# SECTION 16050

# BASIC ELECTRICAL MATERIALS AND METHODS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:
1. Supporting devices for electrical components.
2. Concrete equipment bases.
3. Cutting and patching for electrical construction.
4. Touchup painting.
5. Electrical demolition.
6. Electricity-metering components.

### 1.3 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

### 1.4 SERVING UTILITY COMPANIES

A. Serving Electric Utility is as follows:
1. Name: Black Hills Energy
Contact: Ted Diaz
Address: 105 S. Victoria Ave., Pueblo, CO 81003
Telephone: 719.546.6418

B. Owner's Contact is as follows:
1. Name: Joe Dean
Address: 1001 Beulah Ave., Pueblo, CO 81004
Telephone: 719.924.0153

C. Pay all charges and/or fees levied by the serving utility companies relative to this project.

D. Obtain and pay all fees for permits, licensing, and inspections applicable to work of Division 16.

### 1.5 COORDINATION

A. Coordinate overhead primary demolition and/or disconnections with Utility Co.

B. Coordinate conduit routes with Contractor performing boring/trenching and patch/repair of existing surfaces. Layout conduit routes to minimize trenching and repair work.

C. Coordinate installation of meter centers with transformer secondary work by Utility Co.

D. Coordinate electrical service connections with Utility Co.
   1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordinate telephone and intercom overhead cabling work with Owner's IT representative and serving utility company.

F. Salvage: Owner retains the first right of salvage for existing electrical distribution gear being demolished under this work.

## PART 2 - PRODUCTS

### 2.1 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.

D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.
   1. Channel Thickness: Selected to suit structural loading.
   2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

I. Powder-Driven Threaded Studs: Heat-treated steel.

### 2.2 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

### 2.3 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

A. Meter Sockets: Comply with requirements of electrical power utility company.

B. Modular Meter Centers: See Section 16420.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Materials and Components: Install level, plumb, and parallel and perpendicular to building construction, poles, frames and other and components, unless otherwise indicated.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

C. Right of Way: Give to raceways and piping systems installed at a required slope.

D. Clearances: Install equipment to maintain NEC work and overhead clearances for gear; and overhead wiring to festoon lighting.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Selection of Supports: Comply with manufacturer's written instructions.

C. Strength of Supports: Listed for intended use, adequate to carry present and future loads, times a safety factor of at least four.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Separately support cast boxes that are threaded to raceways.

D. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

E. Install sleeves for cable and raceway penetrations of existing walls where required, unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Fire ratings of penetrations shall be installed to match original ratings.

F. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
   1. Wood: Fasten with wood screws or screw-type nails.
   2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
   3. New Concrete: Concrete inserts with machine screws and bolts.
   4. Existing Concrete: Expansion bolts.
   5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.

6. Steel: Welded threaded studs or spring-tension clamps on steel.
   a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 UILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.5 CONCRETE BASES AND PEDESTALS

A. Construct concrete pole bases and vendor pedestals as indicated on Civil Drawings and Division 2 & 3 specifications.

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Owner has first-right-of-refusal on demolished gear. Remove all unclaimed demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill walls and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 REFINISHING AND RESTORATION

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

B. Restore all surface material and grades impacted by this Work; to match original or other; as defined by the Division 2 & 3 Specifications.

3.9 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. This Section includes modification of existing neutral-ground bonds located downstream of Meter Centers.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Ground rods.

B. Field Test Reports: Submit written test reports to include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve compliance.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. Apache Grounding/Erico Inc.
      b. Boggs, Inc.
      c. Chance/Hubbell.
      d. Dossert Corp.
      e. Erico Inc.; Electrical Products Group.
      f. Framatome Connectors/Burndy Electrical.
      g. Galvan Industries, Inc.
      h. Ideal Industries, Inc.
      i. ILSCO.

j. Kearney/Cooper Power Systems.
k. Korns: C. C. Korns Co.; Division of Robroy Industries.
l. O-Z/Gedney Co.; a business of the EGS Electrical Group.
m. Raco, Inc.; Division of Hubbell.
n. Salisbury: W. H. Salisbury & Co.
o. Superior Grounding Systems, Inc.
p. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

F. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch dia.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Irreversible Compression Connectors: UL listed, irreversible compression-type connectors as manufactured by Burndy/Framatome Group or approved equal.

2.4 GROUNDING ELECTRODES

A. Ground Rods: 3/4"x 10 feet, UL listed, Copper-clad 13-mil min coating, steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. In raceways, use insulated equipment grounding conductors.

B. Bolted Connections: Use for grounding conductors at main ground bus and underground connections.

C. Compression Connections: Use for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 INSTALLATION

A. Ground Rods: At each meter center, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes. Ground rods for the exterior light fixtures and other items shall be installed per construction details.
   1. Drive ground rods until tops are 2 inches (50 mm) below final grade, unless otherwise indicated.
   2. Interconnect ground rods with grounding electrode conductors. Use irreversible compression connections, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Neutral-Ground Bond: Any existing N-G bond in main panel or gear, located downstream from a service meter center, shall be removed. The grounding electrode system shall remain; and shall include components per NEC. Verify ground and neutral wires at the main panel are properly terminated to the correct bus.

E. Grounding Electrode System: Building services shall maintain components required for a grounding electrode system, including:
   a. Metal Water Service Pipe: Insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Braided-type bonding jumpers at water meter.
   b. Building Steel.
   c. Grounding Electrodes.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

C. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

D. Tighten screws and bolts for grounding and bonding 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.

E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with project requirements, ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

B. Applications include, but are not limited to the following:
1. Indicate circuit numbers.
2. Labeling all electrical distribution gear.
3. Underground as-builts.

C. Related Sections Include:
1. Division 16 Section "Raceways and Boxes" for identification on divided raceway covers.

1.3 SUBMITTALS

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

B. Schedule of Nomenclature: Submit the text intended to be used for each plaque associated with meter centers and distribution equipment.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2 and NFPA 70.

B. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

C. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.2 NAMEPLATES AND SIGNS

A. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
   1. Engraved legend with white letters on a black face.
   2. Punched or drilled for mechanical fasteners.

B. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

C. Exterior, Metal-Backed, Butyrate Signs: 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 the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

D. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 UNDERGROUND CONDUIT MAPS

A. Provide a partial site plan showing as-built underground conduit routes associated with each Meter Center. Permanently install a laminated copy of the site plan inside the cover of the main disconnect for each Meter Center.

B. Provide the Engineer with as-built mark-ups to update project AutoCAD site plans. A PDF copy of the local site for each Meter Center will be provided to the Contractor for preparing the UG Conduit Maps.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength: 50 lb (22.3 kg) minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.
   1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
   2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
   3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
   4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Building Main Panels: At each main panel located inside a building, provide a plaque that identifies the Meter Center that serves the building. Plaque shall denote:
   1. Meter Center ID and serving breaker size.
   2. "Do Not Bond Grounds to Neutral Bus".

F. Install painted identification according to manufacturer's written instructions and as follows:
   1. Clean surfaces of dust, loose material, and oily films before painting.
   2. Prime surfaces using type of primer specified for surface.
   3. Apply one intermediate and one finish coat of enamel.

G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

H. Circuit Identification Labels on Boxes: Label the coverplate of j-boxes in unfinished spaces and above accessible ceilings using permanent black marker. Install labels externally.
   1. Labeling Legend: Permanent, waterproof, neatly written listing of panel and circuit number or equivalent.

I. Color-Coding of Secondary Phase Conductors: Use the following colors for service, feeder and branch-circuit phase conductors:
   1. 208/120-V Conductors:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White.
      e. Ground: Green.
   2. 240/120-V Conductors:
      a. Phase A: Black
      b. Phase B: Red
      c. Neutral: White.
      d. Ground: Green - striped.
   3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
      a. Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch-(25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
      b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

J. Apply identification to conductors as follows:
   1. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each circuit with source and circuit number.

K. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
   a. Install a plaque on all disconnect switches controlling remote equipment that identifies its purpose per NEC.
   b. Install a plaque at each main disconnect for services with multiple main disconnects per NEC.
   c. Install a plaque on each piece of distribution equipment that incorporates series rated circuit breaker devices per NEC.

L. Equipment Identification Labels: Plaques rated for outdoor use, engraved. Install on each unit of equipment as noted below, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
   1. Panelboards, electrical cabinets, and enclosures.
   2. Meter Centers.
   3. Disconnect switches.

END OF SECTION

# SECTION 16120

# CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

### 1.3 SUBMITTALS

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

B. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by the Contractor.

### 1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
   1. American Insulated Wire Corp.; a Leviton Company.
   2. General Cable Corporation.
   3. Houston Wire.
   4. Senator Wire & Cable Company.
   5. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper, except feeders No. 1 AWG and larger may be compact-strand aluminum, complying with NEMA WC 5 or 7 as manufactured by Alcan Stabiloy or approved equal. Conductors shall be stranded or solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger. Contractor may substitute copper conductors for feeders shown on the Drawings as compact-strand AL and may reduce the associated conduit size to the NEC code-required size for each copper feeder.

D. Conductor Insulation Types: Types THW, THHN-THWN, XHHW and SO as defined in Part 3 below, complying with NEMA WC 5 or 7.

E. Minimum wire size shall be No. 12 AWG, except No. 14 AWG shall be permitted for signal, pilot control circuits and fixture whips.

F. Direct-buried conductors are not allowed for this Project.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

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

C. Connectors and fittings shall be rated for 75 degrees C.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Feeder and Branch Circuits - Wet Locations: Type THWN or XHHW, 75°C min., nylon outer jacket, in raceway.

B. Aluminum Option: Type XHHW, compact strand, dry/wet rated, 75°C min. Provide Type XHHW-2, 90°C where required to meet derating requirements for voltage drop.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

E. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification".

F. Three-Phase Wiring: A maximum of three phase conductors, each of a different phase, and one common neutral shall be installed per conduit homerun. Derating factors for additional conductors installed in the same conduit shall be applied per NEC Table 310.

G. Use No. 10 AWG minimum conductor size in lieu of No. 12 AWG minimum for 20 ampere, 120 volt branch circuits where homeruns are longer than 75 feet. For feeders; increase in size as required for a maximum of 3 percent voltage drop from meter centers to panels.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

END OF SECTION

SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Raceways and fittings.
   2. Boxes, enclosures, and cabinets for electrical wiring.
   3. Mounting Heights for boxes, devices and equipment.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

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

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 MANUFACTURERS

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

2.2 METAL CONDUIT AND TUBING

A. Available Manufacturers:
   1. AFC Cable Systems, Inc.

2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
6. LTV Steel Tubular Products Company.
7. Manhattan/CDT/Cole-Flex.
8. O-Z Gedney; Unit of General Signal.
9. Wheatland Tube Co.

B. Rigid Steel Conduit: Steel, hot-dipped galvanized, UL-6, ANSI C80.1.

C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

D. EMT and Fittings: Steel, hot-zinc galvanized, UL-797, ANSI C80.3 for use in open, concealed installations.
1. Fittings: Steel compression type.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers:
1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe & Plastics Group.
6. Condux International.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.
13. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC. UL 651, NEMA TC-2, rated for 90 deg C and sunlight resistant.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

D. LFNC: UL 1660.

2.4 CONDUIT BODIES

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.

C. Conduit Bodies 2 Inches and Smaller: Use steel bodies with compression-type EMT connectors. Die-cast or pressure cast fittings are not permitted.

D. Conduit Bodies 2-1/2 Inches - 4 Inches: Malleable.

E. Nonmetallic Conduit: Use nonmetallic conduit bodies conforming to UL 514 B.

2.5 INNERDUCTS

A. Manufacturers:
1. Carlon or approved equal.

B. Inside Plant: Duct shall be listed for use as a Plenum Riser and/or General as applicable for its installation. Innerduct shall be installed in EMT conduit [where installed in plenum spaces].

C. Outside Plant: Ribbed I.D., smooth O.D. for use as an innerduct, sizes (1-2 inches) as indicated. Carlon Optic-Gard/PE PVC with factory installed, color-coded innerducts by American Pipe & Plastics, Inc., or approved equal.

D. Innerducts shall be orange in color and shall have a 1/4-inch poly pull line installed.

2.6 BOXES, ENCLOSURES, AND CABINETS

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

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

C. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:
1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.

3. Underground: RNC with coated rigid steel ells.
4. Enclosures: NEMA 250, Type 3R.
5. Boxes: Cast aluminum. Malleable iron prohibited.

B. Indoors:
1. Exposed: EMT.
2. Concealed: EMT.
3. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 3/4-inch trade size, 1/2-inch for wiring device conduit.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.2 INSTALLATION

A. Complete raceway installation before starting conductor installation.

B. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."

C. Install temporary closures to prevent foreign matter from entering raceways.

D. Protect stub-ups from damage during construction. Arrange so curved portions of bends are not visible above final grade.

E. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

F. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

G. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.

H. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

I. Communications Ducts: Stub rigid conduit 12-in AFG, tight to outside of KCH Building, at locations selected by the Owner's IT Rep and cap. Route empty conduit parallel to vendor power conduits as shown on Sheet E2.2, keeping 12-inches minimum separation from power conduit. Mark and cap ends of conduit as shown on the Drawings.

J. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where otherwise required by NFPA 70.

K. Install pull boxes plumb. Support at each corner or per manufacturer instructions.

L. Building Services. Tie into existing conduit wherever possible. For each building that was served by a weather-head mast; abandon the mast in place and provide an LB fitting and wall penetration near the existing service conduit. Field coordinate and obtain Owner's approval for the location and elevation of each building penetration required. Provide a weather-proof finished product; including sealant around conduit with a finish to match local exterior finish.

M. Mounting Heights: Install equipment and devices at heights indicated in Table 1 (located at the end of this Section), unless noted otherwise.

3.3 PROTECTION

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

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

TABLE 1

MOUNTING HEIGHT SCHEDULE

| Device | Centerline of Box Above Finished Floor |
|---|---|
| 1. Exterior Switch | 42 inches |
| 2. Exterior Receptacle | Match mounting height of existing local receptacles |
| 3. Disconnect Switch | 54 inches |
| 4. Panelboard | 72 inches to top |
| 5. Meter Center | 72 inches to top |
| 6. IC Exterior Speakers | Per Owner's Rep by Location |

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes various types of receptacles, connectors, switches, and finish plates.

B. Related Sections include:
   1. Division 16 Section "Basic Electrical Materials and Methods."
   2. Division 16 Section "Field Quality Control."

1.3 SUBMITTALS

A. Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each product specified.

C. Operation and maintenance data for materials and products specified in this Section to include in the "Operating and Maintenance Manual" specified in Division 1.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for devices and installation.

B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wiring Devices:
      a. Arrow Hart Div., Cooper Industries.
      b. Bryant Electric, Inc.
      c. Hubbell Inc.
      d. Leviton Mfg. Co., Inc.
      e. Pass & Seymour/Legrand.
   2. Wiring Devices for Wet Locations (Power Pits):
      a. Appleton Electric Company.
      b. Crouse-Hinds Electrical Construction.
      c. Hubbell

## 2.2 WIRING DEVICES

A. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices."

B. Enclosures: NEMA 1 equivalent, except as otherwise indicated.

C. Receptacles for ordinary application shall be grounding type with nylon or thermoplastic construction, polarized parallel slots, triple-wipe contacts. Residential type back-wired receptacles are unacceptable. Back-wired receptacles shall have a contact plate on each side of the conductor with the ability to side wire as well.

D. Receptacles, Straight-Blade: NEMA 5-20R. Comply with UL Standard 498, "Electrical Attachment Plugs and Receptacles," heavy-duty grade except as otherwise indicated.

E. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicted, and with the following additional requirements:
   1. Ground-Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Design units for installation in a 2-3/4-inch (70-mm) deep outlet box without an adapter.

F. Receptacles, Industrial Heavy-Duty: Conform to NEMA Standard PK 4 "Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use."

G. Snap Switches: Quiet-type a.c. switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches," and with Federal Specification W-S-896. 20 ampere, 120-277V A.C.

H. Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:
   1. Color: Matches wiring device except as otherwise indicated.
   2. Plate-Securing Screws: Metal with heads colored to match plate finish.
   3. Weatherproof Receptacle: In-use, die-cast cover/ backbox, single-gang, horizontal, GFCI, gasketed, cord openings. Intermatic WP1000HC Series or approved equal.
   4. Weatherproof Switch: Cast housing and die-cast or hi-impact PCV weatherproof lift cover, gasketed, vertical mount, Hubbell CWP1CR or approved equal.

## 2.3 STREET POWER PIT RECEPTACLE

A. Provide a water-tight pin-sleeve outlet mounted on a cast water-tight backbox surface mounted to the inside wall of a flush, in-grade box with traffic-rated lid. Assembly shall be customized to hold a removable post for temporarily mounting a panel with a matching cord and plug pigtail. See detail on Civil Drawings.

B. Outlet shall be IEC309-1 & 309-2, 120/240V 1ph (2 hots, N, G) 100A. Features shall include positive locking, make/break maximum listed amperage and voltage. Waterproof listed UL50 Level 4X, IEC 529 IPX7 and CSA 4X for immersion to a depth of 1M. Provide Appleton PM4100C12W with matching 100A plug or approved equal.

C. Provide in-grade box, cover, gasketing, and gravel drainage per detail on Civil Drawings.

D. Panel and Cord: Provide one NEMA 3R panelboard per power pit. Panel shall meet requirements of Section 16470, Electrical Drawings and Civil Detail. Panel shall have a 6-foot

600V, hard-service, wet location, oil-resistant cord with kellum grips and 100A matching pin/sleeve receptacle permanently mounted to the end of the cord.

E. Provide panel post and mounting accessories per detail on Civil Drawings.

F. Each pit shall have a remote panel ground rod per NEC 250.32; bonded.

G. Provide duct seal at PVC connection to outlet backbox within power pit and conduit seal at serving panel near grade.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

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

D. Protect devices and assemblies during painting.

E. Mount wiring devices at heights indicated in Table 1, Section 16130, "Raceway and Boxes," unless noted otherwise.

3.2 GROUNDING

A. Bond receptacles per NEC and street power pits per local inspector.

3.3 CLEANING

A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

# SECTION 16410

# DISCONNECT SWITCHES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes individually mounted disconnect switches and used for the following:
   1. Feeder and branch-circuit protection.

B. Related Sections include the following:
   1. Division 16 Section "Field Quality Control for associated field testing.
   2. Division 16 Section "Fuses" for fusible devices.

### 1.3 SUBMITTALS

A. Product Data: For each type of switch, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Maintenance Data: For disconnect switches and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
   1. Routine maintenance requirements for components.
   2. Manufacturer's written instructions for testing and adjusting switches.

### 1.4 QUALITY ASSURANCE

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

B. Comply with NEMA AB 1 and NEMA KS 1.

C. Comply with NFPA 70.

### 1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2000 m).

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fusible Switches:
      a. Cutler Hammer/Westinghouse.
      b. General Electric Co.; Electrical Distribution & Control Division.
      c. Siemens Energy & Automation, Inc.
      d. Square D Co.

2.2 DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type **HD** with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.

2.4 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive disconnect switches for compliance with installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 CLEANING

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

END OF SECTION

SECTION 16420

METER CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes main breaker, feeder breakers and meter sockets and associated components for main meter centers from 600A to 1000A maximum, 120/240V 1ph and 120/208V 3ph.

B. Related Sections include the following:
1. Division 16 Section "Basic Electrical Materials and Methods" for general and installation materials and methods.
2. Division 16 Section "Electrical Identification" for identification materials.

1.3 SUBMITTALS

A. Product Data: For each product and component specified.

B. Shop Drawings: For each meter center. Show dimensioned plans and elevations, including required clearances and service space, component and device lists, and a single-line diagram showing main- and branch-bus current ratings and short-time and short-circuit ratings of equipment. Include the following:
1. Schedule of features, characteristics, ratings, and factory settings of individual protective devices.
2. Utility company metering provisions with indication of approval by utility company.

C. Reports of Field Tests and Observations: Certified by testing agency.

D. Maintenance Data: For meter centers to include in the maintenance manuals specified in Division 1. Include detailed manufacturer's written instructions on adjusting overcurrent protective devices.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide meter center assemblies specified in this Section that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NFPA 70 and NEMA PB2.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for meter center equipment, including clearances between meter center and adjacent surfaces and

items. Meter centers having equal performance characteristics and complying with indicated maximum dimensions may be considered.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.

B. Store so condensation will not occur on or in meter centers. Provide temporary heaters as required to avoid condensation.

C. Handle meter centers according to NEMA. Use only factory-installed lifting provisions.

1.6 PROJECT CONDITIONS

A. Verify exact locations for mounting each meter center with Owner prior to rough-in.

B. Verify clearance requirements. Locate meter center to meet installation tolerances.

C. Revise locations and elevations from those indicated as required to suit Project conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Eaton Corp.; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution and Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D Co.

2.2 MANUFACTURED UNITS

A. Front-Connected, Front-Accessible Meter Center: Panel-mounted main device, panel-mounted branches, and sections rear aligned.

B. Ratings: Provide nominal system voltage, continuous main-bus amperage, and short-circuit current ratings as indicated on drawings.

2.3 FABRICATION AND FEATURES

A. UL listed, NEMA PB1, multi-metering, service rated Meter Center. Equipment shall be rated:
1. Operating Voltage: 120/208 VAC, 3-phase or 120/240 VAC, 1-phase as indicated.
2. Bus Ampere: Ratings as indicated.
3. Short Circuit Rating: As indicated on one-line diagram and schedules.
4. Grade: All 3-phase gear shall be commercial grade. Gear with 120/240V 1ph output may be residential grade if commercial grade is unavailable from the manufacturer.

B. Enclosure: Steel; NEMA 250, Type 3R rainproof.
1. Constructed of formed and welded, code gauge steel with gray baked enamel finish electrodeposited over cleaned galvanized steel.
2. All compartments with unmetered circuits shall be provided with sealing means.
3. Outdoor Finish: Factory-applied finish in manufacturer's standard color, including undersurfaces treated with corrosion-resistant undercoating.

C. Construction: All components shall be factory assembled. All bussing shall be complete from main lugs to each meter socket and to each overcurrent device. Belleville washers shall be used at all joints. Meter Centers shall have the following features:
   1. Main Circuit Breaker; size as noted.
   2. Service entrance rated.
   3. Meter socket types as approved by the utility company, with quantity of meter sockets as shown.
   4. Mechanical lugs, 75-degC.
   5. Molded case, inverse time breakers
   6. Bottom Feed.

D. Bussing: 3 phase, 4 wire, except as otherwise indicated. Features as follows:
   1. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with copper or tin-plated, aluminum circuit-breaker line connections.
   2. Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
   3. Ground Bus: 1/4-by-2-inch (6-by-50-mm) minimum size, drawn-temper copper of 98 percent conductivity; equipped with pressure connectors for feeder- and branch-circuit ground conductors.
   4. Contact Surfaces of Buses: High-strength, zinc-plated.
   5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the meter center main and distribution sections. Include ground bus and provide for future extensions. Belleville type washer connectors.
   6. Vertical Bus: The vertical bus in each section shall extend full height.
   7. Isolation Barrier Access Provisions: Permit checking bus bolt tightness.
   8. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral cables.

E. Provide Cutler Hammer 35/37MM commercial series Meter Centers or Square D EZ-Meter Centers.

## 2.4 METER SECTIONS

A. UL 414 listed distribution sections with two to six meter socket positions, 9" on-center, and corresponding overcurrent device. Enclosure and ratings shall match those noted herein.

B. Meter Sockets: Meter socket jaws must be spring reinforced and front removable, with features as required by the utility company.
   1. Rated 200 ampere or 350 ampere continuous duty.
   2. Tin-plated copper, spring-reinforced jaws.
   3. Lockable hinged covers for overcurrent devices.
   4. Engraved brass tags to identify service point/tenant for each meter socket position.
   5. Individual sections shall bolt together using 'Visi-tite' nuts.

C. Meter sockets shall be approved for use by serving utility; Black Hills Energy.

## 2.5 OVERCURRENT PROTECTIVE DEVICES

A. UL listed, NEMA AB1. Provide overcurrent devices and shown on the Drawings and/or as scheduled.

B. Circuit breakers shall be quick-make, quick-break, thermal magnetic or electronic trip as indicated; with handle positive indication. Contacts shall be nonwelding silver alloy and arc extension shall be accomplished by means of DE-ION arc chutes. Provide Square D type QO, Q2M, QE or LA breakers or equal.

C. Main Breaker: Enclosed, Insulated-Case Circuit Breaker: Fully rated, molded case circuit breakers with inverse time and instantaneous tripping. A fused (Type L) main OCPD would be acceptable if the total unit cost savings is documented to be 5% or more.

D. Feeder Breakers: Enclosed, Molded-Case Circuit Breakers: NEMA AB 1, handle lockable.
   1. Breakers 15-125A: Square D, two-pole, plug-on Type QO or equal.
   2. Breakers 150 to 200A: Square D Type Q2 breaker or equal.

E. Interrupting ratings shall be selected to provide the required current and short circuit current interrupter rating indicated on the Drawings.

2.6 IDENTIFICATION

A. Nameplates and label products are specified in Division 16 Section "Basic Electrical Materials and Methods."

B. Nameplates and label products are specified in Division 16 Section "Electrical Identification."
   1. Compartment Nameplates: Engraved laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive meter center for compliance with installation tolerances and other conditions affecting performance of meter centers.
   1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install meter centers level and plumb as indicated, according to manufacturer's written instructions and NEMA requirements. Maintain minimum clearance for utility transformers.

B. Support meter centers on unistrut frames or wall-mounted frames where indicated. Frames shall be free-standing with posts in concrete footings unless noted otherwise. Wall mounting on 'historic' listed structures is not allowed; and shall be confirmed with the Owner's Rep.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from meter center units and components.

D. Meters. Coordinate with the utility company for installation of all meters shown on the Dwgs.

3.3 CONNECTIONS

A. Connect meter centers and components to wiring systems and to ground as indicated and instructed by manufacturer.
   1. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."

B. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Electrical Identification."

C. Install compartment nameplates.

3.5 CLEANING

A. Upon completion of installation, inspect interior and exterior of meter centers. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

# SECTION 16470

# PANELBOARDS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.

B. This Section includes Vendor Panelboard rated 600V or less.

C. Related Sections include the following:
1. Division 16 Section "Basic Electrical Materials and Methods" for general materials and installation methods.
2. Division 16 Section "Electrical Identification" for labeling materials.
3. Division 16 Section "Field Quality Control."

### 1.3 SUBMITTALS

A. Product Data: For each type of panelboard, accessory item, and component specified.

B. Shop Drawings: For distribution panelboards. Include dimensioned plans and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
1. Enclosure type with details for types other than NEMA 250, Type 1.
2. Bus configuration and current ratings.
3. Short-circuit current rating of panelboard.
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 1. Include manufacturer's written instructions for testing circuit breakers.

### 1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NFPA 70.

C. Comply with NEMA PB 1.

1.5 EXTRA MATERIALS

A. Keys: 6 spares of each type for panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Eaton Corp.; Cutler-Hammer Products.
   2. General Electric Co.; Electrical Distribution & Control Div.
   3. Siemens Energy & Automation, Inc.
   4. Square D Co.

2.2 PANELBOARD FABRICATION

A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 3R, unless otherwise indicated to meet other conditions at installed location.

B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Each cover shall include a keyed lock.

C. Directory Frame: Metal, mounted inside each panelboard door.

D. Bus: Hard drawn copper of 98 percent conductivity or Tin plated Aluminum.

E. Main and Neutral Lugs: Mechanical lug type. All lugs shall be rated 75 degrees C.

F. Equipment Ground Bus: Copper, adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

G. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

H. Minimum Interrupting Capacity: 10,000 AIC for 240 volt panels, 14,000 AIC for 480 volt panels.
   1. Panelboards shall have AIC ratings greater than or equal to the available fault currently listed on the drawings.
   2. Series rating of OCPD's shall not be acceptable unless otherwise indicated.

I. Feed-through Lugs: Sized to accommodate feeders indicated.

2.3 VENDOR PANELBOARDS

A. Specialty panelboard fabricated to the following specs to provide power for vendor food trailers and other event loads.
   1. Features include lift-up receptacle hood, dead-front interior, main circuit breaker panelboard, factory wired outlets to panel breakers and removable hubs for field-wired feed-thru lugs.
   2. Housing: Surface mounted within a concrete bollard, NEMA 3R in-use cover/hood, nominal 14" Wx 25" H x 5"Deep. See detail on Civil Drawings.
   3. Ratings: 120/240V, 1phase, 100A with 100/2 main breaker.

4. Interior Panel: Four Circuit, 3-phase, with the following branch breakers:
   a. One 50A 2-pole factory wired to 50A receptacle
   b. Two 20A GFI breakers, each wired to half of duplex receptacle.
5. Receptacles: One 50A 120/240V 1ph (NEMA 14-50R) and one 20A GFI-protected duplex (NEMA 5-20R).
6. Feed-thru lugs: 100A, located behind removable hubs; for a single 120/240V hard-wired connection to vendor trailers.
7. Cutler-Hammer Cat No. CH6B3100RFD1N9N or approved equal (verify Cat No. to spec). Reference CH Quote No. SJ5103081001.
8. Where noted; provide a 150A version of this product. Panel shall have same features as noted above; with bus and feed-thru lugs rated for 150A, 120/240V, 1-phase. The panel width shall fit within the concrete base as detailed on Civil Sheets.
9. Provide a secure means to prevent the public from gaining access to 'hot' lugs section of the vendor panel.

B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

C. Two Section Panel: Where more than 42 poles are indicated, provide two adjacent panelboards with bus tie cables per NEC.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
   1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
   2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
   3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
   4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
   5. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
   6. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting Heights: Refer to Mounting Height Schedule, Division 16 Section 16130 "Raceway and Boxes."

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Electrical Identification."

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

3.3 GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 ADJUSTING

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

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

SECTION 16475

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Fuses.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each fuse type specified.

C. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:
1. Cooper Industries, Inc.; Bussmann Div.
2. Gould Shawmut.
3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Feeders, 0 - 600 Amperes: Class RK1 or J, dual element, time delay.

B. Main Disconnects, 600-800 Amperes: Class L, dual element, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

B. Fuses in distribution equipment shall be factory installed.

C. Install fuses in fusible devices as indicated.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION

# SECTION 16515

# LIGHTING FIXTURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes lamps, ballasts, and accessories for exterior lighting.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 16 Section "Field Quality Control."

### 1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data describing fixtures, lamps, ballasts, emergency lighting units and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on features and accessories and the following:
   1. Outline drawings indicating dimensions and principal features of fixtures and poles.
   2. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for fixtures and lamps.
   3. Battery and charger data for emergency lighting units.

C. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

D. Maintenance data for fixtures to include in the operation and maintenance manual specified in Division 1.

E. Prior approvals will not be considered for light fixtures. Substitutions will be considered from the successful Bidder only.

F. Scheduled fixtures shall be used as a standard of comparison for proposed substitutions based on, but not limited to, photometrics, coefficient of utilization values and aesthetics.

### 1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

B. Listing and Labeling: Provide fixtures, emergency lighting units, and accessory components specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, required to be mounted on ceiling or in ceiling space.

1.5 STORAGE AND HANDLING OF POLES

A. General: Store poles on decay-resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.

B. Wood Poles: Do not drag treated poles along ground. Do not handle poles with tongs, cant hooks, and other pointed tools capable of producing indentation more than 1/4 inch (6 mm) in depth. Do not apply tools to ground-line section of poles.

C. Metal Poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, fixtures that may be incorporated into the Work include, but are not limited to, the products specified in the Lighting Fixture Schedule.

B. Lamps: Subject to compliance with requirements, provide products by the following:
1. General Electric.
2. Osram/Sylvania.
3. Philips.

C. Ballasts: Subject to compliance with requirements, provide products by the following:
1. Advance.
2. Magnetek.
3. Motorola.
4. Osram/Sylvania.
5. Prescolite.
6. Universal.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges. Exposed hardware on exterior fixtures shall be stainless steel.

B. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging. Exterior fixture components shall be corrosion resistant aluminum, rigid formed, weather and light-tight. Enclosed housings for exterior fixtures shall include filter/breather.

C. High-Intensity-Discharge (HID) Fixtures: Conform to UL 1572.

D. HID Ballasts: Conform to UL 1029 and ANSI C82.4. Include the following features, except as otherwise indicated.

1. Super constant wattage pulse-start (SCWA) high-power-factor type, unless otherwise indicated.
2. Operating Voltage: Match system voltage.
3. Single-Lamp Ballasts: Minimum starting temperature of minus 30 deg C. Provide one fuse in each ungrounded supply conductor for exterior fixtures.
4. Normal Ambient Operating Temperature: 40 deg C.
5. Open circuit operation will not reduce average life.
6. Encapsulation: Manufacturer's standard epoxy-encapsulated model designed to minimize audible fixture noise. Exterior fixtures shall have a noise rating of B or better.

2.3 LAMPS

A. Comply with ANSI C78 series that is applicable to each type of lamp.

B. Metal Halide Color Temperature and Minimum Color-Rendering Index (CRI): 3600 K and 70 CRI, except as otherwise indicated.

2.4 EXTERIOR FIXTURE SUPPORT COMPONENTS

A. Pole-Mounted Fixtures: Conform to AASHTO LTS-3.

B. Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mi./h (160 km/h) with a gust factor of 1.3.

C. Arm, Bracket, and Tenon Mount Materials: Match poles' finish.

D. Mountings, Fastenings, and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

E. Metal Pole Bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts, and bolt covers.

F. Wood Pole Bases: Embedded type with underground cable entry.

G. Poles: Steel tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi (317 MPa). Poles are 1-piece construction up to 40 feet (12 m) in length and have access handhole in wall.

H. Metal Pole Grounding Provisions: Welded 1/2-inch (12-mm) threaded lug, accessible through handhole.

I. Pressure-Treated-Wood Poles: Conform to ANSI O5.1. Conform to AWPA C4 for wood species used. Bore, roof, and gain poles before treatment. See Fixture Schedule.

J. Aluminum Mast Arms: Tapered oval arms continuously welded to pole attachment plate with span and rise as indicated.

K. Steel Mast Arms: Fabricated from 2-inch NPS (DN50) black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.

L. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate fixture.

M. Wood Pole Brackets: Conform to ANSI C136.13.

N. Concrete for Pole Foundations: Comply with Division 3 Section "Cast-in-Place Concrete" and details shown on the Drawings.

2.5 FINISHES

A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.

B. Concrete Foundations: Construct according to Division 3 Section "Cast-in-Place Concrete."
1. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished. Trowel and rub smooth parts exposed to view.

3.2 CONNECTIONS

A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 EXTERIOR FIXTURE INSTALLATION

A. Install a 10-foot driven ground rod at each pole base as noted on the Drawings. Connect pole or metallic components of fixture for non-metallic poles to the ground rod with No. 6 AWG conductor.

B. Use web fabric slings to raise and set poles.

C. Construct pole bases per Details on the Drawings.

D. Embedded Poles: Set poles to depth indicated, but not less than 1/6th of pole length below finished grade. Backfill and compact in 6-inch layers. Compaction shall be equal to or greater than that of undisturbed earth.

3.4 ADJUSTING AND CLEANING

A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION

SECTION 16994

FIELD QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes field quality and testing requirements for equipment and their installation previously specified in other Division 16 sections.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1.

B. Ground resistance test report.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check for proper tightness of all electrical connections and in accordance with manufacturers recommended values.

3.2 ADDITIONAL REQUIREMENTS

A. Conductors and Cables:
   1. Prior to energization, perform a visual check; and check each feeder for continuity and for short circuits.
   2. Perform insulation resistance test with megohm meter for all feeders. Apply 1000V to 600V conductors for a period of 60 seconds.
   3. Replace failing conductors.
   4. Provide documentation of test results.

B. Wiring Devices:
   1. Test ground fault interrupters for proper operation.
   2. Ensure proper polarity of connections.
   3. Replace malfunctioning units.

C. Grounding:
   1. Measure the resistance of the main grounding electrode at each Meter Center; under normal dry conditions using a certified hand-held clamp-on ground resistance tester as manufactured by AEMC. Resistance shall not exceed 20 ohms.

D. Utility Transformers:
   1. Measure the secondary voltage at each Meter Center.
   2. Coordinate with Black Hills Energy to make appropriate tap adjustments to achieve desired secondary voltage.

E. Panelboards:
   1. Check continuity of each connection.
   2. Check tightness of bolted connections of feeders with torque wrench.
   3. Test per ANSI/NETA ATS-2009 to ensure meet requirements and perform safely.
   4. Replace or correct any malfunctions noted and retest.

F. Overcurrent Protective Devices:
   1. Verify indicated rating and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, recommend final device ratings and settings. Use accepted revised ratings or settings to make the final system adjustments.
   2. Verify installation of proper fuse types and ratings in fusible OCPDs.
   3. Check for proper operation, including interlocks, relays, shunt-trips, and other safety devices.

G. Meter Centers:
   1. Verify installation of proper sizes, types and ratings of overcurrent devices.
   2. Check for proper voltages on main bus.
   3. Test per ANSI/NETA ATS-2009 to ensure meet requirements and perform safely.
   4. Replace or correct any malfunctions noted and retest.

H. Exterior Lighting:
   1. Inspect installed units for damage.
   2. Tests: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:
      a. Check for excessively noisy ballasts.
      b. Check for uniformity of illuminations.
   3. Replace or repair damaged and malfunctioning units and retest.

I. Public Address System (by Owner - NIC):
   1. Perform an operational system test to verify proper operation of any PA speaker and associated wiring relocated under this Work.
   2. Observe sound reproduction for proper volume levels and freedom from noise. Replace malfunctioning or damaged items with new.

J. Lighting Control Equipment:
   1. Verify proper operation of all exterior lighting controls impacted by this Work for proper operation.
   2. Visual and Mechanical Inspections: Include the following inspections:
      a. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
      b. Check tightness of electrical connections with torque wrench.
      c. Exercise mechanical parts and operable devices according to manufacturer's instructions to verify proper operation.

END OF SECTION