

**LASELLS STEWART CENTER MECHANICAL & ROOF
RENEWAL**

EXHIBIT G.3 – SPECIFICATIONS VOLUME 3



Oregon State
University

**Construction Contracts Administration
Oregon State University
644 SW 13th Ave.
Corvallis, Oregon 97333**



PROJECT MANUAL FOR:
LaSells Stewart Center Mech and Roof Renewal
OREGON STATE UNIVERSITY (OSU)
PERMIT SET

BA PROJECT No. 2108
OSU PROJECT No. 2240-21
VOLUME 3 - DIVISIONS 26 - 28
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PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Basic electrical requirements for all Division 26 Sections

1.02 SCOPE OF THIS SECTION

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:

1. Compliance with all codes and standards applicable to this jurisdiction
2. Shop Drawings for Equipment
3. Coordination Documents
4. Record Drawings
5. Start-up Service and Building Commissioning
6. Instruction, Maintenance, and O & M Manuals
7. Work associated with Delivery, Storage, and Handling of products
8. Work associated with provision of Temporary Facilities
9. Preparation of Posted Operating Instructions
10. Meeting Project Safety and Indemnity requirements
11. Proper Cleaning and Closing
12. Supplying proper Warranty information
13. Supply specified Guarantee documentation
14. Design and provision of Supports and Anchors
15. Access Panels and Doors
16. Identification Markers

1.03 QUALITY ASSURANCE

- A. Provide equipment and materials which conform to the standards effective as of the date of the Contract Documents as promulgated by the following bodies:

1. Underwriters' Laboratories (UL)
2. National Electrical Manufacturers' Association (NEMA)
3. Electrical Testing Laboratories (ETL)
4. American National Standards Institute (ANSI)
5. Insulated Cable Engineers Association (ICEA)

1.04 SUBMITTALS

- A. Submit electronic copies of manufacturer's submittal sheets or shop drawings for major items of electrical equipment and for any items specifically requested by the Electrical Engineer. When possible, make all electrical submittals at the same time.

1.05 INSTALLATION DRAWINGS

- A. Prepare dimensionally accurate floor plans of each electrical and signal room and/or closet, fire control room and the like, drawn to 1/4" scale minimum. Submit electronic copies for review with two prints for Architect's record. Indicate all equipment within the rooms to scale based on shop drawing data, include structural support for suspended equipment. Indicate system and equipment grounding details as applicable. Review elevator machine room shop drawings and coordinate location of electrical gear to maintain clearances. Submit with shop drawings.
- B. Where conduit runs, 2" trade size and larger, are run in exposed locations, prepare dimensionally accurate floor plans indicating routing, coordinated with work of other trades and the structure. Submit legible reproducible transparencies with two prints for review.
- C. Prepare dimensionally accurate floor plans showing the routing of the secondary feeder from the utility transformer to the main electrical room.
- D. Prepare dimensionally accurate floor plans showing the routing of the busway through the building.
- E. Prepare dimensionally accurate floor plans showing device locations, including mounting heights, for each unique dwelling unit type, including healthcare levels, as well as common spaces. Devices include outlets, switches, etc.

1.06 PROJECT RECORD DOCUMENTS

- A. Maintain Record Documents which clearly indicate variances from the specified systems and which accurately locate all underground electrical conduits and structures.

1.07 EXAMINATION OF DOCUMENTS

- A. Before submitting a bid, visit the Project Site and become familiar with conditions which may be pertinent to, or affect the cost of, the electrical installation.
- B. Become acquainted with the Work of other installers whose activities will adjoin or be affected by the electrical Work. Consult with these other installers and study all pertinent Drawings in order to coordinate the Work and to avoid conflicts, omissions and delays.

1.08 PERMITS AND FEES

- A. Obtain and pay for all necessary electrical permits and fees.

1.09 SUBSTITUTIONS

- A. Refer to other Sections of these Specifications for substitution requirements.

1.10 DRAWINGS

- A. For purposes of clarity and legibility, the electrical Drawings are essentially diagrammatic. although the size and location of electrical equipment is drawn to scale wherever possible, make use of all data in all of the Contract Documents, and verify this at the Project Site. Determine the exact location of conduits, outlets and equipment by the study of details, shop drawings and/or the Architect's directions.
- B. The electrical Drawings show the required size and points of termination of the conduits and the quantity and size of the conductors within. However, the Drawings do not show all of the necessary conduit bends. Install conduits in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep passageways and openings clear.
- C. Locate outlets symmetrically with architectural elements, notwithstanding the fact that the locations shown of the electrical drawings may be distorted for clarity of representation.
- D. The architectural Drawings take precedence over the electrical Drawings. Study the reflected ceiling plans and interior elevations to determine the exact location of lighting fixtures, wall-mounted devices and fixtures, etc. Should there be a conflict between locations shown on the architectural and electrical drawings, contact the Engineer for clarification prior to rough-in.
- E. Before submitting a bid, examine all pertinent Contract Documents for electrical requirements which are not necessarily indicated on the electrical Drawings and include in the bid a sum which is sufficient to cover the costs of these other requirements.
- F. Should it be perceived that the Contract Documents do not sufficiently define the required electrical work, contact the Architect for clarification or further description. Failure to do this will be construed as evidence of an understanding of the required electrical systems and their installation.

1.11 VERIFICATION OF AVAILABLE SPACE

- A. Throughout the course of construction, verify that sufficient space will be available for the equipment to be installed.

1.12 IDENTIFICATION MARKINGS

- A. Switchboards, distribution and branch panelboards, terminal cabinets and other miscellaneous electrical equipment shall be identified with laminated black and white engraved plastic nameplates which properly identify each item. Nameplates shall be attached with steel rivets or bolts and nuts.

1.13 GENERAL REQUIREMENTS

- A. Examine all existing conditions at building site.
- B. Review contract documents and technical specifications for extent of new work to be provided.
- C. Provide and pay for all permits, licenses, fees and inspections.

- D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for access.
- E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 26 for rough-in requirements.
- F. Coordinate electrical equipment and materials installation with other building components.
- G. Verify all dimensions by field measurements.
- H. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- J. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- K. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
- L. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
- M. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components.
- N. Coordinate the installation of electrical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.
- O. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- P. All materials located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- Q. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.14 MINOR DEVIATIONS

- A. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include
 - 1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
 - 2. Minor deviations from the electrical plans required by architectural and structural coordination.
- B. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Mechanical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.
- C. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.
- D. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.15 COORDINATION DOCUMENTS

- A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.
- B. The Drawings shall be prepared as follows:
 - 1. Mechanical Subcontractor shall be responsible for and lead the coordination of the mechanical, plumbing, fire protection, controls and electrical work. Subcontractor shall complete detailed coordination drawings for this Bid Package scope of work in accordance with the contract documents. Subcontractor shall assign a detailer to this project who shall take the lead in coordinating drawings with other subcontractors to ensure all systems will be installed without conflict. Coordination drawings shall be

produced utilizing the format directed by the general contractor and consistent with other trades. Coordination drawings shall be drawn to the specified scale of the Structural 3d model. The structural steel drawing model plans will be provided to the Subcontractor in the same format for coordination. The Mechanical Subcontractor shall provide the coordination drawings on disk and printed plans, which will then be forwarded to the Plumbing, Electrical, and Fire Sprinkler Subcontractors for their use in overlaying their work in the coordination drawings. Coordination Drawings must consist of more than overlaid plan views. Sections and elevations must be included as required to verify that everything fits. Include ceiling spaces as well as wall elevations. Subcontractor shall provide and allow costs for collision checking of all mechanical, electrical, fire sprinkler piping, waterslide, structure and rough-in and shall review submitted coordination drawings as well as manage meetings to resolve conflicts. Subcontractor shall overlay 3D drawings and or drafted shop drawings for review. Conflicts shall be identified and recommended resolution shall be submitted to design for review. Please note this effort is above and beyond normal project coordination responsibilities typically found on other projects. Subcontractor's detailing personnel shall participate in joint coordination meetings with other Subcontractors on the project. Subcontractor shall adequately staff and lead the detailing efforts to insure fast track schedule requirements are met.

2. The Plumbing Contractor shall obtain access to the latest models created to date and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor. Drawings should be presented in the format directed by the general contractor and consistent with other trades. Plumbing contractor detailer will be required to attend all MEP coordination meetings for coordination of their work with all other trades.
 3. The Fire Protection Contractor shall obtain access to the latest models created to date. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor. Drawings should be presented in the format directed by the general contractor and consistent with other trades. Fire protection detailer will be required to attend all MEP coordination meetings for coordination of their work with all other trades.
 4. The Electrical Contractor shall obtain access to the latest models created to date, and indicate all electrical distribution equipment and power generation equipment with required clearances, feeders over 100 amps, conduit racks containing more than four conduits, cable trays, electrical connections to Mechanical equipment, proposed ceiling grid and lighting layout. Drawings should be presented in the format directed by the general contractor and consistent with other trades. Electrical subcontractor detailer will be required to attend all MEP coordination meetings for coordination of their work with all other trades.
 5. Plans are to incorporate all addenda items and change orders.
 6. Distribute plans to all trades and provide additional coordination as needed.
- C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.
- D. Provide means of access to all junction boxes, disconnect switches, controllers, operable devices, and other apparatus that may require adjustment or servicing.
- E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.
- F. Provide copy of Record Drawings to Commissioning Agent for their use when doing their work.

1.16 RECORD DRAWINGS

- A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record." Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,
 - 1. Edit project files to incorporate all site markups, changes, and revisions to the Contract Drawings.
- B. Mark Drawings to indicate revisions to raceways; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground raceways; concealed equipment, dimensioned to column lines; Change Orders.
- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.
- D. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.17 WATERPROOFING

- A. Wherever electrical Work pierces waterproofing or waterproofing membranes, install it in an approved watertight manner.

1.18 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.
- B. Provide new electrical materials and deliver them to the Project Site in unbroken packages.

1.19 CUTTING AND PATCHING

- A. Provide core drilling, cutting and patching of existing construction and surfaces for the installation of electrical systems. Concrete, asphalt or plaster surfaces which have been damaged by such drilling or cutting shall be patched and repaired to match the surrounding surface.

1.20 ADJUST AND CLEAN

- A. Keep the Project Site free from accumulations of electrical rubbish and debris. Remove such accumulations from the Project Site.
- B. Thoroughly clean electrical equipment and materials of plaster, cement and other foreign materials and leave smooth, clean and dry.

1.21 FIELD QUALITY CONTROL

- A. At project Completion or upon request of the Architect anytime, make necessary tests under the observation of the Architect which will ensure that electrical equipment, materials and installation methods are as specified.
- B. At Project Completion, test electrical loads and controls under full operating conditions and immediately replace, at no cost to the Owner, defective electrical equipment, devices and workmanship. Make standard electrical equipment, materials and performance tests and also tests as may be required by the Architect, such as electrical insulation and ground resistance, or temperature rise.
- C. Closing-in of Work: Do not allow Electrical Work to be covered or enclosed until it has been observed by the Architect's Representative. Should unobserved Electrical Work be covered or enclosed, uncover it for observation and then make repairs as necessary to restore the Electrical Work and the Work of other affected installers to its original and proper condition, at no cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
- B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.02 ACCESS PANELS AND ACCESS DOORS

- A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.
- B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
- C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

- D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.03 SLEEVES FOR RACEWAYS AND CABLES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2-inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Adjust list below to suit Project.
 - 2. Building wires and cables rated 600 V and less.
 - 3. Connectors, splices, and terminations rated 600 V and less.

1.03 DEFINITIONS

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

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control test reports.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

- 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:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70. Copper conductors of 98 percent conductivity shall be used.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW.

2.02 CONNECTORS AND SPLICES

- 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:
 - 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.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid or stranded for No. 14 AWG and smaller; stranded for No. 12 AWG and larger.
- B. Branch Circuits: Copper. Solid or stranded for No. 14 AWG and smaller; stranded for No. 12 AWG and larger.
 - 1. Minimum size for lighting and power branch circuits: No. 12 AWG

2. Use No. 14 AWG stranded for control wiring and auxiliary system circuits.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-THWN, single conductors in raceway Mineral-insulated, metal-sheathed cable, Type MI.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway Mineral-insulated, metal-sheathed cable, Type MI.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Armored or Metallic BX Cable (AC, MC, or BX) and Nonmetallic sheathed cable is not allowed.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway Mineral-insulated, metal-sheathed cable, Type MI.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway Mineral-insulated, metal-sheathed cable, Type MI
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- K. Any cable, including signal, communication, and low-voltage wiring, pulled in a raceway on grade or below shall be rated for wet locations.

3.03 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.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Connections in No. 10 and smaller wire shall be made with threaded-on plastic or nylon insulated wire nuts. Crimp connectors, except butt connectors are prohibited. Joints in No. 8 and larger conductors shall be made with pre-insulated mechanical lugs.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.06 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."

3.07 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 entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
 - a. Feeders to all panels
 - b. Feeders to all motors over 1 HP
 - c. Feeders and branch circuits to all Mechanical Equipment
 - d. Feeders and branch circuits to all elevators.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Consider the cost and benefit of infrared scanning of cable and conductor splices before retaining subparagraph and associated subparagraphs below.

4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

- 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

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

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

2.02 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 B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.03 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Conduit Hubs: Mechanical type, terminal with threaded hub.
- G. Ground Rod Clamps: Mechanical type, copper or copper alloy.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- J. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- K. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- L. Straps: Solid copper, copper lugs. Rated for 600 A.

- M. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.
- N. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- O. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 14 AWG and smaller, and stranded conductors for No. 12 AWG and larger unless otherwise indicated.
- B. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- C. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.04 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. A wire equipment ground shall be installed within the branch circuit conduit and be grounded to the cabinet of the panel board to an uninsulated ground bus. The neutral bar of the panel shall not be used for equipment grounds. Equipment grounds and the identified neutral shall not be electrically interconnected on the building side of the service ground.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Convenience Outlets: A wired ground shall be provided for continuity of ground path from the device-grounding pole. Provide ground fault interrupter outlets in wet conditions and where required by NEC and other related codes.
- G. 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.
- H. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.05 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 (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
 - 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one

- of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
- 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.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- H. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.06 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.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.03 DEFINITIONS

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

1.04 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.05 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 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. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
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. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Appleton
 - b. Raco
 - c. Thomas & Betts
 - d. Kindorf
 - e. Steel City
 - f. Pline
- E. 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.

- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used. All anchors shall have provisions for removal.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.
- H. Trapeze or wall surface supports shall be Kindorf "bolt-hole" base galvanized steel channels with C105 and C106 single bolt pipe straps.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.03 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

3.01 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 using spring friction action for retention in support channel.
- 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.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Hanger spacing
 - 1. Do not exceed 8' on center.
 - 2. Provide a hanger adjacent to each outlet box.
 - 3. Provide one hanger within 12" on each side of a change in direction.

- G. Conduits are not permitted to be supported from ductwork, pipes, t-bar ceiling supports or other systems foreign to electrical installation.
- H. Support conduits as close to ceiling structure as practical.
- I. Coordinate conduit locations with other trades.

3.03 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.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. NBR: Acrylonitrile-butadiene rubber.
- H. RNC: Rigid nonmetallic conduit
- I. ARC: Aluminum rigid conduit.
- J. GRC: Galvanized rigid steel conduit.
- K. IMC: Intermediate metal conduit.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of EGS Electrical Group.
 - 6. Republic Conduit.
 - 7. Robroy Industries.
 - 8. Southwire Company.
 - 9. Thomas & Betts Corporation.
 - 10. Western Tube and Conduit Corporation.
 - 11. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel.

- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Coordinate "Conduit Fittings for Hazardous (Classified) Locations" Subparagraph below with Drawings. Engineer to select setscrew or compression. Steel selected as default
 - 2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 3. Fittings for EMT:
 - a. Material: Steel
 - b. Type: Setscrew for indoors, compression for outdoors.
 - 4. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- J. Joint Compound for IMC, GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 PVC-COATED STEEL CONDUIT

- A. Manufacturers: Subject to compliance with requirements manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Kor Kap
 - 2. Perma-Cote
 - 3. Plasti Bond
 - 4. Thomas & Betts
- B. Description: PVC-coated rigid steel conduit.
 - 1. ETL Verified and must bear the ETL PVC-001 label.
 - 2. Hot dip galvanized inside and out.
 - 3. Comply with NEMA RN 1.
 - 4. PVC Coating Thickness: 0.040 inch (1 mm), minimum.
 - 5. Conduit must have a urethane coating on the interior of all conduit and fittings
 - a. Urethane coating thickness: .002 inch (.05 mm), minimum.
- C. Fittings for Conduit; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Coordinate first subparagraph below with Drawings.
 - 2. Condulets 1/2" through 2" diameter shall have tongue-in-groove gasket.
 - 3. Condulets be supplied with plastic encapsulated stainless steel cover screws.

2.03 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.

3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.
 6. Condux International, Inc.
 7. Electri-Flex Company.
 8. Kraloy.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Niedax-Kleinhuis USA, Inc.
 11. RACO; a Hubbell company.
 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Rigid HDPE: Comply with UL 651A.
- G. Continuous HDPE: Comply with UL 651B.
- H. RTRC: Comply with UL 1684A and NEMA TC 14.
- I. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- J. Fittings for LFNC: Comply with UL 514B.
- K. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
 2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4, or Type 12 as shown on drawings, unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.05 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
- C. Surface Nonmetallic Raceways: Shall not be used on project.

2.06 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a Pentair company.
 - 7. Hubbell Incorporated; Killark Division.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. Mono-Systems, Inc.
 - 11. O-Z/Gedney; a brand of EGS Electrical Group.
 - 12. RACO; a Hubbell Company.
 - 13. Robroy Industries.
 - 14. Spring City Electrical Manufacturing Company.
 - 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 - 16. Thomas & Betts Corporation.
 - 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable .
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
 - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- N. Gangable boxes are prohibited.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4, or Type 12 as shown on drawings with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic .
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- P. Cabinets:

1. NEMA 250, Type 1, Type 3R, or Type 12 as shown on drawings, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried or concrete encased where shown.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Electrical rooms.
 - e. Warehouse spaces
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Damp or Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel or nonmetallic in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch (16-mm) to devices with 3/4-inch (21-mm) minimum homerun. 1-inch (32-mm) minimum trade size for ENT underground outdoor use.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing

conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. A. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 2 inches (50 mm) Insert dimension of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 24 inches (600 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Revise list below to include all locations in Project with environmental conditions that require considering expansion-joint fittings in conduit runs. For each Project, consider only locations with PVC conduit with straight-run length exceeding 25 feet (7.6 m) or metal conduit in lengths over 100 feet (30 m). Also revise temperature change for each location so it safely represents conditions anticipated. Temperature-change figures below are examples of maximum total swings from the lowest to the highest environmental temperatures at the indicated types of locations and must be revised to represent temperature swings or changes that may occur at Project locations.
 - b. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - c. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - d. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - e. Attics: 135 deg F (75 deg C) temperature change.
 3. Formula in first subparagraph below provides about 15 percent safety factor (extra expansion-contraction capability).
 4. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 5. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 6. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 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 (150 mm) 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 (300 mm) 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."
 - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Retain first two subparagraphs below with either of last two subparagraphs above.
 - b. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
 - c. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.04 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.05 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.06 PROTECTION

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

END OF SECTION 260533

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

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

- B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC sleeves in "PVC-Pipe Sleeves" and "Molded-PVC Sleeves" paragraphs below may be prohibited by authorities having jurisdiction.

- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Presealed Systems.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

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

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
3. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
4. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
5. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Sleeve-seal fittings in this article are used above and below grade in concrete slabs and in concrete walls for a watertight seal around piping. These fittings do not require a sleeve.
- B. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- C. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- D. Secure nailing flanges to concrete forms.
- E. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes Seismic Restraints for electrical equipment and systems.
- B. Related Sections include the following:
 - 1. Division 26 Section "Hangers and Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

1.03 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.04 PERFORMANCE REQUIREMENTS

- A. Refer to Structural Drawings for design criteria.

1.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.

- B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 3. Field-fabricated supports.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 5. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
 6. Welding certificates.
 7. Qualification Data: For professional engineer.
 8. Field quality-control test reports.

1.06 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

PART 2 - PRODUCTS

2.01 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
 2. Loos & Co.; Seismic Earthquake Division.
 3. Mason Industries.

- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.02 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.
- B. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
- C. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.03 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Tapes and stencils.
 - 5. Tags.
 - 6. Signs.
 - 7. Cable ties.
 - 8. Paint for identification.
 - 9. Fasteners for labels and signs.

1.03 ACTION SUBMITTALS

- A. None required.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.02 CONDUCTOR AND CABLE IDENTIFICATION

- A. Conductor Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, conductor markers with preprinted numbers and letters. Handwritten graphics are prohibited.

- B. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for color coding. For outdoor applications provide black UV resistant ties only; white ties are prohibited.

2.03 NAMEPLATES, LABELS, SIGNS, AND INSTRUCTION PLATES

- A. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with Eyelet for fastener.
- B. Aluminum-Faced Card Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inches thick, and laminated with moisture-resistant acrylic adhesive. Pre-print legend to suit the application, and punch for tie fastener.
- C. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 inches by 2 inches by 19 gage.
- D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. All exterior plates shall be punched for mechanical fasteners (pop rivets). Refer to details on drawings. Use Rowmark "Matt" for indoor use and Rowmark "Ultra-Matt" for exterior use. Nameplate lettering font shall be Helvetica, with bold or extra-bold strokes where indicated.
- E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.
- G. Legend Plates: Die-stamped metal legend plate with mounting hole and positioning key for panel mounted operator devices, i.e. motor control pilot devices, hand-off-auto switches, reset buttons, etc. Stamped characters to be paint-filled.
- H. Fasteners for Plastic-Laminated and Metal Signs:
 - 1. Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
 - 2. Aluminum pop rivets.

2.04 PANELBOARD, DISTRIBUTION AND MCC IDENTIFICATION

- A. Circuit Numbering: Provide factory-supplied permanent self-adhesive labels to identify each pole of all panelboards.
- B. Nameplates: Provide nameplates per above section: "Nameplates, Labels, Signs, and Instruction Plates."
- C. Schedule Holder: Provide crystal clear, heavy duty, 5 1/8" x 81/2" vinyl, long side open. Storesmart #STB897 peel and stick 8GA. Vinyl or approved equal.

2.05 DEVICE COVERPLATE LABELS

- A. Coverplate material shall be as specified in Section 262726: Coverplates.
- B. Embossed metallic or plastic tape (Dymo) is not acceptable for any application.
- C. Methods of Inscription: (Unless otherwise noted)
 - 1. Self-adhesive Tape: For Imprinted or thermal transfer characters onto permanent waterproof tape lettering system. (Brother's or Kroy). Apply Matte finish spray coating (Krylon #1311) as required to make lettering waterproof.

2.06 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to 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,.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Use numbers, lettering, and colors as approved in submittals and as required by code.
- B. Sequence of Work: Where identification is to be applied to surfaces that requires finish, install identification after completion of finish work.
- C. Installation:
 - 1. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
 - 2. Clean surface of dust, loose material, and oily films before applying identification.
 - 3. Install identification parallel to equipment lines.
 - 4. Apply using permanent methods and materials (such as tape and nameplate materials) that is suitable for the environment installed and will not degenerate over time due to UV, sunlight, humidity, temperature swings, etc.
 - 5. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. Do not cover up other instructions or labels.

3.02 RACEWAY IDENTIFICATION

A. Identify Junction, Pull, and Connection Boxes:

1. Identify junction, pull, and connection boxes above accessible ceilings, exposed in mechanical and electrical rooms and other non-finished areas such as tunnels, loading docks, etc., by neatly spray painting the box and cover plate the following colors: The boxes and covers shall be painted prior to installation. It is unacceptable to paint the boxes after installation where the overspray paints the conduits and other surrounding items. It is the Electrician’s responsibility to ensure that the boxes are not painted over by the architectural painting Contractor.
 - a. Fire alarm system: Red with white label.
 - b. Emergency power or lighting: Red {1}.
2. Notes: {1} Label box covers with identity of contained circuits per the following convention: "Panel/ MCC Name"- "Circuit Numbers." Example: "HD1A-1,3,5." Use Brother or Kroy Type labeling or neatly hand letter using block uppercase lettering and permanent type black marker. Engineer has right to require lettering to be redone if not done neatly.
3. In exposed public areas where the ceiling plane, structure, ductwork and conduits are to be painted an architectural color verify with Engineer the required methods for conduit and junction box identification.

3.03 CONDUCTOR AND CABLE IDENTIFICATION

A. Conductor Color Coding: Provide color coding for the following:

1. Secondary service, feeder, and branch circuit conductors throughout the project electrical system:

<u>208 and 120 Volts</u>	<u>Phase</u>	<u>480 and 277 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White*	Neutral	Grey*

* neutrals in common raceways, provide color band/stripe on neutral that corresponds with phase conductor color

Green	Ground	Green
Green w/ yellow stripe	Isolated Ground	Green w/ yellow stripe
Pink	Switch leg	Pink
Purple	Traveler	Purple

2. Control wiring inside custom electrical equipment and control panels throughout the project electrical system, refer to mechanical specifications.

3. Use conductors with color factory-applied the entire length of the conductors except as follows:
 - a. The following field-applied color-coding methods may be used in lieu of factory-colored conductor for sizes larger than No. 10 AWG.
 - b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each conductor or cable at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
 - B. Future Connections: Tag or label conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
 - C. Multiple Conductors/Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for color-coded, three-circuit, four-wire home runs) and wherever there is possible confusion in identifying each conductor, label each conductor or cable. Provide label indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of color-coded conductor insulation. For control and communications/signal wiring, use color coding or conductor/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on conductor/cable marking tapes. Conductor numbers shall match the manufacturer's shop drawings.
 - D. Cable and Feeder Identification Tags: Securely fasten identifying tags around cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with stamped letters and numbers with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties.
- 3.04 NAMEPLATES, LABELS, SIGNS, AND INSTRUCTION PLATES
- A. Apply warning, caution, and instruction signs and stencils as follows:
 1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 2. Emergency Operating Signs: Install engraved, laminated signs with white text on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
 - B. Install equipment/system circuit/device identification as follows:
 1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system.

This includes communication/ signal/alarm systems, unless the factory supplied labeling on the unit is acceptable to the Engineer.

2. Refer to drawings for details of signs, if details are not included provide the following minimum information:
 - a. Equipment or device designation. (Minimum 1/4" high)
 - b. Amperage, KVA or horsepower rating, where applicable.
 - c. Voltage or signal system name.

 3. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
 - a. Panelboards, electrical cabinets, disconnects, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. All junction boxes and enclosures larger than 4" square.
 - d. Each circuit breaker or fused switch in distribution boards, switchboards and switchgear.
 - e. Electrical switchgear and switchboards.
 - f. Electrical substations.
 - g. Motor control centers.
 - h. Motor starters.
 - i. Pushbutton stations.
 - j. Power transfer equipment.
 - k. Contactors.
 - l. Dimmers.
 - m. Control devices.
 - n. Battery racks.
 - o. Power generating units.
 - p. Telephone switching equipment.
 - q. Clock/program master equipment.
 - r. Call system master station.
 - s. TV/audio monitoring master station.
 - t. Fire alarm master station or control panel.
 - u. Security monitoring master station or control panel.
 - v. Spare conduits at both ends.

 - C. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, circuit breakers in distribution, switchboard and switchgear, lights, motor control centers, and similar items for power distribution, except panelboards and alarm/signal components, where labeling is specified elsewhere.

 - D. Provide legends on panel mounted operators devices such as pilot lights, reset buttons, hand-off-auto switches, pushbuttons and other control components.
- 3.05 ARC FLASH HAZARD LABELS
- A. Arc flash labels shall be orange for PPE levels 0 through 4.
 - B. Arc flash labels shall be red for a dangerous hazard risk category.
 - C. The portion of the arc flash hazard label that contains the hazard risk category information shall be color coded as follows:
 1. Hazard risk category 0: Green
 2. Hazard risk category 1: Yellow
 3. Hazard risk category 2: Tan

4. Hazard risk category 3: Orange
5. Hazard risk category 4: Pink
6. Hazard risk category 5: Red
7. Shall meet the requirements of NFPA & 2009 ANSI/NETA Standard for maintenance testing specifications: chapter 6, Power system studies.

D. See spec section 260573 – Over-current protection device coordination study and arc flash hazard analysis, for additional requirements.

3.06 PANELBOARD, DISTRIBUTION AND MCC IDENTIFICATION

- A. Circuit Numbering: Starting at the top, odd numbered circuits in sequence down the left hand side and even numbered circuits down the right hand side.
- B. Panelboard Nameplates: Mount nameplates with black Bakelite, white letters fastened with sheet metal screws. In finished public areas, such as in lobby or corridor walls, mount the nameplate to the top of the inside of the inner door then also provide an additional 0.75" high, single-line, white nameplate with black 1/4" high panelboard name. All nameplates that are to be mounted on the outside shall be centered, 1/2" up from the top on the inner door on the outside of the outer door.
- C. Panelboard Schedule Holder: Mount schedule holder, secured to inside face of inner panel door. Contractor shall install construction panel schedules in holders during construction and replace with "as of record" panel schedules in holder at end of project. Final schedules shall include room numbers and explicit description and identification of items controlled by each individual breaker.

3.07 DEVICE COVERPLATE LABELS

- A. Provide self-adhesive type labels for all receptacles, switches, outlets, plugmold, etc. per the following:
 1. Lettering Type: Helvetica, 1/4" high.
 2. Text: Label coverplates with identity of source and circuit number serving the device per the following convention: "Panel Name"- "Circuit Numbers" (except UPS circuits, which have word UPS as part of the label). Example: "MTE0032-1", "UPS MTE0033-3".
 3. Color of Characters shall be as follows:

Text Color	Background Color	System Description
Black	White	Normal power devices coverplates
 4. Installation of self-adhesive tape:
 - a. Imprinted tape shall be coated with a permanent, non-gloss protective finish. Spray coating shall be applied prior to installation or simultaneously as with Brother's unit.
 - b. Tape shall be applied to coverplate there is no need to wrap label and label should be at bottom of plate. Top of plate for special equipment designations.
 - c. Inscription shall be centered and square with coverplate.
- B. Provide engraved coverplates for switches, dimmers, etc. as follows: (in addition to panel-circuit number labels)
 1. All multi-ganged (three or more) switches or dimmers.

2. All special purpose switches or controls, i.e. - fan, projector screen, etc. where it is not obvious what it controls.
3. Engraving shall indicate fixtures or devices controlled (i.e. "Down Lights", "Cove Lights", etc.)
4. Switch cover plates that control various systems (AV, projection screens, etc.) shall be labeled with 1/8" black lettering indicating the function.

3.08 GROUND CONDUCTOR

1. Label ground conductors at main ground bar.
2. No. 6 and larger are to be identified at accessible points per NEC.

END OF SECTION 260553

SECTION 260800 - COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes Commissioning activities required for work of Division 26 Sections including but not limited to construction checks, equipment start-up, functional testing, and operator training.
 - 1. Comply with Section 01 91 13 – General Commissioning Requirements for Commissioning activities for Division 26 work.

1.02 SEQUENCING

- A. Provide written notification to Commissioning Provider (CxP) in advance of significant project dates including but not limited to the following:
 - 1. Two weeks prior to Manufacturer's start-up of lighting control system.

1.03 SUBMITTALS

- A. Provide submittals of systems being commissioned to Owner's Authorized Representative as required by Section 01 91 13 and 26 08 00

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Manufacturer's representative to perform construction checks and operational training as specified in Division 26 including the following systems:
 - 1. New roof Lighting

3.02 CONSTRUCTION CHECKLISTS

- A. Contractor shall perform as required by Section 01 91 13. Construction checklists for each system being commissioned will be prepared by Commissioning Provider during construction.
 - 1. Perform voltage and amperage measurements for mechanical equipment as required in Section 23 08 00 and 26 08 00

3.03 LIGHTING CONTROL VERIFICATION REPORT

- A. Control Contractor shall perform construction checks, start-up, and verification of automatic lighting control system. Provide verification report demonstrating proper system installation and operation. Verification shall include the following:
 - 1. Equipment Startup: All equipment being controlled shall be initially started and tested as required by the manufacturer. All required manufacturer installation and start-up checklists shall be attached to the construction checklists.

3.04 FUNCTIONAL TESTING

- A. Contractor shall perform testing as directed by Commissioning Provider and as required by Section 01 91 13. Functional Test Plans for each system being commissioned will be prepared by Commissioning Provider during construction. Provide an allowance of on-site labor hours per trade for assisting Commissioning Provider with Functional Testing as listed below. Labor required for retesting due to failure of equipment or systems to perform in accordance with Contract Documents shall be provided at no additional cost to Owner.

3.05 OPERATIONS AND MAINTENANCE TRAINING

- A. The Contractor shall provide operation and maintenance instruction to Owner's personnel as required by Division 01 and 26.

3.06 SCHEDULE OF SYSTEMS BEING COMMISSIONED

- A. Commission systems and equipment listed below including associated equipment and control systems.
 - 1. New roof lighting

END OF SECTION 260800

SECTION 260923 - ROOM CONTROLLER SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Occupancy, Vacancy and Daylighting Sensor Control
2. Wall or Ceiling Mounted Occupancy Performance Requirements
3. Ceiling Mounted Sensors
4. Room Controller Zone Wallstations
5. Room Controller Scene Wallstations
6. Daylighting Adjustment Handheld Remote Controls
7. Personal Adjustment Handheld Remote Controls
8. Room Controllers
9. Daylight Photosensors/ IR Receiver
10. Room Controller Local Network
11. Room Controller Network
12. Network Accessories and Control Interfaces
13. Emergency Lighting

1.02 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- B. Underwriter Laboratories of Canada (ULC)
- C. International Electrotechnical Commission (IEC)
- D. International Organization for Standardization (ISO)
- E. National Electrical Manufacturers Association (NEMA)
- F. Underwriters Laboratories, Inc. (UL)
 1. 508 – Industrial Control Equipment
 2. 924 – Emergency Lighting

1.03 SYSTEM DESCRIPTION & OPERATION

- A. The Lighting Control and Automation system as defined under this section covers the following equipment:

- B. Room Controller QuickKit (RCQK) – Turn key solutions to meet typical applications and provide product necessary to help a space meet the requirements ASHRAE 90.1 out of the box. The RCQK includes all defined equipment to meet the following applications.
 - 1. Conference Room
 - 2. Office
- C. Room Controller Starter Kits – Pre-defined solutions to provide the Electrical Contractor the product they need to meet typical applications for rough in installation to help a space meet the requirements of ASHRAE 90.1 out of the box.
- D. Room Controllers – Stand-alone three relay controller with 0-10 volt control for ballasts or LED drivers with integral UL 924 emergency relay (model dependent), that RCQK smart devices connect to over the RCQK communications network.
- E. Network Room Controllers – Stand-alone three relay controller with 0-10 volt control for ballasts or LED drivers with integral UL 924 emergency relay (model dependent), that RCQK smart devices connect to over the RCQK communications network.
- F. Occupancy Sensors – Auto adjusting, MicroSet technology NEMA WD7 compliant occupancy sensors.
- G. Wallstations – Smart device that is pre-configured, pre-engraved digital pushbutton wallstations and dimmers.
- H. Scene Wallstation – Smart device that is pre-configured, pre-engraved digital pushbutton scene wallstations, dimmers and programmable scene buttons.
- I. Daylight Photosensor – Smart device that is a multi-zone open loop daylight sensor with two-way active infrared (IR) communications, which can provide dimming control for daylight harvesting and personal control and programming for the space.
- J. Demand Response – OpenADR or other demand response input shall be connected to one or more Room Controllers. Each Room Controller shall respond to the demand response input and automatically reduce the light level by at least 15% but not more than 40% of target light level.
- K. RCQK communication network – Pre-defined lengths of QuickConnect cable (RJ45) for power and data to smart devices.

1.04 LIGHTING CONTROL APPLICATIONS

- A. Minimum lighting control performance required, unless local Energy Code is more stringent.
- B. Occupancy/vacancy requirements – Provide an occupancy/vacancy sensors with Manual On/ Automatic Off or Automatic On/ Automatic Off functionality in all spaces. Manual On vacancy sensors should be used for any enclosed space with a Manual On switch that does not require hands free operation. Spaces with multiple occupants or where line of sight might be obscured ceiling or corner mount sensors and Manual wallstations would be required. Automatic On of lighting via occupancy sensor cannot exceed 30% of lighting. Systems that do that allow the user to select Occupancy or Vacancy Mode shall not be acceptable.

- C. Bi-Level switching – Provide multi-level switching and/or variable dimming for maximum energy savings.
- D. Daylight Zones – Primary sidelit or toplit areas within an enclosed space shall be controlled separately and automatically by a multi-level photocontrol device without the need for programming. Adjustments to the daylight zones must be provided by a simple to use, intuitive remote handheld device.
- E. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to dim electric light to the lowest light level.
- F. Provide the ability to adjust the high end and low end trim of the dimmers to ensure the lighting automatically provides energy saving even when daylighting calls for full illumination.
- G. Provide the ability for the dimmers and the relays to function separately. Systems where the 0-10V dimmers and relays are tied together reduce design capabilities and shall not be acceptable.
- H. Provide the ability to provide occupancy status to a Building Automation System. Occupancy status shall happen automatically and be provided to the BAS without the need of programming any device in the Room Controller System. Systems that require programming for BAS occupancy status shall not be acceptable.
- I. Shall be capable of automatically responding to a Demand Response Signal and adjusting the lighting level, without the need of programming or software. Systems that require software or commissioning to provide Demand Response integration shall not be acceptable.
- J. Additional controls:
 - 1. Provide occupancy or vacancy sensors (Auto On or Manual On) for any enclosed office, conference, meeting or training rooms. Spaces with multiple occupants or where line of sight may be obscured require ceiling or wall/corner mounted sensors with Manual On switches.
 - 2. Conference, meeting, training, auditoriums and multi-purpose rooms shall have controls that allow for scene based and independent control of each output. Rooms larger than 300 square feet shall support at least four (4) pre-set lighting scenes. Occupancy or vacancy sensors shall ensure all lighting, receptacles, and HVAC in the space is turned Off when no occupancy.
 - 3. Provide integral control of an adjustable toplight control system such as a Solatube® Daylight Dimmer. Coordinate the adjustable toplight control with wallstation push buttons for A/V Mode and presentations to automatically reduce the amount of toplight when pressed. Systems that require additional interfaces for connection and control or programming shall not be acceptable.
 - 4. Egress lighting control shall be integral to the system. The system shall provide an automatic control of adjacent corridor and/or egress lighting based upon room occupancy without programming. Systems that do not ensure that adjacent corridor and/or egress lighting is controlled with room occupancy shall not be acceptable.
 - 5. Provide integral connection for a healthcare patient pillow speaker for integration between the lighting control system, nurse call system and room entertainment system. The pillow speaker shall be provided from the same manufacturer as the lighting control system, which allows integration with multiple nurse call systems. The pillow speaker shall provide control of 0-10V dimming of up to three zones from the patient bed. Systems that utilize dry contact inputs from the nurse call system may not provide full

dimming of up to three zones and shall not be acceptable. For pillow speaker, use the Cooper Lighting Solutions catalog numbers: RC3DEHC-PL for Room Controller, GG37-P, GPCS-3Z-DIM.

1.05 PERFORMANCE REQUIREMENTS

- A. The Room Controller QuickKit shall be accompanied by: recessed or suspended luminaires specified as fluorescent or LED with defined CRI and lumen output, provided by the same manufacturer as the control systems.
- B. The Room Controller QuickKit shall include: the Room Controller (RC3-PL, RC3D-PL, or RC3DE-PL), wallstations, matching color screwless wallplates, occupancy sensor, Daylight Sensor, Receptacle Switchpack, QuickConnect cable (plenum or non-plenum pre-terminated and defined for package).
- C. The Room Controller Starter Kit shall include: the Room Controller (RC3D-PL, or RC3DE-PL), Receptacle Switchpack, plenum QuickConnect cable (defined for package).

1.06 SUBMITTALS

- A. Submittals Package: Submit the shop drawings and the product data specified below at the same time as a package.
- B. Shop Drawings:
 - 1. Composite wiring and/or schematic diagram of each control circuit, as proposed, to be installed (standard diagrams will not be accepted).
 - 2. Scale drawing for each area showing exact location of each sensor, room controller and digital switch.
- C. Product Data: Catalog sheets, specifications and installation instructions.
- D. Include data for each device which:
 - 1. Indicate best mounting and installation locations for each device. This may be contained within drawings or installation instructions depending upon the project.
- E. Warranties: Standard and special warranty information.

1.07 QUALITY ASSURANCE

- A. Manufacturer: Minimum 10 years' experience in manufacture of lighting controls.
- B. Products: All electrical components and devices shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency and marked for intended use.
- C. Comply with NFPA 70.
- D. Source Limitations: Obtain luminaires and control systems from a single manufacturer.

1.08 DELIVERY, STORAGE AND HANDLING

- A. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements.
- B. Packaging: All components of the lighting control system shall be packaged in a single box as a QuickKit or as individual components. The QuickKit catalog number will be marked on package label along with bill of materials. Individual component packages will be marked with product catalog number.
- C. Handling: Packaging will include clear installation instructions for all components with typical illustrations of installation locations and connections. The installing contractor can easily match each package to the layout on the design floor plans.

1.09 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0° to 40° C (32° to 104° F)
 - 2. Relative humidity: Maximum 90 percent, non-condensing
- B. Coordinate layout and installation of luminaries and controls with other construction.
- C. Coordinate site commissioning with manufacturer no less than 21 days prior to required date.

1.10 WARRANTY

- A. Manufacturer shall supply a 5-year warranty on all hardware and software. These warranties will be in effect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

1.11 MAINTENANCE

- A. Provide extra materials described below when needed. Products shall match those that are installed. Extra materials should be stored and identified with labels describing contents. Inclusion of extra materials on the bill of materials is not the responsibility of the manufacturer.
- B. Recommended extra materials:
 - 1. Occupancy Sensors: Provide 1 of each product type for every 200 installed, to be used for maintenance.
 - 2. Daylight Sensors: Provide 1 of each product type for every 100 installed, to be used for maintenance.
 - 3. Wallstations: Provide 1 of each product type for every 200 installed, to be used for maintenance.
 - 4. Receptacle Switchpack: Provide 1 of each product type for every 100 installed, to be used for maintenance.
 - 5. Room Controller: Provide 1 of each product type for every 200 installed, to be used for maintenance.

6. QuickConnect Cable: Provide 1 of each product type for every 200 installed, to be used for maintenance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer:

1. Cooper Lighting Solutions
 - a. System: Room Controller QuicKit (RCQK)
 - b. System: Room Controller Starter Kit
 - c. System: Room Controller
 - d. System: Room Controller Network

B. Substitutions: Not Permitted

1. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices and wiring. The contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design, highlighted in an alternate color, to the engineer for review and approval prior to rough-in.

2.02 WALL OR CEILING MOUNTED OCCUPANCY PERFORMANCE REQUIREMENTS

A. Sensing mechanism:

1. Infrared: Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
2. Ultrasonic:
 - a. Utilize an operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - b. Utilize Doppler shift ultrasonic detection technology.
3. Dual technology:
 - a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 - b. Utilize an operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - c. Incorporate Doppler shift ultrasonic and passive infrared motion detection technologies. Products that react to noise or ambient sound shall not be considered.

B. Power failure memory:

1. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.

C. Designed and tested to withstand discharges of 15,000 volts per IEC 801-2 without impairment of performance.

- D. Products tested in identical manner, complaint to NEMA WD 7 -2011 Occupancy Motion Sensors Standards.
- E. Sensor shall have time delays from 10 to 30 min.
- F. When specified, sensors shall automatically adjust time delay and sensitivity settings.
- G. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- H. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- I. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

2.03 CEILING MOUNTED SENSORS

- A. Product: OAC-DT-2000, OAC-DT-1000, OAC-P-1500, OAC-U-2000.
- B. Provide all necessary mounting hardware and instructions.
- C. Sensors shall be Class 2 devices.
- D. Connect to Room Controller via Click & Go cable to eliminate wiring errors.
 - 1. OCC-RJ45 Room Controller accessory is used to allow any standard occupancy/vacancy sensor to utilize Click & Go cable connections.
 - 2. Two RJ45 connection ports for connection to Room Controller.
 - 3. Occupancy Sensor and Daylight sensor shall be capable of a daisy chain connection to the Room Controller.
- E. Device calibration and features:
 - 1. Sensitivity – 0-100% in 10% increments.
 - 2. Time delay – 1-30, self-adjusts to 10 min based on room occupancy.
 - 3. Test mode – Fifteen second time delay.
 - 4. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - 5. Walk-through mode.
- F. Ultrasonic and Dual Technology Sensors utilize two independent sensor detection circuits simultaneously to ensure optimum performance, regardless of location or proximity to walls and structures.
- G. Ultrasonic and Dual Technology Sensors utilize Variable Drive Circuitry (VDC) in cases of over saturation from misapplication, which automatically adjusts the volumetric output without reducing detection capability. Systems that reduce detection coverage area shall not be acceptable.

- H. Automatically and continually self-adjust ultrasonic frequency to ignore specific frequency, continuous noise from airflow to prevent detuning which can lead to inadvertent lights out. Sensors that require detuning shall not be acceptable.
 - 1. All load parameters including Automatic On/Manual On, blink warning and daylight enable/disable when daylight sensors are pre-defined with the Room Controller local network.
- I. Device Status LEDs including:
 - 1. PIR Detection
 - 2. Ultrasonic detection
 - 3. Occupancy sensors are pre-defined to specific loads within the room without wiring or special tools for maximum energy savings.
 - 4. Manual override of controlled loads.
- J. Multiple occupancy sensors may be installed in a room by simply daisy-chaining them together to the Room Controller via Click & Go cable. No additional configuration will be required
- K. Where specified, sensor packaging shall be 100% recycled made entirely from post-consumer waste (100% post-consumer fiber content) as well as, 100% recyclable.
- L. Sensors shall be RoHS compliant.

2.04 ROOM CONTROLLER ZONE WALLSTATIONS

- A. Low voltage momentary pushbutton switches in 2, 3, 4, 5 and 6 button configuration; available in white, ivory, grey and black; compatible with wall plates with decorator opening. Wallstations shall include the following features:
 - 1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons ENGRV-*BTNL-*, ENGRV-*BTNS-*. Button replacement may be completed without removing the switch from the wall.
 - 2. Intuitive button labeling to match application and load controls.
 - 3. Pre-defined digital button configurations. Each wallstation is shipped with pre-defined digital button configurations which are automatically sensed by the connected Room Controller and mapped to specific load controls for immediate out of the box functionality.
 - 4. Two RJ-45 ports for connection to the Room Controller local network.
 - 5. Multiple digital wallstations may be installed in a room by simply connecting them to the Room Controller local network. No additional configuration will be required to achieve multi-way switching.
 - 6. Room Controller digital wallstations are delivered with pre-defined functions including, raise, lower, A/V Mode, Quiet Time, manual and scene control. No additional configuration is required to provide a fully functional system. Systems that require configuration or load binding and do not deliver maximum energy savings out of the box shall not be acceptable.
 - 7. Optional custom labeling is available for application or location specific wallstation button labels.

B. Cooper Lighting Solutions catalog numbers:

RC-2TLB-ES1-*	Entry, All Off (2 large buttons *= W,V,B,G)
RC-6TSB-TS1-*	General, Whiteboard, Quiet Time, A/V Mode, Raise, Lower (6 small buttons *= W,V,B,G)
RC-6TSB-TS2-*	General, Whiteboard, Quiet Time, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-5TSB-TS3-*	General, Whiteboard, Quiet Time, A/V Mode, All Off (5 small buttons *= W,V,B,G)
RC-6TSB-TS4-*	General, Whiteboard, A/V Mode, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-4TSB-TS5-*	Entry, General, Whiteboard, All Off (4 small buttons *= W,V,B,G)
RC-6TSB-TS6-*	Entry, General, Whiteboard, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-TS7-*	Row 1, Row 2, Row 3, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-TS8-*	Uplights, Downlights, Accent, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-TS9-*	Entry, General, Quiet Time, Whiteboard, A/V Mode, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-TS10-*	Main, Whiteboard, A/V Mode, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-ZAD-*	Zone 1 UP, Zone 1 DN, Zone 2 UP, Zone 2 DN, Zone 3 UP, Zone 3 DN (6 small buttons *= W,V,B,G)
RC-3TLB-Z1D-*	Zone 1, Raise, Lower (3 large buttons *= W,V,B,G)
RC-3TLB-Z2D-*	Zone 2, Raise, Lower (3 large buttons *= W,V,B,G)
RC-3TLB-Z3D-*	Zone 3, Raise, Lower (3 large buttons *= W,V,B,G)
RC-4TSB-HC1-*	General, Exam, Reading, All Off (4 small buttons *= W,V,B,G)
RC-6TSB-HC2-*	General, Exam, Reading, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-3TLB-OS1-*	Half Lights, Full Lights, All Off (3 large buttons *= W,V,B,G)
RC-5TSB-OS2-*	Half Lights, Full Lights, Raise, Lower, All Off (5 small buttons *= W,V,B,G)
RC-6TSB-OS3-*	Half Lights, Full Lights, Undercabinet, Raise, Lower, All Off (6 small buttons *= W,V,B,G)
RC-2TLB-OS4-*	All On, All Off (2 large buttons *= W,V,B,G)

2.05 ROOM CONTROLLER SCENE WALLSTATIONS

- A. Low voltage momentary pushbutton switches in 2, 3, 4, 5 and 6 button configuration; available in white, ivory, grey and black; compatible with wall plates with decorator opening. Wallstations shall include the following features:
 - 1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons ENGRV-*BTNL-*, ENGRV-*BTNS-*. Button replacement may be completed without removing the switch from the wall.
 - 2. Intuitive button labeling to match application and load controls.
 - 3. Pre-defined digital button configurations. Each scene wallstation is shipped with a pre-defined digital button configuration which is automatically sensed by the connected Room Controller and mapped to specific load controls for immediate out-of-the-box scene based functionality.
 - 4. Two RJ45 ports for connection to the Room Controller local network.
 - 5. Multiple digital wallstations may be installed in a room by simply connecting them to the Room Controller local network. No additional configuration will be required to achieve multi-way switching.
- B. Room Controller Scene Wallstations are delivered with pre-defined scene control. No additional configuration is required to provide a fully functional system. Systems that require configuration or load binding and do not deliver maximum energy savings out of the box shall not be acceptable.
- C. Optional custom labeling is available for application or location specific wallstation button labels.
- D. Scene wallstations scene control shall be adjustable through a simple interface or handheld control for flexibility of lighting scenes. This personal remote shall allow individual zone control, scene control and scene setting capabilities. HHPR-RC
- E. Cooper Lighting Solutions catalog numbers:

RC-3TLB-P1-*	Scene 1, Scene 2, All Off (3 large buttons *= W,V,B,G)
RC-6TSB-P2-*	Scene 1, Scene 2, Scene 3, Scene 4, Scene 5, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-P3-*	All, On, Scene 1, Scene 2, Scene 3, Scene 4, All Off (6 small buttons *= W,V,B,G)
RC-6TSB-P4-*	Scene 1, Scene 2, Scene 3, Raise, Lower, All Off (6 small buttons *= W,V,B,G)

2.06 DAYLIGHTING ADJUSTMENT HANDHELD REMOTE CONTROLS

- A. Battery-operated handheld 10 button configuration for remote daylight sensor configuration. Remote controls shall include the following features:
 - 1. Two-way infrared (IR) transceiver for line of sight communication with the Room Controller daylight sensors within up to 30 feet.
 - 2. Red communication LED on the daylight sensor confirms button press.
 - 3. Inactivity timeout to save battery life.
 - 4. Three intuitive daylight sensor range pushbuttons.
 - 5. Intuitive daylight zone adjustment raise/lower pushbuttons.

6. Cooper Lighting Solutions catalog numbers: HHPRG-RC.

2.07 PERSONAL ADJUSTMENT HANDHELD REMOTE CONTROLS

- A. Battery-operated handheld 10-button configuration for remote daylight sensor configuration. Remote controls shall include the following features:
 1. Two-way infrared (IR) transceiver for line-of-sight communication with the Room Controller daylight sensors within up to 30 feet.
 2. Red communication LED on the daylight sensor confirms button press.
 3. Inactivity timeout to save battery life.
- B. Intuitive individual Control of each relay and 0-10V dimming zone.
- C. Six user adjustable scene pushbuttons for simple selection and control of space lighting.
- D. Cooper Lighting Solutions catalog numbers: HHPR-RC.

2.08 ROOM CONTROLLERS

- A. Room Controllers are fully functional out-of-the-box to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will include line voltage wiring space and will not require additional electrical junction boxes. The control units will include the following features:
 1. Fully functional room configuration to the most energy-efficient sequence of operation based upon the connected devices in the room.
 2. Simple replacement – Using the automatic configuration capabilities, a Room Controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Quick installation features including:
 - a. Included line voltage space to simplify wiring and eliminate the need for separate junction boxes.
 - b. Included emergency voltage space to simplify wiring of emergency luminaire connections.
 - c. Breakouts or knockouts for direct conduit connection.
 - d. Line and low voltage sections include conduit connection points. Systems that require special accessories for direct conduit connections may not comply with local building codes and shall not be acceptable.
 - e. Quick low voltage connections using standard RJ45 QuickConnect cable.
 - f. 120-277 VAC, 50/60 Hz input voltage.
 - g. Zero cross circuitry for each load.
 - h. Three relay configuration.
 - i. Efficient 150 mA switching power supply.
 - j. Six RJ45 Click & Go local network ports.
 - k. All models shall be available in either a plastic or metal enclosure for simplified installation in appropriate spaces
 - l. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
- B. On/Off/Dimming Room Controllers shall include:

1. Real time current metering (optional).
 2. Room Controller metal enclosure options include a "-PL" in the catalog number.
 3. Room Controller Network options include a "-N" in the catalog number.
 4. Three relay, switching zone configuration RC3, RC3-PL, RC3-PL-N
 - a. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
 5. Three relay, three 0-10V dimming zone configuration RC3D, RC3D-PL, RC3D-PL-N.
 - a. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
 - b. Up to three 0-10V analog outputs per relay for control of compatible ballasts and LED drivers.
 6. Three relay, three 0-10V dimming zone configuration with one emergency UL 924 relay RC3DE, RC3DE-PL, RC3DE-PL-N.
 - a. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
 - b. Up to three 0-10V analog outputs per relay for control of compatible ballasts and LED drivers.
 7. Three relay, three 0-10V dimming zone configuration for patient rooms RC3DEHC, RC3DEHC-PL, RC3DEHC-PL-N.
 - a. All models support local network connections of wallstations, occupancy-based controls and receptacle controls.
 - b. Up to three 0-10V analog outputs per relay for control of compatible ballasts and LED drivers.
- C. Cooper Lighting Solutions networkable metal enclosure catalog numbers: RC3-PL-N, RC3D-PL-N, RC3DE-PL-N, RC3DEHC-PL-N.
- D. Cooper Lighting Solutions metal enclosure catalog numbers: RC3-PL, RC3D-PL, RC3DE-PL, RC3DEHC-PL.
- E. Cooper Lighting Solutions plastic enclosure catalog numbers: RC3, RC3D, RC3DE, RC3DEHC.
- 2.09 DAYLIGHT PHOTOSENSORS/ IR RECEIVER
- A. Daylight photosensors work with Room Controllers to provide automatic daylight dimming capabilities for any load type connected to a room controller. Open loop daylight sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Daylight sensors shall be interchangeable without the need for rewiring. Daylight sensors shall be capable of daisy-chaining with occupancy sensors in each room.
- B. Digital daylight sensors include the following features:
1. An internal photodiode that measures only within the visible spectrum and has a response curve that closely matches the photopic curve.
 2. The daylight sensor has three light level ranges: Low (3-300 lux), High (30-3000 lux), and Direct Sun (300-30000 lux).
 3. For dimming daylight harvesting, the daylight sensor shall provide the capability of controlling multiple (up to three) daylight zones immediately upon connection without programming.

4. Optional digital wallstations to allow occupants to reduce lighting level to increase energy savings and lower lighting levels for a selected period of time or cycle of occupancy.
5. Infrared (IR) transceiver for daylight sensor range and daylight zone gain adjustments via handheld remote programmer. HHPRG-RC
6. Infrared (IR) receiver for personal control and scene programming via handheld remote programmer. HHPR-RC
7. Red configuration LED that blinks to indicate data transmission.
8. Green Mode status LED that blinks to indicate Daylight Commissioning Mode.
9. Green Mode status LED that remains constant ON when daylight range is set to low for available natural light.
10. One RJ45 port for connection to Room Controller local network.
11. An adjustable head and an optional mounting bracket to accommodate multiple mounting methods and building materials. The daylight sensor may be mounted on a ceiling tile, skylight well, suspended lighting fixture or backbox.

C. Open loop digital daylight sensor includes the following additional features:

1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
2. Automatically establishes dimming set-points upon power up without any programming. Optional calibration using the wireless IR handheld programmer. HHPRG-RC
 - a. Cooper Lighting Solutions Catalog Number: DS-FMOIR

2.10 ROOM CONTROLLER LOCAL NETWORK

A. The Room Controller local network is a physical connection and communication protocol designed to optimally control a space within a building. Room Controller devices connect to the local network using CAT 5e cables with RJ45 QuickConnect cables which provide both data and power to room devices. Features of the Room Controller local network include:

1. Click & Go default functionality of occupancy sensors, wallstations, daylight sensors, receptacle controls, BMS status output and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
2. Replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
 - a. Cooper Lighting Solutions Catalog Number:
 - 1) GGRC-COUPLER (Joins two cables)
 - 2) GGRC-SPLITTER (Joins three cables)
 - 3) NON PLENUM CABLES: GGRJ45-006-G, GGRJ45-03-G, GGRJ45-10-G, GGRJ45-25-G, GGRJ45-50-G, GGRJ45-100-G
 - 4) PLENUM CABLES: GGRJ45-10P-G, GGRJ45-25P-G, GGRJ45-50P-G, GGRJ45-100P-G

2.11 ROOM CONTROLLER NETWORK

A. The Room Controller network allows up to 254 lighting control panels to exist on a single communication network designed to optimally control a building. Digital communication shall be RS485 with each lighting control panel being a master to ensure no single point of failure.

B. Each panel shall have a unique device address. This allows for unique identification of the lighting control panel on the network.

- C. Lighting control relays in any panel can be controlled via a network command sent from a panel on the network.
- D. Breaks in the physical RS485 network shall not inhibit local panel operation. Systems that do not use Master/Master architecture shall not be acceptable.
- E. The network shall be capable of connecting to the building LAN for easy TCP/IP access to the lighting control panels.
- F. Network access to the building LAN shall be provided by an Ethernet Interface Module [EIM]
- G. Access to computers on the building LAN shall be secured by site user name and password policies (provided by local site IT).
- H. Setup and programming of each panel on the network is performed using the Keeper Enterprise software. Network programming can be achieved by any factory certified personnel, which may include Electrical Contractors, Agents, Customer, Factory Representatives, or Factory Employees. System that require startup and programming to be performed only by Factory Employees shall not be acceptable.

2.12 NETWORK ACCESSORIES AND CONTROL INTERFACES

- A. Ethernet Interfaces; Cooper Lighting Solutions Model Ethernet Interface Module
- B. Provide ability to communicate by means of TCP/IP over Ethernet to ControlKeeper lighting control system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 300 feet (100 meters) of Ethernet source.
 - 1. Communications protocol to provide access to:
 - a. Individual Relay Commands
 - b. Individual Relay Status
 - c. Input Status
 - d. Network Override Commands
 - 2. Network Programming Software; Cooper Lighting Solutions Model Keeper Enterprise Programming software.
 - 3. The software permits the organization of the lighting control panels into Buildings and Networks.
 - 4. Multiple panels and panel types can exist in a building or network.
 - 5. Each Network permits the ability to have a dedicated IP address for communications.
 - 6. The software shall permit the following to be programmed for each Room Controller panel
 - a. Name descriptor
 - b. Panel address and communication method
 - c. Panel firmware updates over the network
 - d. Define, broadcast and log Output information
 - e. Define daylight gain settings for three dimming zones
 - f. Adjust High End/Low End trim settings for each panel
 - g. Adjust Demand Response values for each panel
 - h. Configure Remote network listener commands, to take action based on inputs from other panels on the network
 - i. Configure scene values for each panel

- j. Copy/paste already programmed panels for template driven programming
7. (Optional) Graphical floor plan software; Cooper Lighting Solutions Model VisionTouch®
- 5.
 - a. The software permits up to 255 floors or site plans to be illustrated for intuitive control. The software provides real-time feedback to the operator of network control overrides and relay status.
 - b. Web-based user interface – Software that is not accessed through standard web browsers shall not be acceptable.
 - c. Interactive floor plan – Floor plan software that does not provide immediate area status via defined color code or other readily available visible indication shall not be acceptable. Software that requires selecting an area to check overall status shall not be acceptable.
 - d. Up to 500 simultaneous users – Software that is limited to less than 100 active users shall not be acceptable.
 - e. Up to 10 simultaneous facility managers – Software that provides access for less than 5 facility managers or administrator accounts shall not be acceptable.
 - f. Supports multiple IP access connection points (at least 10) to different lighting control systems. Each IP access connection shall be capable of supporting up to 254 lighting control panels. Each IP access connection shall be capable of being remote to the VT5 server, however must be on the same IP network.
 - g. Import AutoCAD (DXF), .PNG, .JPG, or .SVG files
 - h. Calendar interface – Software provides a centralized calendar to schedule Day Event Schedules. Each day event schedule can be individual day or reoccurring. Each day event schedule can support multiple schedule items for any area that is defined on the Interactive floor plan.
 - i. Calendar interface – Software supports multiple calendars based on defined floors and areas.
8. (Optional) The lighting zones may be controlled using standard calendar based scheduling software. Create events which include individual and groups of relays and link them to any time and day on the calendar. This software package for lighting control event scheduling is called Event Manager. This software requires a SQL Server for operation connected to the lighting control system via the Ethernet Interface Module.
9. BACnet Interface; Cooper Lighting Solutions Model ProtoNode FPC-N34:
10. The Room Controller network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual relays, relay groups and read the status of those relays. The Room Controller network shall respond efficiently to the requested information from the BACnet network.
11. The ProtoNode provides up to 10,000 points of control and can communicate to multiple panel types.
12. Provide PIC list definition and object model to other system manufacturers.
13. LonWorks Interface; Cooper Lighting Solutions Model FPC-N35:
 - a. Provide ability to communicate by means of LonWorks FTT-10 communication to centralized lighting system from user-supplied LonWorks FTT-10 twisted pair network.
14. The Room Controller network shall permit data protocol translation through a building automation interface Gateway. The LON Gateway shall permit LonWorks communication protocol to operate individual relays, relay groups and read the status of those relays. The Room Controller network shall respond efficiently to the requested information from the LonWorks network.

15. The ProtoNode provides up to 4,096 points of control and can communicate to multiple panel types.
 - a. Provide LonWorks interface object model specification to secondary equipment manufacturers.
16. The Room Controller Network has several other lighting control panels types that may be utilized to enhance your lighting control application. At least one ControlKeeper® lighting control panel must exist on a Room Controller network.
17. ControlKeeper® Metering or Metering with Breakers (CKM or CKMB)
 - a. The CKM or CKMB shall provide additional flexibility by providing up to 48 - 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CKM or CKMB controllers, although accessible through the network, shall be fully stand-alone in their control capability. The CKM or CKMB provides full status indication of CPU status, network communication, power, and HOA overrides. The CKM or CKMB shall provide a TouchScreen panel processor for programming and control functionality. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 128 additional global commands for network control and shall reside in the CKM or CKMB. Networks that rely on a single time clock for system operation shall not be acceptable.
18. ControlKeeper® TouchScreen (CKT)
 - a. The CKT shall provide additional flexibility by providing up to 48 - 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CKT controllers, although accessible through the network, shall be fully stand-alone in their control capability. The CKT provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide thirty-two, 3-wire or 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 128 additional global commands for network control and shall reside in the CKT. Networks that rely on a single time clock for system operation shall not be acceptable.
19. ControlKeeper® 4A (CK 4A)
 - a. The CK 4A shall provide additional flexibility by providing four 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4A shall optionally provide four, 0-10VDC outputs to control dimming ballasts. The CK 4A controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4A provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four, 3-wire or eight, 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4A. Networks that rely on a single time clock for system operation shall not be acceptable.
20. ControlKeeper® 4 (CK 4)
 - a. The CK 4 shall provide additional flexibility by providing four normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully

programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4 provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4. Systems that utilize the parent child topology shall not be acceptable.

21. ControlKeeper® 2 (CK 2)
- a. The CK 2 shall provide additional flexibility by providing two normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 2 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 2 provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide two dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 2. Systems that utilize the parent child topology shall not be acceptable.

2.13 EMERGENCY LIGHTING

- A. Room Controller with emergency relay – The Room Controller is a UL 924 listed device that monitors normal power circuit to the Room Controller. The Room Controller has a dedicated UL 924 output which includes emergency power line in and emergency power load out connections. The UL 924 relay will track with output 1 (Yellow) during normal power operations. Upon loss of normal power the UL 924 output will force the emergency lighting On and full bright (if dimming) until normal power is restored. Features include:
1. 120-277VAC, 50/60 Hz, 3 amp ballast rating.
 2. Ladderless testing: Push the "All Off" button on any wallstation four times [e-mer-gency], will turn off normal lighting and force UL 924 emergency output On and full bright.
 3. Auxiliary input for remote Alert Mode (All On, and full bright).
 4. Cooper Lighting Solutions Catalog Number: RC3DE, RC3DE-PL.
- B. Emergency Power Control – A UL 924 listed device installs down line of an output that monitors a switched or dimmed circuit providing normal lighting to an area. The unit provides normal ON/OFF or 0-10V dimming control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
1. 120-277 volts, 50/60 Hz., 20 amp ballast rating.
 2. Push to test button.
 3. Cooper Lighting Solutions Catalog Numbers:
 - a. CEPC-1 (switching)
 - b. CEPC-1-D (0-10V dimming)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits.
- B. All low voltage smart devices shall connect using QuickConnect wire provided by Cooper Lighting Solutions. When using wire for connections other than the QuickConnect low voltage wire (pre-defined lengths of RJ45 cable), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contractor termination requirements.
- C. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- D. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.).
 - 3. Load parameters (e.g. blink warning, etc.).

3.02 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

END OF SECTION 260923

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Floor service outlets.
 - 4. Switches, dimmers, occupancy sensors.

1.03 DEFINITIONS

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

1.04 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. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer.

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

1.06 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Leviton Mfg. Company Inc. (Leviton).
 - 2. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
 - 3. Hubbell, Inc.; Wiring Devices.
 - 4. Wiremold Company (The)
 - 5. Lutron.

2.02 RECEPTACLES

- A. Straight Blade Convenience Receptacles, heavy-duty specification grade, decory style, 125 V, 20 A, Plug Tail-Type: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A. Straight blade, non-feed-through to be used in all locations, Plug Tail-type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
 - 1. All receptacles located with weatherproof cover plates shall be classified in this category.
- C. Twist-lock Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498 or Nema configuration as indicated on the drawings.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.
- D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
 - 1. Devices: Listed and labeled as isolated-ground receptacles.

2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- E. Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
- F. Surface mounted outlet boxes shall be utilized only in conjunction with exposed conduits and shall be of the cast metal type with internal hubs and mounting flanges.

2.03 CORD AND PLUG SETS

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

2.04 SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: General-Duty grade, Decora Style.
- C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
1. Switch: 20 A, 120/277-V ac.
 2. Receptacle: NEMA WD 6, Configuration 5-15R.
- D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
 2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
 3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
- E. Wallbox Occupancy Sensor: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft., option to choose Auto-ON or Manual-ON. Subject to compliance with requirements, provide one of the following:
1. Watt Stopper (The); DW-100/DW-200.
 2. Hubbell;
 3. Leviton;

2.05 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. No plastic coverplates.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant with in-use protection and a lockable cover. All receptacles requiring a weatherproof cover plate shall be GFCI protected. These include but are not limited to the following;
 - 1. Outdoor areas

2.06 FLOOR SERVICE FITTINGS

- A. Floor Box
 - 1. The floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be fully adjustable, providing a maximum of 1 3/8" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate workstation connectivity outlets and modular inserts, Wiremold RFB2 or RFB4 or as approved.
- B. Activation Covers
 - 1. Activation covers shall be manufactured of die-cast aluminum or die-cast zinc, and be available in a brushed aluminum finish, plated brass finish, or a powder-coated paint finish. Finish to be verified with Architect for each area of facility. Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, flush covers, or covers with one 1" trade size screw plug opening and one combination 1 1/4" and 2" trade size screw plug openings for furniture feed applications.
 - 2. Flanged covers shall be Wiremold S38BBTCXX, S38CCTCXX or S38PPTCXX or as approved.
 - 3. Flangeless covers shall be Wiremold S39BBTCXX, S39CCTCXX or S39PPTCXX or as approved.
 - 4. The activation cover shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
- C. Power Receptacle: NEMA WD 6 configuration 5-20R, finish by architect, unless otherwise indicated. White

2.07 POKE-THROUGH ASSEMBLIES

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
 2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 4. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of two, 4-pair, Category 5 voice and data communication cables.

2.08 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish. White
- C. Wire: No. 12 AWG.

2.09 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color. For existing building, designs shall match the existing color scheme that is prevalent throughout building.
1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing. White
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.01 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 (152 mm) 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.
10. Ground per specification section "Grounding and Bonding for Electrical Systems"

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, 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. Outlet boxes are to be sealed at exterior walls and as needed in other locations.

H. Outlet boxes shall be supported independent from the raceway system.

I. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.
- K. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 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.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
 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 UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:

- 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches and switchboards.
 - 2. Spare-fuse cabinets.

- B. SUBMITTALS

- C. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

- 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

- D. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

- 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 4. Coordination charts and tables and related data.

1.03 QUALITY ASSURANCE

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

1.04 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.05 COORDINATION

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

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Provide three (3) of each size used.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 CARTRIDGE FUSES

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

2.03 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
 - 5. Location: Main electrical room.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class RK1, time delay.
 - 2. Motor Branch Circuits: Class RK5, time delay.
 - 3. Other Branch Circuits: Class RK5, time delay Class J, fast acting.

3.03 INSTALLATION

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

3.04 IDENTIFICATION

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

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches
 - 2. Nonfusible switches
 - 3. Shunt trip switches
 - 4. Molded-case circuit breakers (MCCBs)
 - 5. Enclosures

1.03 DEFINITIONS

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

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.05 SUBMITTALS

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

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.06 PROJECT CONDITIONS

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

1.07 COORDINATION

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

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, 600A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

2.02 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Provide auxiliary contacts to break contact to motor drives when used with motors.

2.03 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight green ON pilot light.
3. Isolated neutral lug; 200 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.04 MOLDED-CASE CIRCUIT BREAKERS

- 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. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. 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.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- G. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

6. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.
7. Accessory Control Power Voltage: ; 12-V dc and 24-V dc.

2.05 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas if Indicated on Drawings: NEMA 250, Type 7 or Type 9.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices and provide spare fuses for each fusible device.
- E. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements 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 metal or laminated-plastic nameplate.

END OF SECTION 262816

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Performance requirements.
 - 2. Luminaire requirements.
 - 3. Materials.
 - 4. Metal finishes.
 - 5. Luminaire support.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The

adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.
- D. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
1. Include Samples of luminaires and accessories involving color and finish selection.
- E. Samples for Verification: For each type of luminaire.
1. Include Samples of luminaires and accessories to verify finish selection.
- F. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- G. All submittal reviews for luminaires and ballasts, light engines/modules and drivers shall include the following:
1. Catalog cut sheets and replacement costs.
 2. Lists of spare parts with quantities to be furnished.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
 4. Structural members to which luminaires will be attached.
 5. Initial access modules for acoustical tile, including size and locations.
 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.

- b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of luminaire.
- E. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
- 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Provide the following spare parts with the listed quantities for all luminaires for each item and size required: Spare products shall be the percentage or the minimum, whichever is greater. Spares are to be added to OSU FS Stores warehouse inventory. All re-order information, for lamps, ballasts, lighting modules, and drivers shall be provided to OSU FS Stores.
 - 2. Ballasts/drivers: 5 percent or a minimum of three (3) of each type.
 - 3. Lamp Sockets: 10 percent or a minimum of ten (10) of each type.
 - 4. Fixture Lenses and Supporting Hardware: 10 percent or a minimum of ten (10) of each type.
 - 5. Specialty lamps or light modules (those not carried by the OSU FS "Stores"): 10 percent or a minimum ten (10) of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
1. Obtain Architect's approval of luminaires in mockups before starting installations.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance:
1. Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 2. Luminaires and lamps shall be labeled vibration and shock resistant.

3. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
- B. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).
 1. Relative Humidity: Zero to 95 percent.
- C. Altitude: Sea level to 1000 feet (300 m).

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. Lumen output per Drawings.
- E. CRI per Drawings.
- F. CCT per Drawings.
- G. Rated lamp life of 50,000 hours to L70.
- H. Dimmable from 100 percent to zero percent of maximum light output.
- I. Internal driver.
- J. User-replaceable lamps.

2.3 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.
 2. Sheet metal components shall be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.

- B. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
 - 1. Manufacturer's standard grade.
 - 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: **1/2-inch (13-mm)** steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, [**12 gage (2.68 mm)**].
- D. Rod Hangers: **3/16-inch (5-mm)** minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaires:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Suspended Luminaires:
 - 1. Ceiling Mount:
 - a. Two **5/32-inch- (4-mm-)** diameter aircraft cable supports adjustable to **10 feet (3 m)** in length.
 - 2. Pendants and Rods: Where longer than **48 inches (1200 mm)**, brace to limit swinging.
 - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

- H. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."
- B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.

2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Luminaire requirements.
 - 2. Luminaire types.
 - 3. Materials.
 - 4. Finishes.
 - 5. Luminaire support components.

1.03 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project, IES LM-79 and/or IES LM-80.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

- b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- 6. Wiring diagrams for power, control, and signal wiring.
- 7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.
- D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For luminaire supports.
 - 1. Include design calculations for luminaire supports and seismic restraints.
- F. All submittal reviews for luminaires and ballasts, light engines/modules and drivers shall include the following:
 - 1. Catalog cut sheets and replacement costs.
 - 2. Lists of spare parts with quantities to be furnished.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Luminaires.
 - 2. Structural members to which luminaires and devices will be attached.
 - 3. Underground utilities and structures.
 - 4. Existing underground utilities and structures.
 - 5. Above-grade utilities and structures.
 - 6. Existing above-grade utilities and structures.
 - 7. Building features.
 - 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
 - 1. Luminaire.
- E. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Provide the following spare parts with the listed quantities for all luminaires for each item and size required: Spare products shall be the percentage or the minimum, whichever is greater. Spares are to be added to OSU FS Stores warehouse inventory. All re-order information, for lamps, ballasts, lighting modules, and drivers shall be provided to OSU FS Stores.
 - 1. Ballasts/drivers: 5 percent or a minimum of three (3) of each type.
 - 2. Lamp Sockets: 10 percent or a minimum of ten (10) of each type.
 - 3. Fixture Lenses and Supporting Hardware: 10 percent or a minimum of ten (10) of each type.
 - 4. Specialty lamps or light modules (those not carried by the OSU FS "Stores"): 10 percent or a minimum ten (10) of each type.

1.08 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- E. Mockups: For exterior luminaires, complete with power and control connections.
 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61 or IEC 60061-1.
- F. Bulb shape complying with ANSI C79.1.
- G. CRI: per Drawings.
- H. L70 lamp life of 50,000 hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: per Drawings.
- L. Lamp Rating: Lamp marked for outdoor use.
- M. Source Limitations:
 - 1. Obtain luminaires from single source from a single manufacturer.
 - 2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.02 LUMINAIRE TYPES

- A. Area and Site:
 - 1. Luminaire Shape: per Drawings.
 - 2. Mounting: Building.
 - 3. Luminaire-Mounting Height: per Drawings.
 - 4. Distribution: per Drawings.
 - 5. Diffusers: per Drawings.
 - 6. Housings: per Drawings.

2.03 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- C. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. 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.
- F. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.04 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - a. Color: per Drawings.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color:
 - 1) As selected from manufacturer's standard catalog of colors.
 - 2) Match Architect's sample of manufacturer's standard color.
 - 3) As selected by Architect from manufacturer's full range.

2.05 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls and roofs for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls, attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members, or attached using through bolts and backing plates on either side of wall.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.04 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.05 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.06 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. 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.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.08 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

SECTION 284621.11 – DIGITAL, ADDRESSABLE FIRE ALARM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Manual fire-alarm boxes.
 - 2. System smoke detectors.
 - 3. Heat detectors.
 - 4. Notification appliances.

1.03 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. The contractor will be responsible for providing the design of the fire alarm system in compliance with this design-build specification.
 - 2. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 3. Include plans, elevations, sections, details, and attachments to other work.
 - 4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor

- sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
5. Detail assembly and support requirements.
 6. Include voltage drop calculations for notification-appliance circuits.
 7. Include battery-size calculations.
 8. Include input/output matrix.
 9. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. The fire alarm designer will also have the necessary credentials as required by the State of Oregon and the City of Corvallis.
 - d. Licensed or certified by authorities having jurisdiction.
- D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.06 SAMPLE WARRANTY: FOR SPECIAL WARRANTY.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.09 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 - 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
- C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and audible/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the existing building system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 MANUAL FIRE-ALARM BOXES

- A. Provide devices compatible with the buildings existing fire alarm system.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.

2.03 SYSTEM SMOKE DETECTORS

- A. Provide devices compatible with the buildings existing fire alarm system.
- B. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors shall be four-wire type.
 - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Multiple levels of detection sensitivity for each sensor.
 - b. Sensitivity levels based on time of day.
- C. Photoelectric Smoke Detectors:
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector shall be Simplex model 4098-9756 and powered through the existing Fire Alarm Panel.
2. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
3. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
4. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
5. Each sensor shall have multiple levels of detection sensitivity.
6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
7. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.04 PROJECTED BEAM SMOKE DETECTORS

- A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
- B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.
- C. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 1. Primary status.
 2. Device type.
 3. Present average value.
 4. Present sensitivity selected.
 5. Sensor range (normal, dirty, etc.).

2.05 HEAT DETECTORS

- A. Provide devices compatible with the buildings existing fire alarm system.
- B. General Requirements for Heat Detectors: Comply with UL 521.
 - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.06 NOTIFICATION APPLIANCES

- A. Provide devices compatible with the buildings existing fire alarm system.
- B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, white.

2.07 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Control Module:
 - 1. Operate notification devices.

2.08 MECHANICAL EQUIPMENT AND CONTROL INTENT

- A. Refer to Division 23 specification sections and drawings for a list of equipment that require a fire alarm interface connection. All final sequence logic shall be design-build per fire alarm contractor. Final design shall be design-build per fire alarm contractor. Fire alarm system to shut down HVAC systems over 2000 cfm.

2.09 LIGHTING CONTROLS INTENT

- A. Refer to Division 26 specification sections and drawings for a list of lighting control zones that require a fire alarm interface connection. The intent is for the fire alarm system to send a signal to all control zones that are part of the egress path. Upon signal, the lighting controls will be overridden and lights will be driven to full output by a control device provided by Division 26.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Fire alarm system installation shall be supervised by a contractor NICET certified at Level II in Fire Alarm Systems.
- C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Connect new equipment to existing monitoring equipment at the supervising station.
 - 3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- D. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- E. Smoke- or Heat-Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
 - 5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
 - 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- F. Electrical contractor to field verify that existing air handlers have smoke detectors for system shutdown, If not, these shall be added as part of the project scope.
- G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

3.03 PATHWAYS

- A. Pathways shall be installed in EMT. Provide a minimum 3/4 inch Electrical Metallic Tubing (EMT) for fire alarm wiring. A single cable run to a single device may be installed in 1/2 inch EMT. Provide a minimum 4 inch square box for junctions and terminations.

3.04 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm-initiating connection to activate emergency lighting control.
 - 2. Smoke dampers in air ducts of designated HVAC duct systems.
 - 3. Magnetically held-open doors.
 - 4. Electronically locked doors and access gates.
 - 5. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 6. Data communication circuits for connection to building management system.

3.05 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Provide labeling of all devices and appliances with their respective system address. Label to be produced from an electronic labeling system visible from the floor without magnification. Hand written labels are not acceptable.
- C. Provide labeling of all conductors and cables at termination points in panels, cabinets and junction boxes. Label to be produced from an electronic labeling system. Hand written labels are not acceptable.

3.06 GROUNDING

- A. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.07 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.08 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.09 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Train owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111