack or connector to be used.

- D. All floor boxes and pockets shall be connected with conduit to an accessible ceiling space in order to route low voltage wiring. Minimum size conduit stubbed to the ceiling space shall be 1.25". Provide multiple conduits or larger conduits where noted on plan.
 - 1. Recessed, flush, floor boxes shall be Wiremold RFB3 series with two duplex receptacles and two blank covers for future low voltage cables, unless noted otherwise on plan. Activation shall be aluminum with carpet insert, Wiremold S36CCTCAL series or approved equal

2.6 LADDER RACK

- A. General: Ladder rack of width indicated complete with tees, crosses, splice plates, adapters, hangers bonding lugs and other accessories designed for use exclusively with the rack and so designed as to enable "site" assembly, fitting and erection without the use of special tools.
- B. Ladder rack depth, width as indicated on plan. Finish shall be factory painted wire.
- C. Rack supports shall be in accordance manufacturer's recommendations.
 - 1. Include all accessories required for a complete installation.
 - 2. Field cut tray as required for installation.
- D. Tray shall be provided with a standard factory finish.
- E. Manufacturers: Cooper B-line or approved equal

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Underground Conduit for services: RNC, Schedule 40, direct buried.
 - 4. Underground Conduit for branch circuit wiring: RNC, Schedule 40, direct buried.

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Raceways and Boxes

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC LFNC.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 - a. Exposed and Subject to Physical Damage: Rigid steel conduit.
 2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: Rigid steel conduit.
 5. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size, unless noted otherwise on plan.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- 3.2 INSTALLATION
- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
 - B. 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. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
 - E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

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- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. 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.
- K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- L. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
 - 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - 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 the Outdoors without Physical Separation: 125 deg F temperature change.

- d. Attics: 135 deg F temperature change.
 - 2. 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.
 - 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- N. 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.
- O. Set metal floor boxes level and flush with finished floor surface.
- P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- 3.3 INSTALLATION OF UNDERGROUND CONDUIT
- A. Direct-Buried Conduit:
- 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 31 Section "Earth Moving."
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

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4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 EXCAVATION AND BACKFILL

- A. All excavating and backfilling to install work specified in the Electrical Division shall be by the Electrical Contractor. All work shall be in accordance with the requirements of the appropriate Architectural Section.
- B. Backfill inside building and under drives and parking areas with well tamped sand. Backfill within 45 degree angle below footing with lean mix concrete. Backfill under drives and parking areas shall be placed in layers not more than 8" in thickness. 95% compaction is required throughout with approved compaction equipment. Tamp and roll as required. Excavated material shall not be used.
- C. Backfill outside building with sand to a height of 12" over top of pipe. Compact to compaction as specified above. Backfill remainder of excavation with unfrozen excavated materials in such a way as to prevent settling.
- D. Electrical Contractor shall be responsible for dewatering of excavations required for the installation of electrical work.
- E. After the installation of conduits within excavations, but prior to backfilling, the Electrical Contractor shall notify the Engineer for inspection of the installation. Excavations shall not be backfilled until inspected by the Engineer. It shall be the Electrical Contractors responsibility to make the necessary arrangements as required for the inspection.

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3.5 TESTING DUCTS AND CONDUITS FOR OBSTRUCTIONS

- A. Ducts and conduits which are installed underground or concealed in concrete floor slab, foundations, etc., shall be cleared of foreign material and obstructions after installation and before conductors or pull-wires are drawn in by wire brushing, swabbing and employing an iron or hardwood mandrel which is 1/4" smaller in diameter than the internal diameter of the duct or conduit.
- B. The installation of conductors or pull wire shall not be made until the raceways are found acceptable.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- 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.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
 2. Legend: Indicate voltage.

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- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage.
- C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

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- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

- 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

- D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

- 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.5 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:

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1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft..
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK
HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select 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 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 30-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems

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with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
 2. Power.
- C. 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 Identification, 600 V or Less: Use colors listed below for ungrounded service and feeder 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.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags 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.

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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 the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
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.
- J. 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.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for Insert emergency operations.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations,

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terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Adhesive film label Adhesive film label with clear protective overlay Self-adhesive, engraved, laminated acrylic or melamine label Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
 - 2. Lighting contactors.
- B. See Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Lighting.
 - 2. Novitas, Inc.
 - 3. Sensor Switch, Inc.
 - 4. Watt Stopper (The).

- C. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- D. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceilings.
- E. Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.
- F. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

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- G. Submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor.
- H. Submit any interconnection diagrams per major subsystem showing proper wiring.
- I. Submit standard catalog literature which includes performance specifications indicating compliance to the specification.
 - A. Catalog sheets must clearly state any load restrictions when used with electronic ballasts.
 - B. It shall be the manufacturer's responsibility to verify all proper adjustments and train owner's personnel to ensure owner's satisfaction with the occupancy system. This service shall be provided at no additional cost.
- J. The listing of any manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for sensors which meet or exceed the specifications included herein.

1. Products:

- 1. Product numbers are indicated on plan to provide general equipment requirements. Exact product numbers shall be as determined applicable by the manufacturer to meet system requirements indicated on plan and here in specified.
- C. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

D. Installation:

- 1. It shall be the manufacturers responsibility to determine proper quantities of sensors and the contractor's responsibility to provide, locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate final locations or quantities. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- 2. It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.
- 3. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation,

- use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.
4. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. This service is provided at an additional cost.
- The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the scheduled commissioning date. Upon completion of the system fine tuning the factory authorized technician shall provide the proper training to the owner's personnel in the adjustment and maintenance of the sensors.

2.2 LIGHTING CONTACTORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 3. GE Industrial Systems; Total Lighting Control.
 4. Square D; Schneider Electric.
 5. TORK.
- C. Description: Electrically operated and electrically held, combination type with, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.

2.3 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lighting Control and Design, Inc.
 2. Bodine

3. 924 Inc.

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 V.

2.4 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 PERFORMANCE REQUIREMENTS

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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 distribution panelboards and overcurrent protective devices shall be as listed below.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices shall be as listed below.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include wiring diagrams for power, signal, and control wiring.
 - 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
- C. Field quality-control reports.
- D. Panelboard schedules for installation in panelboards.
- E. Operation and maintenance data.

1.4 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 NEMA PB 1.
- C. Comply with NFPA 70.

1.5 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: One years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top or bottom as required.
- C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.

3. Ground Lugs and Bus Configured Terminators: Compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.2 DISTRIBUTION PANELBOARDS

- 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. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: As scheduled on the drawings.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Minimum ACI rating for distribution panels shall be 42K AIC.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As scheduled.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals (22K AIC minimum for 208 volt systems, 42K AIC for 480 volt systems).
- 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES
- 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. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.

- d. Ground-fault pickup level, time delay, and I^2t response.
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- 5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 407.
- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- D. 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.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. 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."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test 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.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes

scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 ARC FLASH

- A. The distribution equipment manufacturer shall prepare an Arc-Flash Hazard Study in order to ensure that the equipment is manufactured and labeled with arc flash requirements, in accordance with all applicable codes, regulations and standards including the following:

NEC (NFPA 70) National Electrical Code, 2002
NFPA National Fire Protection Association
ANSI American National Standards Institute
IEEE Institute of Electrical and Electronics Engineers
NEMA National Electrical Manufacturers Association
UL Underwriters Laboratories, Inc.
ETL Electrical Testing Laboratories
OSHA Occupational Safety and Health Act
MICH State of Michigan requirements

- B. The Arc-Flash Hazard Study shall apply to all new and existing distribution equipment including switchboards, switchgear, distribution panels, circuit breaker panels, etc. The study shall determine the requirements for, but not limited to, the following:
Arc-Flash Incident Energy (AFIE) levels
Arc Flash Boundary (AFB)
Personal Protective Equipment (PPE)
- C. The Arc-Flash Hazard Study shall be performed with the aid of computer software intended for the purpose of calculating the Arc-Flash Incident Energy levels and determining the Flash Protection Boundary distances.
- D. Any additional power distribution system studies necessary to complete the Arc-Flash Hazard Analysis shall be included including short circuit and coordination studies.
- E. The Arc-Flash Hazard Study shall be documented in a logical and organized tabular form and shall include all new distribution equipment including input and output overcurrent devices and/or bus names and nodes. For each, provide bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and Arc-Flash Incident Energy levels. The Arc-Flash Hazard Study shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

- F. The Arc-Flash Hazard Study shall be performed by a professional engineer registered by the State of Michigan. The study shall bear the engineers seal.
- G. The Arc-Flash Hazard Study shall be performed in compliance with IEEE Standard 1584-2002, the IEEE Guide for Performing Arc-Flash Calculations.
- H. The Arc-Flash Hazard Analysis shall, where appropriate shall include recommendations for reducing AFIE levels and enhancing worker safety.
- I. The distribution equipment manufacturer shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.
- J. The distribution equipment manufacturer shall demonstrate experience in providing equipment labels in compliance with NEC-2002 section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.
- K. All distribution equipment shall be provided with labeling indicating the flash hazard boundary distance, incident energy level, PPE category and shock hazard.
- L. The Arc-Flash Hazard Study shall clearly identify unsafe working locations. Unsafe working locations shall be those locations having incident energy levels in excess of available PPE ratings. Unsafe working locations shall be clearly identified.
- M. All labeling shall be factory or field applied by the distribution equipment manufacturer.
- N. All labeling shall be accomplished with OSHA approved labels specifically intended for arc fault labeling.
- O. All distribution equipment shall be labeled prior to energization of equipment.
- P. Acceptance by the Owner, or the Owners designated representative, of the Arc-Flash Hazard Study as well as the identification of bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and Arc-Flash Incident Energy levels, both in the report and labeled on the equipment, shall be a condition of acceptance.
- Q. Arc-Flash Hazard Study shall be submitted with distribution equipment shop drawings.

**Section 262416
Panelboards**

END OF SECTION 262416

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Wall-box motion sensors.
3. Snap switches.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. General use receptacles shall be duplex, 2 wire, 3 pole, self-grounding type with standard parallel slots to accommodate both regular and ground type plug caps. Receptacles shall be with white (verify with the architect) face, 20 Amp., and bear UL labels for ratings at 125 volts AC. Install receptacles vertically with bottom of box 18" above the finished floor unless otherwise indicated.
 1. Receptacles used in unfinished areas such as mechanical equipment rooms, Server etc. shall be Hubbell #5362 or equal Arrow-Hart, Bryant, Cooper or P & S.
 2. Receptacles for use in all finished areas shall be designer type such as Hubbell Style Line series # 2162 or equal Arrow-Hart, Bryant, Cooper or P & S.
 3. All receptacles used in the Kitchen Area shall be GFCI type. Ground fault receptacles shall be duplex, 2 wire, 3 pole, self-grounding type with standard parallel slots to accommodate both regular and ground type plug caps. Receptacles shall be with white face, 20 Amp., and bear UL labels for ratings at 125 volts AC. Hubbell series # GF5362 or equal Arrow-Hart, Bryant, Cooper or P & S.

2.3 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Local wall switches shall be specification grade, decorator style rocker switches, 20 Amp., 120 volt rated, non-mercury toggle switches with white (verify with the architect) operating handles. Switches shall be mounted 4'-0" (to center) above finished floor. Note: All wiring shall originate from the ceiling lighting fixture and not from direct floor slab connections to lighting panels.
 1. Switches for use in all finished areas shall be designer type such as Hubbell Style Line series # 2121 or equal Arrow-Hart, Bryant, Cooper or P & S.
 2. Provide switches with integral motion detection where indicated on plan.

3. Low voltage switches shall be a decorator style that is compatible with the low voltage lighting control system.
 - C. Where more than one switch is to be installed in one location or where flush motor starting switches are installed adjacent to light switches, gang boxes and one-piece gang plates shall be used.
 - D. Switches used in unfinished areas such as mechanical equipment rooms, Server, etc. shall be Hubbell #1221 Series or equal Arrow-Hart, Bryant, Cooper or P & S.
 - E. Key-Operated Switches, 120/277 V, 20 A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 3. Description: Single pole, with factory-supplied key in lieu of switch handle.
- 2.4 OCCUPANCY SENSORS
- A. Wall-Switch Sensors:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6111 for 120 V, 6117 for 277 V.
 - b. Hubbell; WS1277.
 - c. Leviton; ODS 10-ID.
 - d. Pass & Seymour; WS3000.
 - e. Watt Stopper (The); WS-200.
 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..
- 2.5 WALL PLATES
- A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished stainless steel.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.6 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: White or as selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.

2.7 POKE THRU FITTINGS

1. Through floor poke thru fittings shall be used to provide 120 volt and low voltage services to workstations, equipment and electrified furniture partitions. Poke thru fittings shall provide a 2 hour fire rating.
2. Poke thru fittings used to serve electrified furniture partitions shall serve 120 volt power and low voltage wiring.
3. Poke thru fittings used to provide 120 volt power and/or low voltage wiring to furniture partitions shall be with a minimum 1 1/4 " diameter conduit for low voltage use. Where poke through fittings are serving furniture only, the fitting shall allow for low voltage cables to be routed through the fitting to the furniture partition. 120 volt power to the furniture system shall be accomplished with a whip connection from the furniture system to the poke through fitting. Wiremold 4FFATC series, assembled furniture feed unit, or approved equal. Electrical contractor shall provide necessary junction box below for low voltage wiring. Data conduit shall be routed below floor and up the wall to the accessible ceiling of the floor being served. Color as selected by the architect.

4. Where poke thru fittings are serving equipment or free standing workstation locations, and both low voltage service and 120 volt power is required, the poke through fitting shall provide a 120 volt duplex receptacle and provisions for up to four (4) RJ-45 jacks protected by sliding spring loaded dead front covers. Wiremold RC9 series or approved equal. Color as selected by the architect.
5. Poke thru devices that serve AV equipment shall be Wiremold AV3 series with an AV3SHTCBK series lid. Confirm all requirements with the owner's AV consultant prior to submitting.
6. Poke thru fittings shall provide the following services
 - a. 120 volt duplex receptacle and low voltage datacom jacks as herein specified.
 - b. 120 volt duplex receptacle only.
 - c. Low voltage datacom jacks only
 - d. Electrified furniture power and low voltage service.
7. Poke thru fittings shall be with brushed aluminum face with black trim ring.
8. Poke thru fittings shall be Walker RC9 series. Verify exact faceplate requirements relative to low voltage outlets, ports, connectors, etc. prior to ordering. Submit poke thru shop drawings to the Owners Technology Consultant and receive approval of the provisions included for voice, data and/or audio visual use prior to ordering. Verify color selection with architect, prior to ordering.
9. Poke thru fittings shall be UL Scrub Water listed.
10. All receptacles provided with poke thru fittings shall be 20 amp, 125 volt.
11. The inside face of coverplate serving all poke thru's, shall be labeled with the circuit(s) serving the device or furniture partition. Utilize a nylon label maker to indicate circuit number.
12. Submit shop drawings on poke thru fittings.

2.8 FLUSH FLOOR POCKETS

1. Flush floor pockets shall be manufactured by Walker as herein specified. Flush floor boxes for 120 volt and low voltage services, shall be stamped steel for shallow floor installation. Floor boxes shall be four compartment combination type. Two compartments shall be used for two (2) 20 amp duplex receptacles. Two other compartments shall be used for low voltage data, telephone and audio/visual jacks or connectors.
2. Floor Pockets shall be Walker RFB4-SS series.
3. Floor box shall include dual flip lids which shall allow cable passage. Lid shall be accommodate carpet insert where used in carpeted area. Lid trim shall be black.
4. Submit shop drawings on floor pockets.
5. Floor pockets shall be UL Scrub Water listed.
6. All receptacles provided with poke through fittings shall be 20 amp, 125 volt.
7. The inside face of coverplate serving all floor pockets shall be labeled with the circuit(s) serving the device. Neatly hand write the circuit number with an indelible marker or provide plastic adhesive label.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard

device plates do not fit flush or do not cover rough wall opening.

- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 ELECTRIFIED FURNITURE PARTITION FEEDS

- 1. The location of wall and floor feeds installed to serve electrified furniture must be located to minimize the visibility of whips and cables and to make the installation as aesthetically pleasing as possible as well as maintain accessibility to boxes, splices, connections, etc. The location of such boxes must be coordinated and with the furniture system installer and architectural trades.
- 2. The locations indicated on plan are to establish a concept only. Exact and final location must be established in the field based on coordination with the furniture system installer and architect.
- 3. The location of floor boxes, poke through fittings, etc. to serve power and voice/data needs must be located based on dimensioned locations. The location of such boxes must be coordinated and with the furniture system installer and architectural trades. Do not locate floor boxes without having received the dimensioned locations.

3.4 POKE THRU DEVICE AND FLOOR BOX INSTALLATION

- A. Installation shall be in accordance with manufacturer's recommendations.
- B. Prior to installation, the location of all poke thru floor fittings shall be verified in the field with architectural trades to best serve furniture partition, work station or equipment indicated. Final location of poke thru floor fittings

indicated on plan shall be determined by the architectural trades and shall be so located at no additional cost. Do not install poke thru fittings without having received dimensioned locations from the furniture installer or architect. All requests for dimensioned locations shall be made no less than 14 days prior to when the dimensions are required.

- C. All floor coring required for the installation of poke thru fittings shall be by the electrical contractor.
- D. Prior to installation, the location of all flush floor pockets shall be verified in the field with architectural trades to best serve furniture, work station or equipment indicated. Final location of flush floor boxes indicated on plan shall be determined by the architectural trades and shall be so located at no additional cost. Do not install floor pockets without having received dimensioned locations from the furniture installer or architect. All requests for dimensioned locations shall be made no less than 14 days prior to when the dimensions are required.
- E. The cost of all cutting and patching required to install flush floor pockets shall be included in the electrical contractors bid.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION 262726

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in control circuits enclosed switches and distribution panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 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 NEMA FU 1 for cartridge fuses.
- C. Comply with NFPA 70.

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: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Feeders: Class RK1, time delay.
- B. Motor Branch Circuits: Class RK1, time delay.
- C. Other Branch Circuits: Class RK1, time delay.
- D. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

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

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 262813

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Multispeed.

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
- D. Field quality-control reports.
- E. Operation and maintenance data.

1.4 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 NFPA 70.
- C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. Show controller pole quantities, voltage, NEMA size and type, accessories, short-circuit current rating (or available short-circuit currents), and enclosure type for each controller on Drawings. See "Full-Voltage Controllers" Article in the Evaluations for selection considerations. Enclosed controllers without integral OCPDs (e.g., fuses, MCPs, or thermal-magnetic circuit breakers) may have very low short-circuit current ratings when used in series with upstream devices. See Editing Instruction No. 2 in the Evaluations.
- B. Not all features, accessories, and options in this article are available for every rating, with every enclosure type, and from every listed manufacturer. Verify availability and unique characteristics with manufacturers. Show on Drawings those features and accessories that apply to each controller.
- C. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- D. Motor-starting switches do not have integral overload relays. See "Motor-Starting Switches" Article in the Evaluations for additional guidance on their use.
- E. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

- c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
- 2. Configuration: Nonreversing.
 - 3. Surface mounting.
 - 4. Pilot light.
- F. One- and two-pole, fractional horsepower manual controllers are suitable for use with single-phase ac motors up to 1 hp. See "Fractional Horsepower Manual Controllers" Article in the Evaluations for additional guidance on their use.
- G. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 - f. Insert manufacturer's name.
 - 2. Configuration: Nonreversing.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 - 4. Surface mounting.
 - 5. Pilot light.
- H. One-, two-, and three-pole integral horsepower manual controllers are suitable for use with single- and three-phase ac motors up to 10 hp at 480-V ac. See "Integral Horsepower Manual Controllers" Article in the Evaluations for additional guidance on their use.
- I. Three-pole integral horsepower magnetic controllers are suitable for use with three-phase ac motors up to 1600 hp, and from NEMA ICS 2, Size 00 to Size 9; however, not all listed manufacturers offer enclosed controllers up to Size 9. Two- and four-pole models are also available in varying minimum and maximum horsepower ratings and NEMA sizes. See "Magnetic Controllers" Article in the Evaluations for additional guidance on their use.

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J. Magnetic Controllers: Full voltage, across the line, electrically held.

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

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- c. Rockwell Automation, Inc.; Allen-Bradley brand.
- d. Siemens Energy & Automation, Inc.
- e. Square D; a brand of Schneider Electric.

K. Individual three phase motor starters shall be in NEMA 1 general purpose enclosures. All three phase motor starters shall be equipped with "Hand-Off-Auto" selector switches mounted on the starter cover unless otherwise noted or required. Starters shall be of the combination type, consisting of a full voltage magnetic starter equipped with three internal manual reset thermal overloads, a fused disconnect switch for short circuit protection and disconnecting means, with dead front operation and provisions for locking in the "closed" and "open" position. Each starter shall come complete with two normally open and two normally closed interlock contacts in addition to the normally open seal-in contacts. Starters shall be provided with a 120 volt holding coil (or as required) and a fused secondary 208/120 volt (or as required) control transformer. Fused disconnect switch units comprising a part of combination starter and contactor assemblies shall be three pole, 600 volt rated, quick-make, quick-break, . horsepower rated, sized to accommodate a dual element type fuse of 150% of motor full load current.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Kitchen Areas: Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 ACCESSORIES

A. Push Buttons, Pilot Lights, and Hand Off Auto Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.

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- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings. All three phase motor starters provided by this contractor shall include under voltage/single phasing protection. Provide in the starter control circuit an under voltage/single phasing protection relay monitoring the 208 volt power of all three phases. When the loss of any phase occurs or when the voltage of any phase drops below a predetermined level of 87%, field adjustable from 80% to 92%, the motor shall be automatically taken off line by opening of the starter power contacts. Voltage drop caused by the motor starting current shall be transparent to the voltage sensing circuit. Restoration of the motor starter to normal operating conditions shall occur automatically when the single phasing or under voltage condition is eliminated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Install fuses in each fusible-switch enclosed controller.
- C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- D. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- E. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.
- B. Connect selector switches and other automatic-control selection devices where applicable.
 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Inspect controllers, wiring, components, connections, and equipment installation.
 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 - D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
 - E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.5 ADJUSTING
- A. Set field-adjustable switches and overload-relay pickup and trip ranges.
 - B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- 3.6 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Exit signs.
 - 3. Lighting fixture supports.
- B. See Division 26 Section "Lighting Control Devices" for automatic control of lighting..

1.2 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- D. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In the Lighting Fixture Schedule, available manufacturers are subject to compliance with requirements, manufacturers offering products that may be incorporated into the work must be submitted to the engineer, 10 days prior to the bid date.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.

2.3 BALLASTS

- A. Unless required to meet the requirements listed in the lighting fixture schedule, the following shall serve as the minimum ballast requirements.

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- B. Electronic Ballasts for Linear Fluorescent Lamps: Comply with ANSIC82.11; programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 10 percent.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Operating Frequency: 20 kHz or higher.
 5. Lamp Current Crest Factor: 1.7 or less.
 6. BF: 0.85 or higher.
 7. Power Factor: 0.95 or higher.
- C. Electromagnetic Ballasts for Linear Fluorescent Lamps: Comply with ANSIC82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- D. Ballasts for Temperatures Minus 20 Deg F and Higher for Linear Fluorescent Lamps: Electromagnetic type designed for use with indicated lamp types.
- E. Ballasts for Dimmer-Controlled Lighting Fixtures with Linear Fluorescent Lamps: Electronic type.
1. Dimming Range: 100 to 10 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- F. Ballasts for Compact Fluorescent Lamps: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher, unless otherwise indicated.
 9. Power Factor: 0.95 or higher.

- G. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
 3. Normal Ambient Operating Temperature: 104 deg F.
 4. Open-circuit operation that will not reduce average life.
 5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- H. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Sound Rating: A.
 3. Total Harmonic Distortion Rating: Less than 15 percent.
 4. Transient Voltage Protection: IEEE C62.41, Category A or better.
 5. Lamp Current Crest Factor: 1.5 or less.
 6. Power Factor: .90 or higher.
 7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 8. Protection: Class P thermal cutout.

2.4 EXIT SIGNS

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

2.5 LAMPS

- A. Low-Mercury Fluorescent Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 Rapid-Start low-mercury Fluorescent Lamps: Rated 32 W maximum, nominal length 48 inches, 2800 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

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- C. T8 Rapid-Start low-mercury Fluorescent Lamps: Rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
 - D. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 Insert value K, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.
 - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
 - 6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).
 - E. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 3500 K.
- 2.6 LIGHTING FIXTURE SUPPORT COMPONENTS
- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
 - B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
 - C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
 - D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
 - E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
 - F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
 - G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
- E. Adjust aimable lighting fixtures to provide required light intensities.
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Poles and accessories.
- B. See Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 SUBMITTALS

- A. Product Data: For each luminaire, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C2, "National Electrical Safety Code."
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

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Exterior Lighting

- M. Factory-Applied Finish for Steel Luminaires: Color as selected by Architect. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- N. Factory-Applied Finish for Aluminum Luminaires: Color shall be as indicated in the lighting fixture schedule.

2.3 BALLASTS FOR HID LAMPS

- A. Comply with ANSIC82.4 and UL1029 and capable of open-circuit operation without reduction average life. Include the following features, unless otherwise indicated:
 - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2. Minimum Starting Temperature: Minus 22 deg F.
 - 3. Normal Ambient Operating Temperature: 104 deg F.
 - 4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.4 HID LAMPS

- A. Metal-Halide Lamps: ANSIC78.1372, with a minimum CRI 65, and color temperature 3500 K.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

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1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

2.6 STEEL POLES

- A. Refer to the lighting fixture schedule for pole requirements. The specification shall serve to support the lighting fixture schedule. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
1. Shape: Square, straight.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation.
- B. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- C. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Color shall be as specified and as verified by the Architect.

2.7 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers, unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- D. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete

materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

END OF SECTION 265600