

## **SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

#### 1.2 SUMMARY

##### A. Section Includes:

- 1. General requirements applicable to components and systems included in Electric Contract.

##### B. Products Installed but Not Furnished Under This Section

- 1. Make electrical connections to equipment shown on Drawings and furnished by other Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Contractor furnishing equipment.

#### 1.3 REFERENCES

- A. AIA American Institute of Architects
- B. ADA Americans with Disabilities Act
- C. AISC American Institute of Steel Construction
- D. ANSI American National Standards Institute
- E. ASTM ASTM International
- F. IBC International Building Code
- G. IEEE Institute of Electrical and Electronics Engineers, Inc. (The)
- H. IES Illuminating Engineering Society of North America
- I. NEC National Electrical Code
- J. NEMA National Electrical Manufacturers' Association
- K. NETA International Electrical Testing Association
- L. NFPA National Fire Protection Association
- M. UL Underwriters' Laboratories, Inc.

#### 1.4 SYSTEM DESCRIPTIONS

- A. Inspection of Existing Systems: Inspect each existing system scheduled for modification in presence of Authorized Owner's Representative and issue a deficiency report to Owner and Architect listing conditions found prior to any removals, relocations, or additions. Modified systems include (but are not limited to):

1. Power distribution.
  2. Lighting.
  3. Emergency lighting.
- B. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):
1. Wiring and raceway for work specified in Project Manual and shown on Drawings.
  2. Electrical devices and equipment for work specified in Project Manual and shown on Drawings.
  3. Systems included, but not limited to:
    - a. Electrical distribution.
    - b. Electrical connections.
    - c. Lighting.
    - d. Emergency lighting.
- C. Electric Layouts: Arrange panels; disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch fire treated, gray painted plywood backboards for surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.
- D. Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Owner. Confirm with Owner prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

## 1.5 SUBMITTALS

- A. General Division 26 submittal requirements:
1. Comply with requirements of SECTION 01 33 00 – SUBMITTAL PROCEDURES and as modified below.
  2. Product Data: Submit product data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.
    - a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under the same cover sheet.

- b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data and, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in the "Part 2 – Products" of each technical section.
- 3. Shop Drawings: Submit detailed drawings for electrical equipment layouts, showing exact sizes and locations for approval before beginning work.
  - a. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.
  - b. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space other pertinent revisions to arrangement and configuration shown in Contract Documents.
- 4. Samples: On all submittals, indicate standard factory color and factory finish surfaces. Where more than one color is available, selection will be made by Architect from manufacturer's full range of colors. Electronically transmitted color samples are not acceptable.

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for penetration firestopping materials. Include ratings, furnished specialties and accessories.
  - 1. Penetration firestopping materials.
  - 2. Penetration firestopping assembly drawings.

## 1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Codes and Standards: Comply with applicable Federal, State and local building and electrical codes, laws, ordinances, and regulations, and comply with applicable NFPA, National Electrical Code and utility company requirements and regulations. Provide Underwriters Laboratories Seal on all materials.
  - 2. Permits and Inspections: Obtain approvals, tests, and inspections required by Architect, Engineer, local electrical inspector, agent or agency specified in Project Manual, or National, State, or local codes and ordinances.
    - a. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.

- b. Furnish materials and labor necessary for tests and pay costs associated with tests and inspections.
  - c. Conduct tests under load for load balancing and where required by codes, regulations, ordinances, or technical Specification.
3. 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.

## 1.8 DELIVERY, STORAGE AND HANDLING

### A. Storage and Protection:

1. Take precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
2. Replace equipment damaged beyond reasonable repair as required by Architect.
3. Refinish any equipment with marks, stains, scratches, dents, and other aesthetic damage that doesn't impede operation of equipment as required by Architect.

## 1.9 COORDINATION OF WORK

### A. New Construction:

1. Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric Contract systems and components): Coordinate requirements with General Contractor for inclusion in General Contract. Furnish necessary information (e.g. locations and sizes) to General Contractor in ample time for installation of systems and components included in Electric Contract.
2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Contract construction that are to be installed in construction included in General Contract.
3. Locate settings, check locations as installation in General Contract progresses, and provide templates or holding fixtures as required to maintain proper accuracy.

### B. Existing Construction:

1. Unless otherwise specified, employ Contractor responsible for General Work for all cutting, patching, repairing, and replacing of general work required for installation of systems and components included in Electric Work. Secure approval from Architect's representative before cutting.
2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Work construction that are to be installed in construction included in General Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

3. Access Doors: Provide access doors shown on Drawings, or as required for access to pull boxes, junction boxes, relays and other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

#### 1.10 ALTERATION PROCEDURES

- A. In locations where existing devices are indicated to be disconnected and removed and existing power circuit or communications cable is not scheduled to be reused:
  1. Remove circuit conductors back to source.
  2. Modify panel directory for that circuit.
  3. Remove all existing exposed and unexposed accessible raceway.
  4. Provide blank cover plates or wall infill (as indicated on plans) and as described below:
    - a. For single gang and multi-gang switch boxes in public or occupied spaces; stainless steel coverplates.
    - b. For single gang and multi-gang boxes in un-occupied spaces; stainless steel, galvanized steel or PVC coverplates.
    - c. For boxes larger than standard switch boxes in public or occupied spaces; remove existing box and provide wall infill, matching existing sub-surface and finished surface conditions. Paint wall to match surrounding finishes.
    - d. For boxes larger than standard switch boxes in un-occupied spaces; 18 gage galvanized sheet metal coverplate with machined edges. Prime and paint to match surrounding finish conditions.
  5. Patch and paint existing walls where disturbed by the electrical work.
- B. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain necessary circuitry to existing devices for complete and proper operation.
- C. In locations where entire existing system is being removed or modified:
  1. Refer to individual system specification sections for documentation and inspection requirements prior to any alteration work on any system.
  2. Take all necessary measures to ensure that down time will not compromise safety.
  3. Notify Owner, Architect and other Contractors not less than 2 weeks prior to interruptions in service.
  4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.

## PART 2 - PRODUCTS

### 2.1 PENETRATION FIRESTOPPING

- A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 "Penetration Firestopping".
- B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint and complies with local regulations.
  - 1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.
- C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

### 2.2 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

### 2.3 SEALANTS

- A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."
- B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following::
    - a. BASF Building Systems; Omniplus.
    - b. Dow Corning Corporation; 786 Mildew Resistant.
    - c. GE Advanced Materials - Silicones; Sanitary SCS1700.

### 2.4 ACCESS DOORS

- A. Comply with requirements for access doors specified in Section 08 31 13 "Access Doors and Frames" for product requirements.

## 2.5 PAINT AND FINISHES

- A. Refer to Division 09 for painting and finishing.

## PART 3 - EXECUTION

### 3.1 CUTTING AND PATCHING

- A. Do not cut and vapor barriers or waterproofing for admission of any equipment or materials and do not pierce any structural members without written permission from Architect.
- B. Furnish and install sleeves, inserts, panels, raceways, boxes, and similar infrastructure., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.
- C. Unless otherwise noted elsewhere in Contract Documents, bear expense of cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Contract or damage done by Electric Contract. Employ and pay Contractor whose work is involved.

### 3.2 GROUTING

- A. Mix and install grout for electrical equipment base bearing surfaces, other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

### 3.3 SEALANTS

- A. Install sealants according to the requirements specified in Section 07 92 00 "Joint Sealants."

### 3.4 FIRESTOPPING

- A. Install firestopping according to the requirements specified in Section 07 84 13 "Penetration Firestopping."
- B. Applied Fireproofing:
  - 1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Electrical Work installation.
  - a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.
- C. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

### 3.5 ACCESS DOORS

- A. Install access doors according to the requirements specified in Section 08 31 13 “Access Doors and Frames.”

END OF SECTION 26 05 00

## **SECTION 26 05 01 – HAZARDOUS MATERIAL DISPOSAL**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Selective removal and subsequent off-site disposal of the following hazardous waste:
  - a. PCB containing light ballasts.
  - b. Mercury containing fluorescent light tubes.
- 2. Requirements for transport and disposal of hazardous waste materials by legal and appropriate means.

- B. Related Sections

- 1. Supplementary Conditions: Additional insurance requirements for hazardous waste disposal.

#### 1.3 REFERENCES

- A. Regulatory Requirements

- 1. United States Environmental Protection Agency (EPA)
  - a. 40 CFR 260 - Hazardous waste management system: General
  - b. 40 CFR 261 - Identification and Listing of Hazardous Waste.
  - c. 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste.
  - d. 40 CFR 263 - Standards Applicable to Transporters of Hazardous Waste
  - e. 40 CFR 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
  - f. 40 CFR 265 - Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
  - g. 40 CFR 266 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
  - h. 40 CFR 268 - Land Disposal Restrictions
  - i. 40 CFR 270 - EPA Administered Permit Programs: The Hazardous Waste Permit Program
  - j. 40 CFR 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions.

2. United States Department of Transportation (DOT)
  - a. 49 CFR 171 - General Information, Regulations, and Definitions.
  - b. 49 CFR 172 - Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
  - c. 49 CFR 173 - Shippers - General Requirements for Shipments and Packaging.
  - d. 49 CFR 174 - Carriage by Rail.
  - e. 49 CFR 175 - Carriage by Aircraft.
  - f. 49 CFR 176 - Carriage by Vessel.
  - g. 49 CFR 177 - Carriage by Public Highway.
  - h. 49 CFR 178 - Specifications for Packaging.
  - i. 49 CFR 179 - Specifications for Tank Cars.
  - j. 49 CFR 180 - Continuing Qualification for Maintenance of Packaging.
  
3. New York State Department of Environmental Conservation (DEC)
  - a. 6 NYCRR 360 - Solid Waste Management Facilities
  - b. 6 NYCRR 364 - Waste Transporter Permits
  - c. 6 NYCRR 370 - Hazardous Waste Management System: General.
  - d. 6 NYCRR 371 - Identification and Listing of Hazardous Wastes.
  - e. 6 NYCRR 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities.
  - f. 6 NYCRR 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements.
  - g. 6 NYCRR 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.
  - h. 6 NYCRR 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waster Facilities.
  - i. 6 NYCRR 376 - Land Disposal Restrictions.

#### 1.4 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain Owner's property.

#### 1.5 PROJECT SITE

- A. Existing Conditions
  1. Building Occupancy: Owner will occupy portions of building immediately adjacent to areas of hazardous material removal operations. Conduct removal operations in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of removal activities that will affect Owner's normal operations.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

- A. Labeling and Packaging Materials: Provide labeling and packaging materials as required by 49 CFR 173 Shippers - General Requirements for Shipments and Packaging.
- B. Hazardous Waste Disposal Vehicles: Provide vehicles for transporting hazardous waste possessing valid Industrial Waste Hauler Permit and equipped with appropriate placards affixed as prescribed by United States Department of Transportation regulations.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which hazardous material disposal is to be conducted and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely hazardous material disposal. Do not proceed with disposal until unsatisfactory conditions have been corrected.

### 3.2 REMOVAL, PACKAGING, TRANSPORTATION AND DISPOSAL PROCEDURES

- A. Removal: Remove light ballasts and fluorescent light tubes whole and intact. Do not release PCBs or mercury to the environment.
- B. Packaging: Package, label, and mark all hazardous waste materials in accordance with applicable requirements of 49 CFR 173, 178 and 179.
- C. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal to prevent damage or vandalism.
- D. Disposal - Transport hazardous waste to treatment or disposal facility that:
  - 1. Is permitted, licensed or registered by state to dispose of hazardous waste;
  - 2. Has interim status to dispose of hazardous waste;
  - 3. Is authorized to manage hazardous waste under Resource Conservation and Recovery Act (RCRA) or
  - 4. Is facility which:
    - a. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
    - b. Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation.

### 3.3 ADJUSTING/CLEANING

- A. At least weekly, remove from building site debris, rubbish, and other materials resulting from hazardous material disposal operations.
  - 1. If additional hazardous materials are encountered during hazardous material disposal operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
  - 2. Burning of removed materials not permitted on Project Site.
  - 3. Transport materials removed and legally dispose off-site.

END OF SECTION 26 05 01

## **SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Building wires and cables rated 2000 V and less.
  - 2. Connectors, splices, and terminations rated 2000 V and less.

#### 1.3 DEFINITIONS

- A. VFC: Variable-frequency controller.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. 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. 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. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable used in VFC circuits.

- E. Conductors: Copper complying with NEMA WC 70/ICEA S-95-658.
  - 1. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2 and Type XHHW-2.
- F. Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.
  - 1. VFC Cable: Type TC-ER VFD with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

## 2.2 CONNECTORS AND SPLICES

- 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. Hubbell Power Systems, Inc.
  - 3. O-Z/Gedney; EGS Electrical Group LLC.
  - 4. 3M; Electrical Products Division.
  - 5. Tyco Electronics Corp.
  - 6. Ideal Industries/Buchanan
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 1. Conductors No. 8 AWG and smaller: Screw on, wing nut wire connectors with fixed square wire threads and wide throated skirt. UL 486C Listed.
  - 2. Conductors No. 6 AWG to 3/0 AWG: Bolt on type or crimped type compression, seamless copper connectors using hand or hydraulic tool, color coded to wire size. Connector shall be electro-tin plated to resist electrolytic corrosion. UL 486A and UL 486B Listed.
  - 3. Conductors No. 4/0 AWG and larger: Compression type solderless connector, long barrel seamless copper with minimum 2 pressure points per conductor. Fully compatible with industry standard crimping tool-die sets. Color coded to wire size and electro-tin plated to resist electrolytic corrosion. UL 486A Listed.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; stranded.
- B. Branch Circuits: Copper, stranded.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway].
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, 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. VFC Output Circuits: Type TC-ER cable with braided shield.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Wire and Cable Installation: Install all wire and cable in approved raceway with exit light circuits, emergency lighting circuits, and special systems wiring installed in separate raceways. Use UL approved lubricants for wire pulling. Tag all feeders, subfeeders, special system wiring and branch circuit wiring at each pull box, junction box, and gutter space indicating point of origin and termination. Install green grounding wire in all raceways for connection to equipment, motors, transformers, and similar equipment. Install low voltage cables as detailed in individual sections.
- B. Splices and Terminations: Make all splices accessible. Insulate all splices, taps, and connections to insulation value of conductor. Follow all instructions and recommendations of splice material manufacturer. Terminate low voltage cables with termination blocks as described in individual sections.
  - 1. Common Neutral Conductor: Do not use common neutral for multiple branch circuits.
- C. Pull all conductors together where more than one is being installed in raceway.
- D. Do not exceed maximum pulling tension of wire being installed. Use pulling compound or lubricant, where necessary. Use compound that will not deteriorate conductor or insulation.
- E. Use pulling means, including fish tape, cable or rope that cannot damage raceway or wire.
- F. Replace wiring damaged during installation.
- G. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- H. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- I. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- J. 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.
- K. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- M. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- N. Metal Clad Type "MC" Cable:
  - 1. Install MC cable, parallel and perpendicular to surfaces or structural members following surface contours, where possible.
  - 2. Do not use MC cable for home runs (from panel to first device in branch circuit).
  - 3. Do not install exposed metal clad cable in any areas, including mechanical and electrical spaces.
  - 4. Do not penetrate floor slabs with MC cable.
  - 5. Metal clad cable may be used for switch, receptacle, light fixture, device and fixture branch circuit wiring above ceilings and in walls beyond corridor walls.
  - 6. MC cable shall include a neutral, whether used or not, to a light switch location.
  - 7. Above corridor ceilings, use MC cable for 6 foot light fixture whips.
  - 8. Maintain a clearance of at least 6 inches from hot water and other high temperature pipes and telecommunications conduits, and at least 12 inches from unshielded telecommunications cables.
  - 9. Support MC cable every 6 feet, and within 1 foot of every box, fitting, and cable termination. Do not support MC cable on hung ceilings or on ceiling support wires. The use of cable ties to support MC cable is prohibited.
  - 10. Use MC cable in branch circuit wiring in movable metal partitions and movable gypsum partitions. Install conductors in accordance with partition manufacturer's recommendations.

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Splices:
  - 1. Dry Locations:
    - a. Conductors No. 8 AWG or Smaller: Use spring type pressure connectors or indent type pressure connectors with insulating jackets (except where special type splices are required).
    - b. Conductors No. 6 AWG or Larger: Use un-insulated indent type pressure connectors. Fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with heat shrinkable splices.
    - c. Gutter Taps in Panelboards: Install gutter tap, fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with gutter tap cover.
  - 2. Damp Locations: As specified for dry locations, except apply moisture sealing tape over entire insulated connection (moisture sealing tape not required if heat shrinkable splices are used).
  - 3. Wet Locations: Use un-insulated indent type pressure connectors and insulate with resin splice kits or heat shrinkable splices. Exception: Totally enclosed splices above ground protected in NEMA 3R, 4, 4x enclosures may be spliced as specified for damp locations.
- E. Terminations:
  - 1. Conductors No. 10 AWG or Smaller - Use terminals for:
    - a. Connecting control and signal wiring to terminal strips.
    - b. Connecting wiring to equipment designed for use with terminals.
  - 2. Conductors No. 8 AWG or Larger - Use compression or mechanical type lugs for:
    - a. Connecting cables to flat bus bars.
    - b. Connecting cables to equipment designed for use with lugs.
  - 3. For Conductor Sizes Larger than Terminal Capacity on Equipment: Reduce larger conductor to maximum conductor size that terminal can accommodate (reduced section not longer than one foot). Use compression or mechanical type connectors suitable for reducing connection.

- F. Provide insulated green ground conductor for each branch and feeder circuit.
- G. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- H. All connections and terminations installed according to manufacturer's recommendations.
- I. All bolted or screw-type terminations specifically torqued to setting specified by manufacturer.

### 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

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

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
  - 2. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey after electrical system activation and is under load.

- c. Inspect compression applied connectors for correct cable match and indentation.
  - d. Inspect for correct identification.
  - e. Inspect cable jacket and condition.
  - f. Insulation-resistance test on each conductor with respect to ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice and termination in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
- 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 and terminations checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice and termination 11 months after date of Substantial Completion.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
- 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

## **SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes: Grounding and bonding systems and equipment.

#### 1.3 QUALITY ASSURANCE

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

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

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

#### 2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: No. 6, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
  - 7. Tinned Bonding Jumper: Tinned-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 inch thick by 2 inches wide by 8 inches long (6.3 by 50 mm by 200 mm), 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. fiberglass reinforced polyester, impulse tested at 5000 V.

## 2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless, non-reversible compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Non-reversible compression or exothermic-type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Non-reversible compression or exothermic-type, copper or copper alloy.
- J. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install stranded conductors for all sizes unless otherwise indicated.
- B. 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 Structural Steel: Welded connectors.

### 3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
  - 7. Armored and metal-clad cable runs.
  - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- 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. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a grounding system complying with requirements in TIA/ATIS J-STD-607-A.
  - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
  - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

### 3.3 INSTALLATION

- A. 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.
- B. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

### 3.4 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

### 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare and submit all test and inspection reports.
- D. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity to 1000 kVA: 5 ohms.
  2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

## **SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.

#### 1.3 DEFINITIONS

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

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

#### 1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

### PART 2 - PRODUCTS

#### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. 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:
    - 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. U-Channel Strut Systems: Provide 16 gauge steel U-channel strut system for supporting electrical equipment of types and sizes indicated with 9/16-inch diameter holes at 8 inches on center on top surface, with standard galvanized or PVC finish and following fittings that mate and match with U-channel:
    - a. Fixture hangers.
    - b. Channel hangers
    - c. End caps
    - d. Beam clamps
    - e. Wiring stud.
    - f. Thin-wall raceway clamps.
    - g. Rigid conduit clamps.
    - h. Raceway hangers.
    - i. U-bolts.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. 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) Hilti Inc.
    - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 3) MKT Fastening, LLC.
    - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - 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) Cooper B-Line, Inc.; a division of Cooper Industries.
    - 2) Empire Tool and Manufacturing Co., Inc.
    - 3) Hilti Inc.
    - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

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

## 2.3 MANUFACTURED SUPPORTING DEVICES

- A. General: Provide supporting devices, complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as specified in this Section. Where more than one type of device meets indicated requirements, select device according to Contractor's option.
  - 1. Fasteners:
    - a. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
    - b. Lag Bolts: FS FF-B-561, square head type.
    - c. Machine Screws: FS FF-S-92, cadmium plated steel.
    - d. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
    - e. Wood Screws: FS FF-S-111 flat head carbon steel.
    - f. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
    - g. Lock Washers: FS FF-W-84, helical spring type carbon steel.
    - h. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.
    - i. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work.

## PART 3 - EXECUTION

### 3.1 APPLICATION

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

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT 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. Fasteners
  - 1. Materials:
    - a. Dry Locations: Use cadmium or zinc coated anchors and fasteners.
    - b. Damp and Wet Locations: Use hot dipped galvanized or stainless steel anchors and fasteners.
    - c. Corrosive Atmospheres Or Other Extreme Environmental Conditions: Use fasteners made of materials suitable for conditions.
  - 2. Types (unless otherwise specified or indicated):
    - a. Use cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.
    - b. Use anchoring devices to fasten items to solid masonry and concrete when anchor is not subjected to pull out loads, or vibration in shear loads.
    - c. Use toggle bolts to fasten items to hollow masonry and stud partitions.
- E. Attachment Devices
  - 1. Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing.
  - 2. Make attachments to steel bar joists at panel points of joists.
  - 3. Do not drill holes in main structural steel members.
  - 4. Use "C" beam clamps for attachment to steel beams
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To 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

8. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Raceway Support

1. Use pipe straps and specified method of attachment where raceway is installed proximate to surface of masonry construction.
2. Use hangers secured to surface with specified method of attachment where raceway is suspended from the surface.
3. Use "C" beam clamps and hangers where raceway is supported from steel beams.
4. Use channel support system supported from structural steel for multiple parallel raceway runs.
5. Where raceways are installed above ceiling, do not rest raceway directly on runner bars, T-bars, etc.
  - a. Raceway Sizes 2-1/2 Inches and Smaller: Support raceway from ceiling supports or from construction above ceiling.
  - b. Raceway Sizes Over 2-1/2 Inches: Support raceway from beams, joists, or trusses above ceiling.

G. Light Fixture Support

1. Do not support fixtures from ceilings or ceiling supports unless specified or indicated on Drawings.
  - a. Comply with NEC, Article 410.36 – Means of Support.
  - b. Support fixtures with hanger rods attached to beams, joists, or trusses—of largest standard diameter—that fits in mounting holes of fixture.
  - c. Where approved, channel supports may span and rest upon lower chord of trusses and be used to support lighting fixtures.
  - d. Where approved, channel supports may span and be attached to underside of beams, joists, or trusses and be used to support lighting fixtures.
2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
  - a. Where adequately supported outlet box is specified to support fixture or be used as one point of support, support box so that box may be adjusted to bring face of outlet box even with surface of ceiling.
3. Ceiling Mounted Lighting Fixtures: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.
  - a. Support individual fixtures less than 2 feet long at 2 points.

- b. Support continuous row fixtures less than 2 feet wide at points equal to number of fixtures plus one. Uniformly distribute points of support over row of fixtures.
  - c. Support individual fixtures 2 feet or wider at 4 corners.
  - d. Support continuous row fixtures 2 feet or wider at points equal to twice number of fixtures plus 2. Uniformly distribute points of support over row of fixtures.
  - e. Use adequately supported outlet box as one point of support for fixtures weighing less than 50 pounds.
  - f. Support recessed mounted fixtures directly from suspension system of suspended acoustical ceilings and securely fasten fixtures to framing members of ceiling using lock clips, wirelashing or leveling supports. Support each fixture weighing more than 50 pounds (including lamps) independent of suspended ceiling grid.
4. Wall Mounted Lighting Fixtures: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.
- a. Support individual fixtures 2 feet long or less at 2 points.
  - b. Support individual fixtures over 2 feet long at 3 points.
  - c. Support continuous row fixtures at points equal to twice number of fixtures. Uniformly distribute points of support.
  - d. Adequately supported outlet box may be used as one point of support for fixtures weighing less than 50 pounds
- H. Channel Support System: Channel supports may be used, as approved, to accommodate mounting of equipment with following material and finish.
- 1. Dry Locations: 16-gage steel channel support system with standard finish.
  - 2. Damp and Wet Locations: 16-gage steel channel support system with hot dipped galvanized or PVC finish

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 – Metal Fabrications for site fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

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

END OF SECTION 26 05 29

## **SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

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

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. GRC: Galvanized rigid steel conduit
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets, custom enclosures, cabinets, and boxes.
  - 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### 1.5 QUALITY ASSURANCE

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

## PART 2 - PRODUCTS

### 2.1 METAL CONDUIT, TUBING AND FITTINGS

- 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. Alflex Inc.
  3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  4. Anamet Electrical, Inc.; Anaconda Metal Hose.
  5. Electri-Flex Co.
  6. O-Z Gedney; a unit of General Signal.
  7. Wheatland Tube Company.
- B. Galvanized Rigid Steel Conduit (GRC): Rigid, hot dipped galvanized steel with galvanized threaded malleable iron fittings and bushings with insulated throat (galvanized steel). ANSI C80.1 and UL 6.
- C. Electrical Metallic Tubing (EMT): Metallic galvanized steel tube with galvanized steel compression or setscrew type fittings and bushings with insulated throat (galvanized steel). ANSI C80.3 and UL 797.
- D. Flexible Metal Conduit (FMC): Flexible, interlocked aluminum metal strip with galvanized screw-in type steel fittings. UL 1.
- E. Liquid Tight Flexible Metal Conduit (LFMC) : Liquid-tight flexible metal raceway with single, flexible, continuous, interlocked and double-wrapped steel core galvanized inside and outside, coated with liquid tight jacket of flexible polyvinyl chloride (PVC). UL 360.
- F. Fittings:
1. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  3. Fittings for EMT:
    - a. Material: Steel .
    - b. Type: Setscrew or compression.
  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.
- G. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 METAL WIREWAYS

- 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. Cooper B-Line, Inc.
  - 2. Hoffman.
  - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, UL 870 and NEMA 250, Type 1, 12, 3R, as indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type or as indicated with manufacturer's standard enamel finish.

## 2.3 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Hubbell, Inc.
    - b. Thomas & Betts Corporation.
    - c. Walker Systems, Inc.; Wiremold Company (The).
    - d. Wiremold Company (The); Electrical Sales Division.
- C. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Butler Manufacturing Company; Walker Division.
    - b. Enduro Systems, Inc.; Composite Products Division.
    - c. Hubbell Incorporated; Wiring Device-Kellems Division.
    - d. Lamson & Sessions; Carlon Electrical Products.
    - e. Panduit Corp.
    - f. Walker Systems, Inc.; Wiremold Company (The).
    - g. Wiremold Company (The); Electrical Sales Division.

D. Tele-Power Poles:

1. Material: Aluminum with clear anodized finish.
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

C. Outlet Boxes

1. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
2. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
3. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
4. Materials
  - a. Recessed Applications and Exposed Applications in Unfinished Spaces: Galvanized, stamped steel.
  - b. Boxes in stud walls shall be 4" square, 2 1/8" deep boxes with raised covers for power circuits. Provide "Far-Side" box support to keep box alignment parallel with wall face.
  - c. Boxes in masonry walls shall be 3 1/2" deep masonry boxes, single or multigang as required

- d. Exposed Applications: In finished spaces requiring exposed applications, provide boxes to match surface raceway system. In situations where surface mount conduits are allowed, conduit style boxes shall be used. Where surface mount devices are provided as components of specific systems, provide surface mount box from same manufacturer to match device.
  - e. Concrete and Wall in Wet Locations: Heavy duty cast aluminum, thermoset protective silver grey finish, with threaded mounting posts.
  - f. Weatherproof Outlet Boxes: Corrosion-resistant cast metal weatherproof outlet wiring boxes of appropriate type, shape, size and depth, with threaded conduit ends and cast metal face plates with cover suitably configured for each application, and including face plate gaskets and corrosion resistant fasteners. Do not compromise outlet weatherproof integrity when attachment plug is inserted.
  - g. Junction and Pull Boxes: Galvanized code gauge sheet steel boxes with screw-on covers, of appropriate type, shape and size suitable for box location and installation with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
- 5. Size: As required for number and size of raceways and conductors. Depth to suit wall depth and device installed.
  - 6. Covers: Design and style for each type, outlet, junction box, etc.; NEMA rated for each location.
- D. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
- 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic.
- E. Cabinets:
- 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
- F. 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.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Raceway Installation: Securely support raceway from building construction, separately from outlet boxes and junction boxes. Secure to masonry surfaces with expansion anchors. Use galvanized hanger rods, inserts and hangers. Conceal all raceway runs except in mechanical rooms, storage room ceilings, and areas above suspended ceilings. Run exposed raceway neatly, parallel and level, to ceilings, walls and floors. Make necessary offsets and bends to comply with construction. Install expansion fittings at all building expansion joints. Support all raceways with clamps per National Electric Code
1. GRC Installation: Use GRC in concrete slabs, below concrete slabs, below grade, damp locations, exterior locations and in hazardous locations. Where exposed leaving concrete slabs, extend minimum 6 inches above and below slabs. Use GRC elbows when penetrating concrete slab from PVC raceway below or in slabs.
  2. EMT: Use EMT for non-hazardous, dry locations above grade. As a minimum, use EMT in corridor ceilings, for home runs and in all unoccupied exposed interior areas. Surface mounted EMT shall not be used in finished areas without written permission from the Architect or Owner.
  3. FMC: Use flexible metal conduit for final connections to motors, step-down transformers, vibrating machines, etc. Terminate with clamp type connectors and anti-short bushing. Maximum length of three feet.
  4. LFMC: Use a maximum of two feet of liquid tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration and also where subjected to one or more of the following conditions:
    - a. Exterior location.
    - b. Moist or humid atmosphere where condensate can be expected to accumulate.
    - c. Corrosive atmosphere.
    - d. Subjected to water spray.
    - e. Subjected to dripping oil, grease or water
  5. All non-metallic or flexible conduit shall contain a separate grounding conductor in addition to the circuit conductors.
  6. Complete raceway installation before starting conductor installation.
  7. Do not secure branch circuit wiring to ceiling support wires. Provide independent support wires dedicated only to electrical raceways.
  8. Use roughing-in dimensions of electrically operated units furnished by supplier. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.
  9. Provide nylon pull cord in empty raceways. Test empty raceways with ball mandrel. Clear any raceway that rejects ball mandrel. Restore raceway and surrounding surfaces to original condition.

10. Fasten raceway terminations in sheet metal enclosures by 2 locknuts and terminate with bushing. Install locknuts inside and outside of enclosure.
11. Do not cross pipe shafts or ventilating duct openings with raceways.
12. Keep raceways at least 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

B. Concealed Raceways

1. Paint raceway threads in metallic raceways installed underground, in floors below grade, or outside with corrosion-inhibiting compound before assembling couplings. Draw coupling and raceway sufficiently tight to ensure water tightness.
2. For floors-on-grade, install raceways under concrete slabs.
3. Install underground raceways minimum of 18 inches below finished grade.
4. Provide raceway in furniture and any other cavity to effectively create a raceway system from the ceiling space to the outlet.
5. Stub-ups to Above Recessed Ceilings:
  - a. Use EMT for raceways.
  - b. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

C. Raceways in Concrete Slabs: Do not embed pipes other than electrical raceway in structural concrete and provide steel sleeves for raceway passing through concrete. Obtain Architect's approval for any variation from following requirements unless shown on Drawings. Request Architect's approval in writing accompanied by suitable sketch.

1. Place raceways between bottom reinforcing steel and top reinforcing steel.
2. Place raceways either parallel or at 90 degrees to main reinforcing steel.
3. Place nearly parallel raceways apart at least six times O.D. of raceway used.
4. Restrict O.D. of raceway in solid slabs to 1/4 of slab thickness with raceway placed in middle of that thickness.
5. Do not use raceway coating, except galvanizing or equivalent coating.
6. Do not cut or displace any reinforcement.

D. Install raceways to avoid damage or penetration of structural members. Avoid horizontal or cross runs in building partitions or sidewalls.

E. For raceway larger than 2 inches, provide minimum 2 inches between raceways vertically penetrating elevated concrete slabs. Provide fire-stopping and spray-on fireproofing at locations where raceways penetrate surface of floor slab that is part of fire rating required for construction.

F. Exposed Raceways

1. Use exposed raceway on exterior surfaces and interior finished spaces only when raceway type and routing are approved by Architect and Owner's representative.
2. Install exposed raceway in unfinished spaces, crawl spaces, pipe spaces, or in areas with existing exposed raceway. In areas where walls/ceilings are to be painted, exposed raceways shall be painted to match.
3. Install exposed raceways and extensions from concealed raceway systems neatly, parallel with, or at right angles to walls of building.
4. Do not run raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeves for raceway runs through these areas.
5. Install exposed raceway to avoid interfering with ceiling inserts, lights or ventilation ducts or outlets.
6. Support exposed raceways using hangers, clamps or clips. Support raceways on each side of bends and space not more than 6 ft. O.C. for 1-inch raceway and not more than 8 ft. O.C. for 1-1/4-inch raceway.
7. Provide exposed raceways for outlets on waterproof walls and set anchors supporting raceway in waterproof cement.
8. Support multiple raceway runs on trapeze style assemblies. Do not support raceway or cable from pipe, ductwork, or other raceway systems.
9. Apply exposed raceways requirements specified above to raceways installed in space above hung ceilings and in crawl spaces.
10. Do not install raceway directly on floors.

G. Minimum Raceway Size: 1/2-inch (16-mm)

H. Surface Raceways: Use surface raceways in finished spaces to conceal new cabling that cannot be installed above accessible ceiling or within walls. Use surface raceway only when raceway type and routing are approved by Architect and Owner's representative. Securely support from building construction and secure to masonry surfaces with expansion anchors. Mount at heights at locations shown on Drawings; obtain approval from Architect and Owner's representative for all routing not indicated on Drawings. Do not run surface raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeve with junction boxes or adapter fittings for raceway runs through these areas. In existing construction, run raceway along top of baseboards, taking care to avoid telephone and other signal wiring around doorframes and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.

I. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways in Architect's presence to demonstrate that raceway is clear of obstructions. Leave pulling-in line in each spare and empty raceway.

J. Raceway Installation in Special Areas

1. Raceways Exposed to Different Temperatures: Where portions of interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from warmer to colder section through raceway installation.
2. Refrigerated Rooms: Install raceway body or junction box in raceway system on warm side of refrigerated room. After cables are installed, seal raceway interior at raceway body or junction box.
3. Heated Areas to Unheated Areas: After cables are installed, seal raceway interior at nearest raceway body, outlet or junction box in heated area adjoining unheated area.

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

1. Provide locknuts for securing raceway to metal enclosure with sharp edge for digging into metal and ridged outside circumference for proper fastening.
2. Provide bushings for terminating raceways smaller than 1-1/4 inches with flared bottom and ribbed sides with smooth upper edges to prevent injury to cable insulation.
3. Install insulated type bushings for terminating raceways 1-1/4 inches and larger with flared bottom and ribbed sides and with upper edge with phenolic insulating ring molded into bushing.
4. Provide screw-type grounding terminal for standard or insulated type bushing.
5. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings and plugs specifically designed for their particular application.

L. 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. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
  - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
  - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (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.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

M. Fittings and Accessories Installation

1. Use zinc electroplate or hot dipped galvanized steel fittings and accessories in conjunction with ferrous raceways in dry and damp locations.
2. Use hot dipped galvanized fittings and accessories in conjunction with ferrous raceways in wet locations.
3. Use caps or plugs to seal ends of raceways until cable is installed (to exclude foreign material).
4. Use deflection fittings where raceways cross expansion joints that move in more than one plane.
5. Use 2 locknuts and insulated bushing (plastic bushing on 1/2-inch raceway and 3/4-inch raceway) on end of each raceway entering sheet metal cabinet or box in dry or damp locations. Terminate raceway ends within cabinet/box at same level.
6. Use watertight hub on end of each raceway entering cabinets or boxes (in wet locations) not constructed with integral threaded hubs.
7. Specific Applications:
  - a. Galvanized Rigid Conduit: Use threaded fittings and accessories. Use 3-piece raceway coupling where raceway cannot be rotated.
  - b. Flexible Metal Raceway: Use flexible metal raceway connectors.
  - c. Liquid Tight Flexible Metal Raceway: Use “seal-tite” connectors.
8. Rigid Nonmetallic Raceway, Metal Surface Raceway, and Wireways: Use manufacturer's standard fittings and accessories.

### 3.2 EXISTING RACEWAYS

#### A. Conditions for Re-Use of Existing Raceways:

1. Existing raceway is adequately sized for new cables.
2. Remove existing cables.
3. Demonstrate to Architect that existing raceway is clear of obstructions and in good condition.
4. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

### 3.3 INSTALLATION

- #### A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.

### 3.4 PROTECTION

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

END OF SECTION 26 05 33

## **SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

##### A. Section Includes:

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

##### B. Related Requirements:

1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 "Penetration Firestopping".

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

##### A. Wall Sleeves:

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

##### B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (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 D 1785, Schedule 40.

##### D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches (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).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, 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 raceway. Include type and number required for raceway material and size of raceway.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

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

## 2.4 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.
  - 2. Sealant shall have VOC content of 40 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm 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 (50 mm) 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 raceway 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.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.4 SLEEVE INSTALLATION FOR FIRE RATED ASSEMBLY PARTITIONS

- A. Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- B. Maintain indicated fire rating of walls, partitions, ceilings and floors at raceway penetrations. Install sleeves and sleeve seals with appropriate firestop materials. Comply with Division 07 Section "Penetration Firestopping".

END OF SECTION 26 05 44

## **SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Warning labels and signs.
  - 5. Instruction signs.
  - 6. Equipment identification labels.
  - 7. Miscellaneous identification products.
- B. Provide identification on all equipment, raceways, boxes, conductors, and devices.
- C. Identification provided should match the identification names, designations, and letters/numbers indicated on drawings, schematic and interconnection diagrams, equipment manufacturer's shop drawings, and in specifications.

#### 1.3 QUALITY ASSURANCE

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

#### 1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.
- G. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- H. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

### 2.2 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

### 2.3 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

### 2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
  - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs:
  - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
  - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 3. Nominal size, 10 by 14 inches (250 by 360 mm).

- E. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

## 2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
  - 1. Engraved legend with black letters on white face.
  - 2. Punched or drilled for mechanical fasteners.
  - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

## 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

## 2.7 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
  - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

## 2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify raceways and the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Emergency Power.
  - 2. Exit lights
  - 3. Power.
  - 4. UPS.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. Colors for 480/277-V Circuits:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
    - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- D. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels:
1. Comply with 29 CFR 1910.145.
  2. Identify system voltage with black letters on an orange background.
  3. Apply to exterior of door, cover, or other access.
  4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Controls with external control power connections.
- H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own, user readable identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

- b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
  - c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Power, Lighting, and Control:
    - 1) Switchboards, Panelboards, MCCs, Equipment Cabinets, Control Panels, Generators, UPS Equipment, Battery Inverter Units, Disconnect Switches, Enclosed Circuit Breakers, and Motor Controllers:
      - a) Typewritten panelboard directory of circuits in the location provided by panelboard manufacturer.
      - b) Provide nameplate with equipment identification as indicated on the drawings.
      - c) Indicate source and location of the source.
      - d) Provide nominal system voltage designation labels on cover.
    - 2) Disconnect Switches and Enclosed Circuit Breakers:
      - a) Indicate the equipment designation and location which the disconnect serves.
    - 3) Motor Controllers and VFD's:
      - a) Indicate the motor designation, location, and the type of service.
  - b. Pull boxes, Enclosures, Junction Boxes:
    - 1) Provide identification labels with feeder, branch circuit, and control circuit numbers on cover.
    - 2) Indicate source(s) and location(s) of the source(s).
    - 3) Indicate the load(s) and location(s) of the load(s) served.
    - 4) Provide nominal system voltage designation labels on cover.
  - c. Feeder Circuits, Branch Circuits, Control Circuits:
    - 1) Provide cable tags, wire markers, and phase identification tape as appropriate.
    - 2) Identify circuits in each junction box, pull box, outlet box, enclosure, gutter, and at each termination.
    - 3) Identify with circuit number, load and location served, and panel (equipment) designation and location from which it originates.

- d. Empty Conduit Runs and Conduits with Conductors for Future Use:
    - 1) Provide cable tags
    - 2) Indicate proposed future use
    - 3) Label conduits and conductors at both ends, including location of another end.
  - e. Receptacles, Switches, and Control Devices:
    - 1) Provide identification label on faceplate.
    - 2) Identify branch circuit number and panel designation and location from which it originates.
    - 3) Identify receptacles supplied from GFCI-type circuit breakers as “GFCI Protected”.
  - f. Emergency Lighting Fixtures:
    - 1) Provide identification labels on ceiling mounted emergency light fixtures, which have integral battery ballast backup or are tied into an emergency power system (i.e. emergency generator, central battery inverter, etc.). Labels should be attached to these fixtures so that they are readily discernible, by a person standing on the normal walking surface in the area, for testing purposes.
3. Normal and Emergency Systems:
- a. Equipment Cabinets, Terminal Cabinets, Control Panels, Patch Panels, Racks:
    - 1) Provide nameplates with equipment identification as indicated on the drawings.
    - 2) Label termination blocks and ports.
    - 3) Provide nominal system voltage designation labels on cover
  - b. Pull boxes, Enclosures, Junction Boxes:
    - 1) Provide identification labels including system type and circuit numbers on cover.
    - 2) Indicate equipment and location(s) from which enclosed cables originate.
    - 3) Indicate the equipment and location(s) of the equipment served.
    - 4) Provide nominal system voltage designation labels on cover.
  - c. Cables and Conduits:
    - 1) Provide cable tags, wire markers, and identification labels including system type and circuit numbers as appropriate.
    - 2) Identify cables in each junction box, pull box, device box, enclosure, gutter, manhole, handhole, and at each termination.
    - 3) Identify with cable number, equipment and location(s) of the equipment served, and equipment designation and location from which it originates.

- 4) Label conduits at both ends, including conduit number and location of other end.
  - 5) Include identification of the building from which it originates for exterior cables.
- d. Empty Conduit Runs and Conduits with Cables for Future Use:
- 1) Provide cable tags and identification labels.
  - 2) Indicate proposed future use.
  - 3) Label conduits and cables at both ends (including location of other end).
- e. Fire Alarm:
- 1) Fire alarm junction boxes and pull fittings should be painted red to identify them as components of the fire alarm system as compared to other systems.
  - 2) Remote Smoke Detector Lamps and Test Stations – Provide nameplate indicating the location of the connected device.
  - 3) Initiation Devices, Notification Appliances, Fire Alarm Relays – Provide device identification and zone or address identification label.
  - 4) Communication:
    - a) Comply with applicable EIA, TIA, and ANSI standards.
    - b) Data Outlets – Provide device identification label on faceplate. Identify equipment designation and location from which it originates.
  - 5) Security:
    - a) Provide device identification labels.
    - b) Identify equipment designation and location from which it originates.
- f. Access doors and panels for concealed electrical items.

END OF SECTION 26 05 53

## **SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.
  - 1. See especially Section 01 08 00, "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

#### 1.2 SUMMARY

- A. Section includes commissioning process requirements for Lighting Control Systems, which are described in more detail in the technical specification 26 09 23 Lighting Control Devices.

#### 1.3 DEFINITIONS

- A. CxA: Commissioning Authority.

#### 1.4 SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 01 33 00 "Submittal Procedures" and the individual sections specifying the work.
- B. Prefunctional Checklists of readiness.
- C. Prefunctional Checklists of completion of installation, prestart, and startup activities.
- D. Certificates of readiness and completion of installation.
- E. Test and inspection reports and certificates.
- F. Corrective action documents.
- G. Functional Performance Test Procedures

#### 1.5 QUALITY ASSURANCE

- A. Lighting Control Testing Technician Qualifications: Technicians to perform Lighting Control Construction Prefunctional Checklist verification tests and demonstrations, functional performance tests and demonstrations shall have the following minimum qualifications:
  - 1. Journey-level or equivalent skill level in Electrical Testing or Installation. Vocational School four-year program graduate or an Associate's degree in electrical systems, or similar field. Degree may be offset by three years' experience in servicing electrical systems in the HVAC or Electrical industry.

## 1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Provide Electrical work in accordance with contract document requirements for Lighting Control Systems.
- B. Perform commissioning tests at the direction of the CxA.
- C. Attend construction phase coordination meetings.
- D. Attend testing, adjusting, and balancing review and coordination meeting.
- E. Participate in Lighting Control systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- F. Provide information requested by the CxA for final commissioning documentation.
- G. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.

## 1.7 CxA'S AUTHORITY

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Lighting Control systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Directing commissioning.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

## 1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Lighting Control system to be verified and tested.
  - 4. Prefunctional Checklists certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Prefunctional Checklists certifying that Lighting Control systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.
  - 8. Verification of testing and adjusting reports.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 TESTING PREPARATION

- A. Certify that Lighting Control systems have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.2 GENERAL TESTING REQUIREMENTS

- A. The CxA in cooperation with the Electrical Contractor shall prepare detailed testing plans, procedures, and checklists for Lighting control systems.

### 3.3 LIGHTING CONTROL SYSTEMS FUNCTIONAL TESTING PROCEDURES

- A. Lighting Control System Functional Testing and Acceptance Procedures:
  - 1. Occupancy Sensor Controls:
    - a. Certify that the occupant sensor has been located and aimed in accordance with manufacturer recommendations.
    - b. Each occupancy sensor shall be tested, where applicable.
      - 1) Verify the correct operation of occupant sensor controls status indicators.
      - 2) Verify the controlled lights turn off or down to the permitted level within the required time.
      - 3) Verify the lights turn on to the permitted level when an occupant enters the space for auto-on occupant sensor controls.
      - 4) Verify the lights turn on only when manually activated for manual-on occupancy sensors.
      - 5) Verify the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
  - 2. Daylight Responsive Controls
    - a. Verify control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
    - b. Verify daylight controlled lighting loads adjust to light level set points in response to available daylight.
    - c. Verify the locations of calibration adjustment equipment are readily accessible to authorized personal.

- B. Provide documentation and certification to the CxA.
- C. Lighting Control systems are shown on the contract drawings.

END OF SECTION 26 08 00

## **SECTION 26 09 23 - LIGHTING CONTROL DEVICES**

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Daylight-harvesting dimming controls, digital.
2. Indoor occupancy and vacancy sensors.
3. Conductors and cables.

##### B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data:

1. Daylight-harvesting dimming controls, digital.
2. Indoor occupancy and vacancy sensors.
3. Conductors and cables.

##### B. Shop Drawings:

1. Show installation details for the following:
  - a. Occupancy sensors.
  - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

##### C. Field quality-control reports.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Sample Warranty: For manufacturer's warranties.

## 1.4 WARRANTY

- A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control devices.

## PART 2 - PRODUCTS

### 2.1 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. hubbell.
  2. Leviton.
  3. Steinel.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
1. Lighting control set point is based on the following two lighting conditions:
    - a. When no daylight is present (target level).
    - b. When significant daylight is present.
  2. System programming is done with two hand-held, remote-control tools.
    - a. Initial setup tool.
    - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **integrated** power pack to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
  3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

- E. Power Pack: Digital controller capable of accepting three 8PSJ inputs with **two** output(s) rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc) Class 2 power source.
1. With integral current monitoring.
  2. Compatible with digital addressable lighting interface.
  3. Plenum rated.

## 2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

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

1. Hubbell.
2. Leviton.
3. Steinel.

- B. General Requirements for Sensors:

1. Ceiling mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated power pack.
4. Hardwired connection to switch.
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
6. Operation:
  - a. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
7. Sensor Output: Sensor is powered from the power pack
8. Power: Line voltage
9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
10. Mounting:
  - a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
  - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  12. Bypass Switch: Override the "on" function in case of sensor failure.
  13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
  4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.
  5. Color: As selected by Architect.

## 2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

### 3.3 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.4 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

### 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Nonconforming Work:
  - 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- C. Prepare test and inspection reports.
- D. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections.

### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

### 3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

## **SECTION 26 27 26 - WIRING DEVICES**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Weather-resistant receptacles.
  - 3. Snap switches.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

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

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

### 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranded building wire.
  - 2. Devices shall comply with the requirements in this Section.

### 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 5351 (single), CR5362 (duplex).
    - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
    - c. Leviton; 5891 (single), 5352 (duplex).
    - d. Pass & Seymour; 5361 (single), 5362 (duplex).

## 2.4 GFCI RECEPTACLES

### A. General Description:

1. Straight blade, feed and non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

### B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Cooper; VGF20.
  - b. Hubbell; GFR5352L.
  - c. Pass & Seymour; 2095.
  - d. Leviton; 7590.

## 2.5 TOGGLE SWITCHES

### A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

### B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Single Pole:
    - 1) Cooper; AH1221.
    - 2) Hubbell; HBL1221.
    - 3) Leviton; 1221-2.
    - 4) Pass & Seymour; CSB20AC1.
  - b. Two Pole:
    - 1) Cooper; AH1222.
    - 2) Hubbell; HBL1222.
    - 3) Leviton; 1222-2.
    - 4) Pass & Seymour; CSB20AC2.
  - c. Three Way:
    - 1) Cooper; AH1223.
    - 2) Hubbell; HBL1223.
    - 3) Leviton; 1223-2.
    - 4) Pass & Seymour; CSB20AC3.

- d. Four Way:
  - 1) Cooper; AH1224.
  - 2) Hubbell; HBL1224.
  - 3) Leviton; 1224-2.
  - 4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Cooper; AH1221PL for 120 and 277 V.
  - b. Hubbell; HBL1201PL for 120 and 277 V.
  - c. Leviton; 1221-LH1.
  - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
- 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Cooper; AH1221L.
  - b. Hubbell; HBL1221L.
  - c. Leviton; 1221-2L.
  - d. Pass & Seymour; PS20AC1-L.
- 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Cooper; 1995.
  - b. Hubbell; HBL1557.
  - c. Leviton; 1257.
  - d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Cooper; 1995L.
  - b. Hubbell; HBL1557L.

- c. Leviton; 1257L.
- d. Pass & Seymour; 1251L.

## 2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.
- C. Cover Plates:
  - 1. Stainless Steel Cover Plates: Type 302 or 304, satin finish, 0.040 inch thick, accurately die cut, protected with release paper. Flush mounting plates shall be beveled with smooth rolled outer edge. Surface mounting plates shall be beveled and pressure formed for smooth edge to fit box. Single and combination plates as required to match types and sizes of specified wiring devices.
  - 2. Weatherproof Cover Plates: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked "Suitable For Wet Locations While in Use" and "UL Listed". There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and the mounting plate/base to assure proper seal. The installation shall be in compliance with NEC Article 406.9.
- D. Material for unfinished spaces: Galvanized steel.

## 2.7 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: **As selected by Architect** unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
  - 3. TVSS Devices: Blue.
  - 4. Isolated-Ground Receptacles: Orange.
- B. Wall Plate Color: For plastic covers, match device color.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall 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. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle 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. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

### 3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

### 3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
  2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display 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 5 percent or higher is unacceptable.
  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. 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.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 26

## **SECTION 26 51 19 - LED INTERIOR LIGHTING**

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Downlight.
2. Germicidal
3. Exit signs
4. Materials.
5. Luminaire support.

- B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

#### 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 ES 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.

#### 1.5 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.

#### 1.6 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.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

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

## 1.8 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 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. California Title 24 compliant.

### 2.2 DOWNLIGHT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Utopia Lighting
  - 2. Code Lighting
  - 3. HE Williams
  - 4. Amerlux
- B. Nominal Operating Voltage: 120 V -277 V ac.
- C. Lamp:
  - 1. Minimum lumens - refer to luminaire schedule.
  - 2. Minimum allowable efficacy of 90.
  - 3. CRI of 80 CCT of 3500k.
  - 4. Rated lamp life of 50,000 hours to L70.

5. Dimmable from 0-10 percent to zero percent of maximum light output.
  6. Internal driver.
  7. User-Replaceable Lamps:
    - a. Bulb shape complying with ANSI C78.79.
    - b. Lamp base complying with ANSI C81.61.
  8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
1. Extruded-aluminum housing and heat sink.
  2. powder-coat finish.
  3. Universal mounting bracket.
  4. Integral junction box with conduit fittings.
- E. 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.
- F. Diffusers and Globes:
1. Fixed lens.
  2. Batwing light distribution.
  3. UV-stabilized acrylic
  4. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  5. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- G. Standards:
1. ENERGY STAR certified.
  2. RoHS compliant.
  3. UL Listing: Listed for damp location.
  4. Recessed luminaires shall comply with NEMA LE 4.
  5. Internal driver.
  6. User-Replaceable Lamps:
    - a. Bulb shape complying with ANSI C78.79.
    - b. Lamp base complying with ANSI C81.61
  7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

H. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.
3. With integral mounting provisions.

I. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

J. Diffusers and Globes:

1. Tempered Fresnel glass.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

K. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

## 2.3 GERMICIDAL

A. Provide certified high-intensity antimicrobial wavelengths of 405 nanometers continuous surface cleaning wherever lighting touches inclusive of the following details:

1. Cable, suspended or wall mount
2. Automatic dimming (0-10V)..
3. Offered with emergency circuit.
4. Removable/replaceable electronics module.
5. Antimicrobial protection combined with white light.
6. CRI of 85, R9 of 10
7. Complies with IEEE C62.41 for surge endurance up to 2.5KV.
8. LED boards with patented single-diode technology that meets international standards for continuous and unrestricted use around people.
9. Compatible with AC (line voltage) driven TLED lamp stops the growth of and kills viruses, bacteria, fungi, yeast, mold and mildew with visible light 24 hour recharge time.

## 2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
  - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
  - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
  - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
3. Master/Remote Sign Configurations:
  - a. Master Unit: Comply with requirements above for self-powered exit signs and provide additional capacity in battery for power connection to remote unit.
  - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 LUMINAIRE SCHEDULE

- A. Refer to Luminaire Schedule on Drawings.

2.6 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 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.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

## 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. 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 two locations, spaced near corners of luminaire.

G. 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 FIELD QUALITY CONTROL

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

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

C. Remove and replace with new, all broken glassware, plastic or fixtures damaged before final acceptance at no additional expense to Owner.

D. No allowance made for breakage or theft before final acceptance.

E. Immediately prior to occupancy, damp clean all diffusers, glassware, fixture trims, reflectors, lamps, and replace burned- out lamps.

### 3.7 STARTUP SERVICE

- A. Verify all luminaires function in conjunction with lighting control system and perform as intended.
  - 1. Illumination is adequate and measured satisfactorily.
  - 2. Dimming performs satisfactorily in accordance with specification.
  - 3. 1 Hour of training of Owner includes technical information about luminaires and is completed in conjunction with lighting control specification.

### 3.8 UTILITY REBATES

- A. Provide Owner with all receipts for the light fixtures, luminaires, etc. eligible for current utility rebate programs at completion of Contract, allowing Owner to apply for rebates and schedule utility company inspections. Provide copy to Architect for record.

END OF SECTION 26 51 19