

## SECTION 26 05 01

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes general requirements specifically applicable to Division 26.
- B. Work Specifically Excluded from Project:
  - 1. Power company metering facilities.
- C. Contractor's Responsibilities:
  - 1. Complete systems in accordance with the intent of these Contract Documents.
  - 2. Coordinate details of facility equipment and construction for specification divisions that affect work covered under this division.
  - 3. Furnish and install incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
  - 4. Equipment and systems to meet project seismic requirements.
- D. Intent of Drawings:
  - 1. Electrical plan drawings show general locations of equipment, devices, raceways, and cable trays unless specifically dimensioned.
  - 2. Contractor: Responsible for proper routing of raceway and cable tray, subject to prior review by JACOBS.
  - 3. Perform the following in addition to what is indicated on the Drawings and Specifications.
    - a. Design, furnish, and install seismic supports, anchors, and bracing for electrical equipment based on indicated project seismic requirements.
    - b. Size pull and junction boxes not shown or sized on the Drawings.
    - c. Route raceways, coordinating with other Contractors. Determine raceway highways in addition to those indicated on plans.
    - d. Increase raceway sizes as needed based upon actual wire size.
    - e. Develop installation details based upon the Drawings and Specifications.
    - f. Route and size grounding system based upon Drawings and Specifications. Include bonding jumpers and grounding electrode conductors to separately derived sources and service entrances.
    - g. Develop wiring and control diagrams based upon Vendor drawings to supplement those shown on the Drawings.
    - h. Develop electrical equipment front elevations and footprint dimensions for layout, purchase, and installation.
    - i. Lay out electrical distribution equipment per NEC required clearances.

## 1.2 DESIGN CRITERIA

- A. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within an ambient temperature of 25 to 94 degrees F, relative humidity of zero to percent.
- B. Compliance by Contractor with provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at specified service conditions.
- C. Electrical Components and Systems Manufactured Within the Scope of Underwriters Laboratories (UL): Conform to UL standards, provide UL listing and label with an applied UL listing mark.
- D. Equipment: Meet applicable requirements of Factory Mutual.
- E. Indoor dry Areas: Use NEMA 1 enclosures for electrical equipment and devices in these areas unless otherwise indicated.
- F. Outdoor and Wet Areas: Use NEMA 3R enclosures for electrical equipment and devices in these areas unless otherwise indicated.
- G. Close unused holes in boxes, equipment, and raceway.
- H. Remove abandoned outlets, cables, and conductors.

## 1.3 REGULATORY REQUIREMENTS

- A. Conform to latest codes and other legal requirements.
- B. Obtain permits and arrange inspections required by codes applicable to this division. Submit written evidence to JACOBS that required permits, inspections, and code requirements have been secured.

## 1.4 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Materials and Equipment: Labeled and/or listed as acceptable to authority having jurisdiction as suitable for use intended.

- B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

## PART 3 EXECUTION

### 3.1 WORKMANSHIP

- A. Install work using procedures defined in NECA Standard of Installation.
- B. Install material and equipment in accordance with manufacturer's instructions. Provide calibrated torque wrenches and screwdrivers as required.

### 3.2 SERVICE CONTINUITY

- A. Maintain continuity of electric service to functioning portions of processes or buildings during hours of normal use.
- B. Arrange temporary outages for cutover work with Owner. Keep outages to a minimum number and minimum length of time.

### 3.3 TOUCH-UP PAINTING

- A. Repair damage to factory-applied paint finishes with touch-up paint.
- B. Use touch-up paint and methods of preparation and application recommended by manufacturer of components to be repaired.

### 3.4 STARTUP TESTING AND INSPECTION OF ELECTRICAL EQUIPMENT

- A. Voltage: At project completion, check voltage at termination point of power supply system to project. Check true rms voltage magnitude and balance between phases for loaded and unloaded conditions. Adjust taps of transformers such that no load voltage is approximately equal to or up to 3 percent above normal.

### 3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 01-02	Individual price and delivery schedule for equipment	X	Per construction schedule
26 05 01-03	Length of time required for certification of information, drawings, etc.	X	Per construction schedule
26 05 01-04	Inspection and permit certificates and certificates of final inspection and acceptance from authority having jurisdiction	X	Per construction schedule
26 05 01-05	Test reports	X	Per construction schedule

END OF SECTION

## SECTION 26 05 05

### BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install the following basic electrical materials and associated methods:
  - 1. Fuses.
  - 2. Boxes and Condulets.
  - 3. Hinged cover enclosures.
  - 4. Cabinets.
  - 5. Contactors.
  - 6. Control relays.
  - 7. Push buttons, indicating lights, and selector switches.
  - 8. Terminal blocks and accessories.
  - 9. Power system monitoring.
  - 10. Penetration sealing systems and firestopping.
  - 11. Low-voltage surge protective equipment.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.

##### 1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 FUSES

- A. Acceptable Manufacturers:
  - 1. Bussmann.
  - 2. Gould-Shawmut.
- B. Zero to 600 Volts:
  - 1. Provide a complete set of current-limiting fuses wherever fuses are indicated. Supply a set of six spare fuses of each type and each current rating installed. Utilize fuses that fit mountings specified with switches and which provide features rejecting Class H fuses. Provide the following types:

- a. For 250- to 600-volt motor and transformer circuits, zero to 600 amps, UL Class RK-5 with time delay, Bussmann Type FRS-R, Shawmut Type TRS-R.
- b. For zero- to 250-volt motor and transformer circuits, zero to 600 amps, UL Class RK-5 with time delay, Bussmann Type FRN-R, Shawmut Type TR-R.
- c. For 250- to 600-volt feeder and service circuits, zero to 600 amps, UL Class RK-1, Bussmann Type KTS-R, Shawmut Type A6K-R.
- d. For zero- to 250-volt feeder and service circuits, zero to 600 amps, UL Class RK-1, Bussmann Type KTN-R, Shawmut Type A2K-R.
- e. For zero- to 600-volt feeder and service circuits, 601 to 6,000 amps, UL Class L, Bussmann Type KRP-C, Shawmut Type A4BY.

## 2.2 BOXES AND CONDULETS

- A. Outlet:
  - 1. Sheet Metal Outlet Boxes: NEMA OS 1; galvanized steel with 1/2-inch male fixture studs where required; minimum depth 2 inches.
  - 2. Nonmetallic Outlet Boxes: NEMA OS 2; minimum depth 2 inches. Provide gasketed, watertight cover.
  - 3. Cast Boxes: Cast Feraloy, deep type, gasketed cover, threaded hubs; minimum depth 2 inches.
- B. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Full adjustable.
- C. Pull and Junction Boxes:
  - 1. Sheet Metal Boxes for Interior Dry Location Installations:
    - a. Electrical:
      - 1) Boxes Having No Dimension Greater Than 12 Inches: NEMA OS1; galvanized steel.
      - 2) Boxes Equal to or Larger Than 12 Inches in Any Dimension: See hinged cover enclosures within this Section.
    - b. Communications: NEMA 250; Type 1, galvanized steel enclosures designed for use as pull boxes with flat screw-applied covers, with or without knockouts, and gray enamel finish.
  - 2. Cast Metal Boxes for Above-Grade Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface mounted junction box, raintight. Galvanized cast Feraloy box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
  - 3. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, outside flanged, recessed cover box for flush mounting, raintight. Galvanized cast Feraloy box and plain cover with neoprene gasket and stainless steel cover screws.
  - 4. Cast Metal Boxes for Above-Grade Hazardous Location Installations: Flat-flanged, surface-mounted, explosion-/dust-/ignition-proof junction box which meets applicable NEC 500 requirements for Class I applications. Cast box for threaded rigid steel conduit connections with threaded cover and gasket.

5. Fiberglass Handholes for Underground Installations: Die molded with precut 6- by 6-inch cable entrance at center bottom of each side; fiberglass weatherproof cover with nonskid finish.
6. Concrete (Precast) Handholes for Underground Electrical Installations: 10- by 17-inch minimum (inside dimensions) cable entrance at center bottom of each side; cast iron cover marked "electrical" or as shown on the Drawings.

## 2.3 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250.
  1. Type 1: Steel.
  2. Type 4: Steel with gasketed door, raintight.
  3. Type 4X: Stainless steel
  4. Type 12: Steel with gasketed door, dusttight.
- B. Finish: Manufacturer's standard.
- C. Covers: Continuous hinge held closed by flush latch; operable by hasp and staple for padlock. Provide neoprene rubber gaskets.
- D. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.

## 2.4 CABINETS

- A. Electric Cabinets:
  1. Cabinet Boxes: Galvanized steel with removable end walls, size(s) as shown on Drawings. Provide 3/4-inch-thick plywood backboard painted matte white for mounting terminal blocks.
  2. Cabinet Fronts: As shown on the Drawings, with concealed trim clamps, concealed hinge, and flush lock keyed to match branch circuit panelboard; louvered for ventilation of internal components; finish same as enclosure.
  3. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

## 2.5 CONTACTORS

- A. Acceptable Manufacturers:
  1. General Electric Company.
  2. Square D Company.
  3. Cutler-Hammer Company.
  4. Siemens.
- B. General Purpose:
  1. NEMA ICS 2: Electrically held, three-wire control.
  2. Enclosure: NEMA 1 unless indicated otherwise on Drawings.
  3. Provide bus terminals suitable for mounting in panelboard.
- C. Lighting:

1. NEMA ICS 2: Electrically held, three-wire control.
2. Provide bus terminals suitable for mounting in panelboard.

## 2.6 CONTROL RELAYS

- A. Acceptable Manufacturers:
  1. General Electric.
  2. Cutler-Hammer.
  3. Potter-Brumfield (Tyco).
  4. Struthers-Dunn (Magnecraft).
- B. General:
  1. Provide magnetic control relays, NEMA Class A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts or A600 (600 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.
  2. Where time-delay relays are specified or required, unless otherwise noted, provide magnetic control relays with timer attachment adjustable from 0.2 to 60 seconds (minimum) and field convertible from on delay to off delay and vice versa.
  3. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

## 2.7 PUSH BUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

- A. Acceptable Manufacturers:
  1. Allen-Bradley, 800H series.
  2. General Electric, CR104P Series, CR2940 series, hazardous locations.
  3. Square D, Class 9001 Type K; Type SK, corrosion resistant; Type BR, hazardous locations.
  4. Cutler-Hammer, 10250T.
- B. General:
  1. For nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, provide heavy-duty, NEMA 13, oiltight-type push buttons, indicating lights, selector switches, and stations for these devices.
  2. For nonhazardous, outdoor, or normally wet locations or where otherwise indicated, provide heavy-duty, corrosion-resistant, watertight-type push buttons, indicating lights, or selector switches mounted in NEMA 4 enclosures.
  3. For locations indicated as corrosive on the Drawings, provide components and enclosures rated NEMA 4X.
  4. Provide individual, extra-large nameplates indicating specific function.
  5. Provide push-button stations with laminated plastic nameplates indicating the drive they control.
  6. Utilize selector switches having standard operating levers. Provide transformer push-to-test type indicating lights. Provide on or start push buttons colored black. Provide off or stop push buttons colored red.



## 2.8 TERMINAL BLOCKS AND ACCESSORIES

- A. Terminal Blocks: NEMA ICS 4; UL listed.
- B. Signal and Control Terminals:
  - 1. Acceptable Manufacturers:
    - a. Phoenix Contact, UK Series (UK10).
    - b. Buchanan, Vanguard Line (10 mm).
    - c. Weidmuller, SAK Series (SAK10).
    - d. Entrelec, 500 Series (MS6/8).
  - 2. Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts; minimum terminal width of 0.24 inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Provide thermoset characters, black on white background, for terminal identification numbers. Provide 25 percent spare terminals.
- C. Power Terminals:
  - 1. Acceptable Manufacturers:
    - a. Buchanan.
    - b. IlSCO.
  - 2. Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

## 2.9 POWER SYSTEM MONITOR

- A. Acceptable Manufacturer: Basic Measurement Instruments (BMI) Model 8800.
- B. Self-contained portable disturbance waveform analyzer with touch screen, dual microfloppy disk drive, high-resolution thermal printer, and keyboard. Inputs: Four each independent ac/dc voltage and current channels. Provide 25-pin RS232C main serial port and 9-pin RS232C external printer port.

## 2.10 PENETRATION SEALING SYSTEMS AND FIRESTOPPING

- A. Install penetration sealing around and within cable or raceway openings where passing through rated floors, ceilings, or walls in a manner to maintain fire rating of structure penetrated as specified on drawings.

## 2.11 LOW-VOLTAGE SURGE PROTECTIVE EQUIPMENT

- A. Provide secondary surge protective equipment consisting of a surge capacitor and surge arrester combination located where indicated on the Drawings. Utilize components for surge protective equipment covered by this Specification, designed and tested in accordance with NEMA LA-1 and ANSI/IEEE C62.1.
- B. Provide surge capacitor impregnated with non-PCB biodegradable dielectric fluid. Include integral discharge resistor which will reduce residual voltage to 50 volts crest in less than 5 minutes after unit has been disconnected from circuit.

- C. Provide arrestor consisting of an assembly of high-strength metal oxide valve elements enclosed in a high-strength, corrosion-resistant, molded resin housing.

## PART 3 EXECUTION

### 3.1 BOXES AND CONDULETS – LOCATION AND BOX TYPE

- A. Types to be Provided, Steel and/or Aluminum Raceway System:
  - 1. Exterior Locations: Cast Feraloy with neoprene gaskets.
  - 2. Interior Dry Locations With:
    - a. Rigid Steel Conduit: Cast Feraloy.
    - b. Intermediate Metallic Conduit: Cast Feraloy.
    - c. Electrical Metallic Tubing: Sheet steel.
    - d. Rigid Aluminum Conduit: Cast aluminum.
    - e. Communications Wireway: Same material as wireway.
  - 3. Interior Wet Locations with Exposed and Concealed Raceways: Cast Feraloy with neoprene gaskets.
- B. Types to be Provided, Plastic Raceway System:
  - 1. Exposed Raceways, Corrosive Locations: Nonmetallic.
  - 2. Concealed Raceways, Corrosive Locations: Nonmetallic.
- C. Types to be Provided, Plastic Coated:
  - 1. Steel Raceway System: Plastic-coated steel.
  - 2. Concrete-Encased Raceways: Cast Feraloy with neoprene gaskets.
- D. Single In-Line Communications Conduit Runs, All Locations:
  - 1. 2-Inch Conduit and Smaller: Type C conduit bodies of cast Feraloy or nonmetallic construction as required for the location. Gaskets outdoors and in wet locations.
  - 2. Conduit Larger Than 2-Inch: Straight-through communications wireway as specified for the location.

### 3.2 COORDINATION OF BOX LOCATIONS

- A. Electrical Boxes: Provide 2 by 4-inch boxes for switches and receptacles with plaster rings as required or as shown on Drawings and as required for splices, taps, wire pulling, equipment connections, and code compliance. Provide 4-inch minimum octagonal boxes for ceiling luminaire outlets.
- B. Communications Boxes: Provide 4- by 4- by 2-inch-deep outlet boxes with single-gang plaster rings for mounting telecommunications outlets.
- C. Electrical and communications box locations shown on the Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

- D. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors with other trades.
- E. Locate and install to maintain headroom and to present a neat appearance.

### 3.3 OUTLET BOX INSTALLATION

- A. Do not install boxes back to back in walls. Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic rated walls.
- B. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes. Use boxes with sufficient depth to permit conduit hubs to be located in masonry void space.
- C. Provide knockout closures for unused openings.
- D. Support boxes independently of conduit.
- E. Use multiple-gang boxes where multiple devices are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- F. Install boxes in walls without damaging wall insulation.
- G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- H. Position boxes to locate luminaires as shown on reflected ceiling plans.
- I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire to be accessible through luminaire ceiling opening.
- J. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud walls and adjustable steel channel fasteners for flush ceiling outlet boxes.
- K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

### 3.4 FLOOR BOX INSTALLATION

- A. Set boxes level and flush with finish flooring material.
- B. Use floor boxes for installations in slab on grade.

### 3.5 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit and wireway.

- C. Provide pull boxes to limit conduit runs as follows, unless accepted by JACOBS:
  - 1. Electric Raceways: Limit conduit runs to 150 feet and contain no more than three 90 degree, right-angle bends.
  - 2. Communications Raceways: Limit conduit runs to 100 feet and contain no more than the equivalent of two 90 degree, right-angle bends.
- D. Install such that boxes are accessible.
- E. Provide communications pull boxes of sufficient size and place raceway connections in a manner that ensures minimum inside cable bend radius is more than 10 times inside diameter of conduit. Do not install boxes, bends, elbows, tees, conduit outlet bodies, and other conduit fittings which do not provide for this minimum inside cable bend radius.

### 3.6 FABRICATION – CONTROL ENCLOSURES AND CABINETS

- A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

### 3.7 INSTALLATION – ENCLOSURES AND CABINETS

- A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.
- B. Provide accessory feet for freestanding equipment enclosures.
- C. Install trim plumb.

### 3.8 OPENINGS

- A. Close openings in boxes, condulets, raceways, and equipment.

### 3.9 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 05-01	Catalog cut-sheets, other descriptive literature for: <ul style="list-style-type: none"> <li>• Fuses</li> <li>• Hinged cover enclosures</li> <li>• Cabinets</li> <li>• Contactors</li> <li>• Control relays</li> <li>• Push buttons, indicating lights, and selector switches</li> <li>• Terminal blocks and accessories</li> <li>• Power system monitoring</li> <li>• Penetrating sealing systems and firestopping</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-02	Layout with dimensions and openings for: <ul style="list-style-type: none"> <li>• Hinged cover enclosures</li> <li>• Cabinets</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-03	Weights for: <ul style="list-style-type: none"> <li>• Hinged cover enclosures</li> <li>• Cabinets</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-04	Capacities and ratings for: <ul style="list-style-type: none"> <li>• Fuses</li> <li>• Contactors</li> <li>• Control relays</li> <li>• Terminal blocks and accessories</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-05	Mounting, including seismic for: <ul style="list-style-type: none"> <li>• Hinged cover enclosures</li> <li>• Cabinets</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule

<b>ITEM NO.</b>	<b>SUBMITTAL REQUIREMENT</b>	<b>WITH BID</b>	<b>AS INDICATED</b>
26 05 05-06	Performance characteristics for: <ul style="list-style-type: none"> <li>• Power system monitoring</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-07	Model numbers for: <ul style="list-style-type: none"> <li>• Power system monitoring</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-08	Data sheets for: <ul style="list-style-type: none"> <li>• Fuses</li> <li>• Hinged cover enclosures</li> <li>• Cabinets</li> <li>• Contactors</li> <li>• Control relays</li> <li>• Push buttons, indicating lights, and selector switches</li> <li>• Terminal blocks and accessories</li> <li>• Power system monitoring</li> <li>• Penetration sealing system</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-09	Wiring and schematic diagrams for: <ul style="list-style-type: none"> <li>• Hinged cover enclosures</li> <li>• Cabinets</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule
26 05 05-10	Software, files, databases for power system monitor	X	Per construction schedule
26 05 05-11	Operation and maintenance manuals for: <ul style="list-style-type: none"> <li>• Power system monitoring</li> <li>• Low-voltage surge protective equipment</li> </ul>	X	Per construction schedule

END OF SECTION

## SECTION 26 05 19

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Building wire.
  - 2. Cable.
  - 3. Wiring connections and terminations.
  - 4. Modular wiring system.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.
  - 2. Section 26 05 53 – Identification for Electrical Systems.

##### 1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 BUILDING WIRE

- A. Acceptable Manufacturers:
  - 1. Okonite.
  - 2. General Cable.
  - 3. Southwire.
- B. Thermoplastic-insulated building wire.
- C. Rubber-insulated building wire.
- D. Feeders and Branch Circuits Larger than 6 AWG: Copper, stranded conductor, 600-volt insulation, XHHW-2.
- E. Feeders and Branch Circuits 6 AWG and Smaller: Copper, stranded conductor, 600-volt insulation, XHHW-2.
- F. Control Circuits: Copper, stranded conductor, 600-volt insulation, XHHW-2.

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## 2.2 ARMORED CABLE

- A. Armored Cable, 14 through 6 AWG: Copper conductor, 600-volt thermosetting insulation, rated 90 degrees C, Type AC.
- B. Armored Cable, 4 through 1 AWG: Copper conductor, 600-volt thermosetting insulation, rated 90 degrees C, Type AC.
- C. Armored Cable Larger than 1 AWG: Copper conductor, 600-volt thermosetting insulation, rated 90 degrees C; Type MC.

## 2.3 REMOTE CONTROL AND SIGNAL CABLE

- A. Acceptable Manufacturers:
  - 1. Brand Rex.
  - 2. Belden.
  - 3. General Cable.
- B. Type 1, 600-Volt Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:
  - 1. Individual Conductors: 14 AWG, stranded copper, PVC insulation, nylon jacket, rated 90 degrees C dry, 75 degree C wet; color coded per ICEA Method 1, plus one green equipment grounding conductor.
  - 2. Assembly: Bundle wrapped with cable tape and covered with PVC jacket.
  - 3. Use 2-, 5-, 7-, 12-, 25-, or 37-conductor cable. Provide grounding conductor in addition to number of conductors shown in table below:

Number of Conductors	Maximum Outside Diameter
2	0.40 inch
5	0.45 inch
7	0.48 inch
12	0.65 inch
25	0.93 inch
37	1.04 inches

- C. Type 2, 300-Volt Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits:
  - 1. Individual Conductors: 14 AWG, solid copper, PVC insulated, rated 105 degrees C dry, individual conductors twisted together, shielded, plus bare stranded tinned copper drain conductor.
  - 2. Assembly: Bundle covered with overall PVC jacket.
  - 3. Use two-, three-, or four-conductor cable.

Number of Conductors	Maximum Outside Diameter
Two	0.40 inch

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Three	0.42 inch
Four	0.45 inch

- D. Type 3, 150-Volt Plenum-Rated Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits:
1. Individual Conductors: 14 AWG, solid copper, Teflon insulated, rated 60 degrees C, individual conductors twisted together, shielded.
  2. Assembly: Bundled covered with overall clear or red Teflon jacket.
  3. Use two, three, four, or six conductors.

Number of Conductors	Maximum Outside Diameter
Two	0.35 inch
Three	0.39 inch
Four	0.43 inch
Six	0.47 inch

## 2.4 POWER CABLE

- A. Type 4, 600-Volt Power Cable, Type TC:
1. Individual Conductors: Conductor size per schedule on Drawings, 7- or 19-strand copper, PVC insulation, nylon jacket, rated 90 degrees C dry, 75 degrees C wet, color coded per ICEA Method 1. On 480Y/277V systems, mark conductors with vinyl tape per the schedule in Section 26 05 53 – Identification for Electrical Systems. Provide one green grounding conductor.
  2. Assembly: Bundle wrapped with cable tape and covered with PVC jacket.
  3. Use the following cables:

Number and Size of Conductors	Size of Grounding Conductors	Maximum Outside Diameter
Three 12 AWG	One 12 AWG	0.47 inch
Three 10 AWG	One 10 AWG	0.51 inch
Three 8 AWG	One 10 AWG	0.65 inch
Three 6 AWG	One 8 AWG	0.75 inch
Three 4 AWG	One 8 AWG	0.90 inch
Three 2 AWG	One 6 AWG	1.10 inches
Three 1 AWG	One 6 AWG	1.20 inches
Three 2/0 AWG	One 6 AWG	1.40 inches
Three 4/0 AWG	One 4 AWG	1.65 inches

## 2.5 LIFE SAFETY AND SECURITY SYSTEMS CABLE

- A. Acceptable Manufacturers: Use only manufacturers and types acceptable to system Vendor as listed on the Legend Drawing.

## 2.6 MODULAR WIRING SYSTEMS

- A. Acceptable Manufacturers:
  - 1. Lithonia/Reloc.
- B. Modular Wiring Systems: Prewired flexible metal conduit assemblies with polarized special connectors to distribute lighting and receptacle branch circuits from accessory distribution boxes; UL listed.

# PART 3 EXECUTION

## 3.1 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits and no smaller than 14 AWG for control wiring.
- B. Place an equal number of conductors for each phase of a circuit in same raceway or cable.
- C. Splice in junction or outlet boxes.
- D. Splice cables only with written permission of JACOBS. Show splice locations on as-constructed drawings.
- E. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- F. Make conductor lengths for parallel circuits equal.
- G. Where connection of cables installed under this Section is to be made by others, provide pigtails of adequate length for neat, trained, and bundled connections.

## 3.2 INSTALLATION

- A. Wiring in Raceways:
  - 1. Pull conductors into a raceway at the same time. Use UL-listed wire pulling lubricant for pulling 4 AWG and larger wires.
  - 2. Install wire in raceway after interior of building has been physically protected from weather and mechanical work likely to injure conductors has been completed.

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3. Completely and thoroughly swab raceway system before installing conductors.
- B. Cable:
1. Provide protection for exposed cables where subject to damage.
  2. Support cables above accessible ceilings; do not rest on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure or ceiling suspension system. Include bridle rings or drive rings.
  3. Use suitable cable fittings and connectors.
  4. Install life safety and security systems cable per the requirements of NFPA 72, National Fire Alarm Code.
- C. Modular Wiring System:
1. Install modular wiring system in accordance with manufacturer's instructions.
  2. Use spring metal clips or plastic cable ties to support cables longer than 6 feet from structure or ceiling suspension system. Include bridle rings or drive rings.

### 3.3 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice in accessible junction boxes.
- B. Terminate aluminum wire in accordance with manufacturer's instructions.
- C. Terminate aluminum conductors with tin-plated aluminum-bodied compression connectors only. Fill with antioxidant compound prior to installation of conductor.
- D. Use suitable reducing connectors or mechanical connector adapters for connecting aluminum conductors to copper conductors.
- E. Use solderless pressure connectors with insulating covers for copper wire splices and taps 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.
- F. Terminate control circuit conductors at terminal blocks only.
- G. Use split bolt connectors for copper wire splices and taps 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of conductor insulation value.
- H. Thoroughly clean wires before installing lugs and connectors.
- I. Where approved, make splices, taps, and terminations to carry full ampacity of conductors without perceptible temperature rise.
- J. Terminate spare conductors with electrical tape.
- K. Splice below-grade conductors in handholes or manholes and make watertight with epoxy resin-type splicing kits similar to Scotchcast.

- L. Label conductors according to the requirements of Section 26 05 53 – Identification for Electrical Systems.
- M. Connect and install armored and other cable per manufacturer's requirements.

### 3.4 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Torque test conductor connections and terminations to manufacturer's recommended values.
- C. Perform continuity and insulation tests on power and equipment branch circuit conductors. Verify proper phasing connections.
- D. Life Safety and Security Systems Cable:
  - 1. Test cable per requirements of NFPA 72, Fire Alarm Code.
  - 2. Test spliced cable shields for continuity and isolation from ground.

### 3.5 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Concealed Interior Locations: Building wire in raceways.
- B. Exposed Interior Locations: Building wire in raceways.
- C. Above Accessible Ceilings: Building wire in raceways.
- D. Wet or Damp Interior Locations: Building wire in raceway.
- E. Exterior Locations: Building wire in raceways.
- F. Underground Locations: Building wire in raceways.

### 3.6 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 19-01	Catalog cut-sheets, other descriptive literature	X	Per construction schedule
26 05 19-02	Weights	X	Per construction schedule
26 05 19-03	Capacities and ratings	X	Per construction schedule
26 05 19-04	Manufacturer's instructions for splicing and terminating aluminum conductors	X	Per construction schedule
26 05 19-05	Performance characteristics	X	Per construction schedule
26 05 19-06	Data sheets	X	Per construction schedule
26 05 19-07	Shop drawings for modular wiring system, including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices	X	Per construction schedule
26 05 19-08	Field test results	X	Per construction schedule

END OF SECTION

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## SECTION 26 05 26

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Power system grounding.
  - 2. Communication system grounding.
  - 3. Electrical equipment, raceway, and cable tray grounding and bonding.
  - 4. Zero signal reference grid grounding.
  - 5. Metal piping system bonding.

##### 1.2 SYSTEM DESCRIPTION

- A. Ground and bond electrical systems and equipment including separately derived sources and communications systems per requirements of NEC Article 250.
- B. Provide communications system grounding conductor at telephone utility point-of-service entrance and connect to nearest effectively grounded building structural steel member.
- C. Provide separate isolated equipment grounding conductor bonded to system at service or separately derived source. Avoid multiple connections to allow reduction of electrical noise.

##### 1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 GROUND RODS

- A. Copperclad steel, 3/4 inch diameter, 10 feet long, driven full length into the earth.

##### 2.2 GROUND CONDUCTORS

- A. Provide grounding conductors sized as shown on Drawings.
- B. Provide bare stranded copper conductors below grade and above grade where not routed in conduit.
- C. Provide XHHW-2 with 600V insulation where routed in conduit.

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- D. For resistance grounded systems above 600V match ground conductor insulation to phase conductor.
- E. When ungrounded conductors increased in size, proportionately increase equipment grounding conductor.

## 2.3 GROUND CONNECTIONS

- A. Below Grade: exothermic welded-type connectors by Cadweld, Thermoweld or compression type connectors designed for purpose by Burndy or Thomas and Betts unless indicated otherwise.
- B. Above Grade or in Manholes: exothermic welded-type connectors by Cadweld, Thermoweld or compression type connectors designed for purpose by Burndy, Thomas and Betts, or Anderson.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Do not splice grounding conductors, except in junction or outlet boxes.
- B. Provide separate, insulated equipment grounding conductor in feeder and branch circuits.
- C. Provide grounding electrode conductors in 1-inch minimum PVC conduit from separately derived sources to nearest effectively grounded building steel.
- D. Provide grounding and bonding at utility company's metering equipment and pad-mounted transformer.
- E. Bare Grounding Conductors Below Grade:
  - 1. Minimum 30 inches below the soil.
  - 2. Not in contact with gravel fill or concrete unless making transition from connections above slab to conductors below grade.
  - 3. Neatly trained around foundations, footings, and other obstacles.
- F. Ground Resistance: maximum 25 ohms unless otherwise accepted. Install sufficient ground rods in addition to code-required grounding if necessary. Where more than one rod required, install rods at least 3 feet apart.
- G. Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Provide electrical continuity between metal frames and railings supporting push-button stations, receptacles, instrument cabinets, etc., and raceways carrying circuits to these devices.

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- H. Bond metal piping systems and metal air ducts that may become energized to nearest effectively grounded building structural steel member.
- I. Grounding Connections:
  - 1. Connect grounding conductors to ground rods at upper end of rod with end of rod and connection point below finished grade.
  - 2. Connect sections of outdoor ground mats (counterpoise) for substations or other equipment below grade. Connect other grounding conductors generally in an accessible manner.
  - 3. In electrical manholes, install ground rods with ends 4 to 6 inches above floor with connections of grounding conductors fully visible and accessible.
  - 4. At telephone manholes, install ground rod outside vault in duct bank trench. Connect ground rod to bonding ribbons inside manhole with 6-AWG copper conductor.
  - 5. When making thermite welds, wire brush or file the point of contact to bare metal surface. Use thermite welding cartridges and molds in accordance with manufacturer's recommendations. After welds made and cooled, brush slag from weld area and thoroughly clean joint. For compression connectors, use homogeneous copper, anticorrosion, surface treatment compound at connectors in accordance with connector manufacturer's recommendations. Use connectors of proper size for conductors and ground rods specified. Use connector manufacturer's compression tool. Notify JACOBS prior to backfilling ground connections.
  - 6. When making bolted connection to aluminum or galvanized structures, apply corrosion inhibitor such as Ideal NOALOX, or Penetrox A to contact surfaces between cable, connector, and surface of structure.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Test ground fault circuit interrupter (GFCI) receptacles, alarm systems, and circuit breakers for proper connection and operation with methods and instruments prescribed by manufacturer.



### 3.3 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 26-01	Catalog cut-sheets, other descriptive technical literature	X	Per construction schedule

END OF SECTION

## SECTION 26 05 29

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Conduit, wireway, cable tray, and equipment supports, including design.
  - 2. Fastening hardware.
  - 3. Concrete equipment pads.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.

##### 1.2 QUALITY ASSURANCE

- A. Provide support systems adequate for weight of equipment, conduit, wireways, and/or cable trays, including wiring, which they carry.

##### 1.3 COORDINATION

- A. Coordinate size, shape, and location of concrete pads with Structural trade.

##### 1.4 DESIGN CRITERIA

- A. Support systems in compliance with project seismic requirements.
- B. Design per project criteria.

#### PART 2 PRODUCTS

##### 2.1 MATERIAL

- A. Support Channel, Slotted Channel Framing, or Angle:
  - 1. Galvanized steel.
- B. Hardware:
  - 1. Cadmium- or zinc-plated steel.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using beam clamps.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls, expansion anchors or preset inserts in solid masonry walls, self-drilling anchors or expansion anchors on concrete surfaces, sheet metal screws in sheet metal studs, and wood screws in wood construction.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, cable, conduit, or vegetation.
- D. Do not use powder-actuated anchors without written permission from JACOBS.
- E. Do not drill structural steel members without written permission from JACOBS.
- F. Fabricate supports from slotted channel framing, structural steel, angle, or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring-lock washers under nuts.
- G. Do not use steel channel in place of steel angle, except in enclosed chases or plenums. Use galvanized round smooth rod, threaded at each end, or galvanized steel angle, for vertical support of steel angle.
- H. Install channel with open face down to avoid collection of debris.
- I. Install freestanding electrical equipment on 3-1/2-inch concrete pads.
- J. Install surface mounted cabinets and panelboards as required but with no less than four anchors. Provide steel channel supports to stand cabinets 1 inch off wall.
- K. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.
- L. Provide extra care in supporting PVC conduit to protect it from potential damage.
- M. Use fiberglass or special-coated metallic supports in areas subject to corrosives.
- N. Support individual raceways using clamps, wall brackets, strap hangers, or ceiling trapeze. Support multiple raceways/cable trays running adjacent to each other by ceiling trapeze.

END OF SECTION

## SECTION 26 05 33

### RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Rigid metal conduit (RMC) and fittings.
  - 2. Intermediate metal conduit (IMC) and fittings.
  - 3. Electrical metallic tubing (EMT) and fittings.
  - 4. Flexible metal conduit (FMC) and fittings.
  - 5. Liquidtight flexible metal conduit (LFMC) and fittings.
  - 6. Rigid polyvinyl chloride conduit (PVC) and fittings.
  - 7. Electrical nonmetallic tubing (ENT) and fittings.
  - 8. Liquidtight flexible nonmetallic conduit (LFNC) and fittings.
  - 9. Conduit supports, clamps, and straps.
  - 10. Warning tape.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.
  - 2. Section 26 05 05 – Basic Electrical Materials and Methods.
  - 3. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
  - 4. Section 26 05 29 – Hangers and Supports for Electrical Systems.
  - 5. Section 26 05 53 – Identification for Electrical Systems.

##### 1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 RIGID METAL CONDUIT (RMC) AND FITTINGS

- A. Rigid Steel Conduit: Rigid galvanized steel.
- B. Rigid aluminum conduit.
- C. PVC Externally Coated Conduit: Rigid steel conduit with external 40-mil PVC coating and internal phenolic coating over a galvanized surface.
- D. Fittings and Conduit Bodies: Threaded type, steel. Do not use setscrew-type couplings, elbows, sweeps, or nipples. Provide bushings with shoulders, grounding lugs, and insulated nonmetallic throats.

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## 2.2 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. Conduit: Galvanized steel.
- B. Fittings and Conduit Bodies: Use fittings and conduit bodies specified above for RMC. Do not use setscrew-type couplings, elbows, sweeps, or nipples. Provide bushings with shoulders, grounding lugs, and insulated nonmetallic throats.

## 2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. EMT: Galvanized tubing.
- B. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron, setscrew type. Provide bushings with insulated nonmetallic throats and shoulders. Provide grounding lugs for bushings on feeders.

## 2.4 FLEXIBLE METAL CONDUIT (FMC) AND FITTINGS

- A. Conduit: Steel.
- B. Fittings and Conduit Bodies: Steel.

## 2.5 LIQUIDTIGHT FLEXIBLE METAL (LFMC) CONDUIT AND FITTINGS

- A. Conduit: Flexible metal conduit with PVC jacket.
- B. Fittings and Conduit Bodies: Metal with PVC jacket.

## 2.6 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

- A. Conduit: Schedule 40 PVC.
- B. Fittings and Conduit Bodies: PVC.

## 2.7 ELECTRICAL NONMETALLIC TUBING (ENT) AND FITTINGS

- A. PVC.
- B. Fittings and Conduit Bodies: PVC.

## 2.8 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND FITTINGS

- A. Conduit: Flexible plastic conduit.
- B. Fittings and Conduit Bodies: PVC.

## 2.9 CONDUIT SUPPORTS, CLAMPS, AND STRAPS

- A. Metallic Raceway Systems: Galvanized steel, cadmium plated steel, or malleable iron.
- B. Nonmetallic Raceway Systems: Nonmetallic fiberglass-reinforced plastic manufactured by Aiken, or nylon, polypropylene, or PVC.

## 2.10 WARNING TAPE

- A. Electrical Warning Tape:
  - 1. Acceptable Manufacturers:
    - a. Reef Industries: Terra Tape.
    - b. Brady: Identoline.
    - c. Panduit: HTDU6R-E.
  - 2. Heavy-gauge plastic tape for use in trenches containing electric circuits.
  - 3. Made of material resistant to corrosive soil.
  - 4. 6-inch minimum width red tape with printed warning that an electric circuit is located below tape.
- B. Communications and Life Safety/Security Warning Tape:
  - 1. Acceptable Manufacturers:
    - a. Reef Industries: Terra D.
    - b. Brady: Detectable Identoline.
    - c. Panduit: HTDU60-T.
  - 2. Metallic tape with tin or nickel coated joining clips furnished by tape manufacturer.
  - 3. Communications Circuits: 6-inch minimum width orange tape with printed warning that communication circuit is located below tape.
  - 4. Life Safety/Security Circuits: 6-inch minimum width yellow tape with printed warning that life safety circuit is located below tape.

## PART 3 EXECUTION

### 3.1 PROTECTION DURING CONSTRUCTION

- A. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured seals during construction.

### 3.2 MINIMUM SIZE

- A. 3/4 inch minimum for exposed or concealed.

### 3.3 TYPE TO BE USED

- A. Exterior, Exposed:
  - 1. Galvanized steel RMC.
  - 2. Aluminum RMC over 2 inches

3. IMC.
  4. PVC.
  5. PVC-coated steel RMC.
  6. EMT.
- B. Interior, Exposed:
1. Galvanized steel RMC.
  2. Aluminum RMC over 2 inches
  3. IMC.
  4. EMT.
  5. PVC.
  6. PVC-coated steel RMC.
- C. Interior, Wet Locations:
1. Galvanized steel RMC.
  2. IMC.
  3. EMT.
- D. Interior, Concealed, Not Installed in Concrete:
1. Galvanized steel RMC.
  2. Aluminum RMC over 2 inches.
  3. IMC.
  4. EMT.
  5. PVC.
  6. PVC-coated steel RMC.
- E. Above Ground, Embedded in Concrete:
1. Galvanized steel RMC.
  2. IMC.
  3. PVC.
  4. ENT.
- F. Underground, Direct Earth Burial:
1. Galvanized steel RMC.
  2. PVC.
- G. Underground, Concrete-Encased:
1. Galvanized steel RMC.
  2. PVC.
- H. Provide minimum 24 inches of cover over underground conduits in areas where traffic can drive over them.
- I. Underslab 5 kV and Above: PVC, 18-inch minimum depth below finished floor. Provide long sweep, steel RMC bends.
- J. Underslab Below 5 kV:
1. Greater Than or Equal to 3-Inch Diameter: PVC, 18-inch minimum depth below finished floor. Provide PVC-coated steel RMC bends for electrical conduits.

2. Less Than 3-Inch Diameter: PVC, 18-inch minimum depth below finished floor. Provide PVC-coated steel RMC bends for electrical conduits.
- K. For final connection to valves, local instrumentation, and other equipment where flexible connection is required to minimize vibration or where required to facilitate removal or adjustment of equipment, use the following guidelines:
1. 60-inch maximum lengths of LFMC with minimum 90 degree turn resulting in a loose and compliant connection.
  2. Provide flexible conduit long enough to allow item to which it is connected to be withdrawn or moved off its base.
  3. Plenums or Ducts: Maximum 48-inch lengths of LFMC.
  4. Do not use FMC except for:
    - a. Final connection to nonvapor-tight or nonweather-resistant light fixtures. Do not exceed 72 inches length and provide minimum diameter of 3/8 inch.
    - b. Nonplenum spaces used for environmental air.

### 3.4 SPECIAL LOCATIONS

- A. Use PVC-coated RMC for electrical installations:
1. Where conduit changes from underground, direct burial to exposed.
  2. Under equipment mounting pads.
  3. To points at least 5 feet outside building walls and concrete slabs.
  4. In exterior light pole foundations.
- B. Do not use aluminum conduit in direct contact with concrete.

### 3.5 LOCATION, ROUTING, AND GROUPING

- A. Arrange conduit to maintain headroom and present neat appearance.
- B. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- C. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources. Maintain minimum 18-inch clearance above ceiling grid.
- D. Arrange conduit supports to prevent distortion of alignment by wire-pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.
- E. Group conduit in parallel runs where practical, and use conduit rack per the requirements of Section 26 05 29 – Hangers and Supports for Electrical Systems. Provide space for 25 percent additional conduit for each size of conduit in rack. If 25 percent equals a fraction of a conduit, round up to next even number.
- F. Attach conduit support systems to structure, not to piping or ductwork.



- G. Provide supports minimum 8 feet on center for conduits smaller than 2 inches.
- H. Do not fasten conduit with wire or perforated pipe straps. Remove wire used for temporary conduit support during construction, before conductors are pulled.
- I. Do not notch structural members for passage of raceways.
- J. Where nonmetallic conduit is installed in exterior locations, provide adequate supports to eliminate sagging due to temperature changes.
- K. Combine homeruns for lighting and general purpose receptacle circuits if desired, but assume responsibility for conduit size and conductor derating. Do not combine neutral conductors or other circuits.

### 3.6 BENDS

- A. General: Use hydraulic one-shot conduit bender or factory elbows and sweeps for bends in conduit larger than 2-inch size. Provide concentric parallel bends.
- B. Electrical Conduit Bends:
  - 1. Install no more than the equivalent of three 90 degree bends between boxes.
  - 2. Use conduit bodies to make sharp changes in direction, as around beams. Install conduit bodies in readily accessible locations.
- C. Communications and Life Safety/Security Conduit Sweeps:
  - 1. Make changes in direction of communications conduit runs with symmetrical sweeps of the longest possible radius. Provide minimum inside radius for 4-inch underground and underslab communications conduit sweeps of 60 inches, and ten times conduit internal diameter for other runs.
  - 2. Install no more than the equivalent of two 90 degree bends between pull points and/or pull boxes.
  - 3. Make no bends in flexible conduit that exceed allowable cable bending radius or that significantly restrict conduit flexibility.

### 3.7 CONDUIT INSTALLATION

- A. Cut conduit square using saw or pipecutter. Deburr cut ends.
- B. Bring conduit to shoulder of fittings and couplings and fasten securely.
- C. Damp or Wet Locations: Use conduit hubs for fastening conduit to boxes and equipment. Enter bottom of electrical equipment with conduit.
- D. Install insulating throat connectors wherever raceway terminates in boxes or cabinets.
- E. Cap exposed steel communications conduit ends with bushings or smooth collars to protect cable sheath.

- F. Do not exceed 100 feet between pull boxes for communications conduit located within buildings.
- G. Where conductor enters or exits cable tray via conduit, securely fasten conduit to cable tray with specific-purpose attachment device.
- H. Avoid moisture traps. Where unavoidable, provide junction box with drain fitting at conduit low point.
- I. Pull Ropes and Pull Tapes:
  - 1. Provide pull ropes or pull tapes secured at each end of each empty conduit, except sleeves and nipples.
  - 2. Use 3/8-inch yellow polypropylene pull rope for each empty electrical conduit.
  - 3. Use nylon pull tape with printed footage indicators for each empty communications conduit.
  - 4. Identify with tags at each end the origin and destination of each empty conduit, and indicate same on empty or spare conduit on as-built drawings.
- J. Where conduit penetrates fire-rated walls and floors, refer to sealing requirements shown on drawings.
- K. Provide watertight seal where underground conduit enters structure through wall or floor.
- L. Route conduit through roof openings for piping and ductwork where possible. Otherwise, route through roof jack with pitch pocket. Coordinate roof penetrations.
- M. Maximum Size Conduit in Slabs Above Grade: 3/4 inch. Do not route conduit to cross each other in slabs above grade. Locate conduit in center one-third of slab.
- N. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes, minimum.
- O. Install concealed, embedded, and buried conduit to emerge at right angles to surface and have no curved portion of bend exposed.

### 3.8 UNDERGROUND DUCTBANK INSTALLATION

- A. See Civil package for trenching and backfill requirements.
- B. Install top of duct bank maximum 30 inches below finished grade.
- C. Install conduit with minimum grade of 4 inches per 100 feet, either from one handhole, manhole, or pull box to next, or from high point between them, depending on surface contour.
- D. Install conduits entering handholes, manholes, and structures at right angles.

- E. Terminate conduit in end bell at electrical manhole entries and in watertight 4-inch duct terminators at communications manhole entries.
- F. Stagger conduit joints in concrete encasement 6 inches minimum vertically.
- G. Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at maximum 4-foot intervals. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement.
- H. Do not use union-type fittings.
- I. Bury warning tapes 12 inches above duct bank.
- J. Pull 3-1/2-inch-diameter by 12-inch mandrel through 4-inch communications ducts to verify circularity and sweep radius. Pull standard length mandrels through other underground conduits.
- K. Provide expansion fittings at structural isolation breaks [and where conduit is subject to movement by settling or frost.

### 3.9 EMPTY RACEWAYS

- A. Electrical Conduit: Provide permanent cap over each end of each empty raceway.
- B. Communications Conduit: Install removable manufactured plugs in empty conduit openings. For underground conduit openings, use screwtight, removable, watertight, and dusttight duct plugs.
- C. Provide pull rope or pull tape in each empty electrical and communications conduit as specified above. Tie pull tape securely to duct plug or wall racking at each end.
- D. Provide conduit identification at each end.

### 3.10 IDENTIFICATION

- A. Follow requirements of Section 26 05 53 – Identification for Electrical Systems.

### 3.11 RACEWAY FINISH

- A. None.

### 3.12 GROUNDING

- A. Follow requirements of Section 26 05 26 – Grounding and Bonding for Electrical Systems.

### 3.13 HANGERS AND SUPPORTS

- A. Follow requirements of Section 26 05 29 – Hangers and Supports for Electrical Systems.

### 3.14 Boxes and fittings

- A. Coordinate conduits with Section 26 05 05 – Basic Electrical Materials and Methods.
- B. Close unused openings in raceways, boxes, and fittings.

### 3.15 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 33-01	Verify length of empty communications conduit at time of installation and provide as-built documentation	X	Per construction schedule

END OF SECTION

## SECTION 26 05 53

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Nameplates and tape labels.
  - 2. Wire and cable markers.
  - 3. Raceway color coding.
  - 4. Box identification.
  - 5. Signage and warning labels.

##### 1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 MATERIALS

- A. Nameplates: Engraved three-layer laminated plastic, minimum 3/16-inch-high black letters on white background. Emergency Equipment Nameplates: White letters on red background.
- B. Tape Labels: Embossed adhesive tape with minimum 3/16-inch white letters on black background or 3/16-inch Kroy black letters on white background.
- C. Wire and Cable Markers: Clear, heat-shrink tubing type Brady LS2000; do not use cloth or wraparound adhesive types.
- D. Conductor and Raceway Color Tape: Colored vinyl electrical tape.

#### PART 3 EXECUTION

##### 3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates or tape labels.
- B. Install nameplates and/or tape labels parallel to equipment lines.

- C. Secure nameplates to equipment fronts. Utilize noncorrosive screws for engraved nameplate mounting. Do not use adhesives. Secure nameplate to outside face of flush-mounted panelboard doors in finished locations.
- D. Use tape labels for identification of individual wall switches and receptacles, control device stations, and boxes.

### 3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each phase, neutral, and ground conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection.
  - 1. Power and Lighting Circuits: Identify with branch circuit or feeder number.
  - 2. Control Wiring: Identify with control wire number as indicated on equipment manufacturer's shop drawings.
  - 3. Life Safety and Security System Wiring: Identify according to requirements shown on life safety legend drawing.
  - 4. Intrinsically Safe Conductors: Light blue.
- B. Identify conductors for power circuits per the following schedule.

Conductor	System Voltage	
	15-kV and 480Y/277V	5-kV and 208Y/120V
Phase A	Brown	Black
Phase B	Orange (also grounded delta high-leg)	Red
Phase C	Yellow	Blue
Neutral	White with orange stripe	White
Grounding	Green	Green
Switchleg (lighting)	Purple	Pink

### 3.3 NAMEPLATE ENGRAVING SCHEDULE

- A. Provide nameplates to identify electrical distribution and control equipment and loads served.
  - 1. Letter Height:

Equipment	Information	Letter Height
Panelboards, Switchboards, Switchgear, Motor Control Centers (MCCs), UPSs, CPSs, Generators, Load Banks, Lighting Inverters, Power Factor Units, Busway	Equipment designation	1/4 inch
	Voltage rating and source	1/8 inch
Individual Circuit Breakers, Switches, Drives, Motor Starters in Panelboards, Switchboards, and MCCs	Load served and source	1/8 inch
Transformers, Power Conditioning, PDUs	Equipment designation	1/4 inch

<b>Equipment</b>	<b>Information</b>	<b>Letter Height</b>
	Primary and secondary voltages, primary source, and secondary load location	1/8 inch
Automatic Transfer Switches	Equipment designation, voltage rating, normal source, standby source, and load served, including location	1/4 inch 1/8 inch

### 3.4 LIFE SAFETY AND SECURITY SYSTEM DEVICE IDENTIFICATION

- A. Label devices with self-adhesive labels, 1/8-inch characters, white letters on black background per life safety drawings.
- B. Where view of device is obstructed by ceiling tile, place additional label on tile visible from floor.

### 3.5 RACEWAY COLOR-CODING SCHEDULE

- A. Use colored tape at 10-foot intervals to identify raceway by system.

<b>System</b>	<b>Color</b>
Primary Distribution	Purple
480-Volt, 3-Phase	Blue
208-Volt, Single-Phase and 3-Phase	Black
Grounding	Green
Facility Management System (FMS) and FMS-Controlled Circuitry (low voltage)	Blue and Black
General Control (non-FMS line voltage)	Brown and White
Telephone and Data	Yellow
Emergency Power	Red
UPS	Red
Fire Alarm, Voice Evacuation	Red and White
Closed-Circuit Television (CCTV)	Gray and White
Security	Gray
[Public Address	Orange and White
Site Radio	Blue and White
Master Clock	Black and Gray



### 3.6 BOX IDENTIFICATION

- A. Use permanent black markers to identify circuits, destinations, and spares on junction and pull box lids. Clarify detail inside larger boxes.

### 3.7 PANELBOARD COLOR CODE

- A. Post neutral and phase color codes at each panelboard.

### 3.8 SIGNAGE AND WARNING LABELS

- A. Place signs at service equipment noting location of generator and uninterruptible power supply systems.
- B. Place signs at grounding electrode conductor noting location of remote emergency and normal sources connected to grounding electrode conductor.
- C. Provide warning ribbon on service laterals 12 inches minimum above underground installation.

### 3.9 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 05 53-01	Catalog cut-sheets, other descriptive literature	X	Per construction schedule
26 05 53-02	Sample of labels for each system		

END OF SECTION

SECTION 26 22 00  
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install the following low-voltage transformers:
  - 1. Dry-type, two-winding transformers.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Handle equipment and store in accordance with manufacturer's instructions.
- B. Store in warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – DRY-TYPE, TWO-WINDING TRANSFORMERS

- A. CPC.
- B. Federal Pacific.
- C. General Electric.
- D. Square D Sorgel.

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- E. Cutler-Hammer.
- F. Siemens.
- G. Acme.

## 2.2 DRY-TYPE, TWO-WINDING TRANSFORMERS

- A. Dry-Type Transformers: NEMA ST 20; factory-assembled, air-cooled, dry-type transformers; ratings as shown on Drawings.
- B. Insulation system and average winding temperature rise for rated kVA as follows:

<b>Rating</b>	<b>Insulation Class</b>	<b>Rise, Degrees C</b>
15 kVA and below	185 degrees C	115
16 to 500 kVA	220 degrees C	115

Obtain required performance without exceeding above-indicated temperature rise in 40-degree C maximum ambient.

- C. Provide NEMA TP-1 energy efficient transformers.
- D. Case Temperature: 35 degree C maximum.
- E. Winding Taps, Transformers Less Than 15 kVA: Two 5 percent below-rated voltage, full-capacity taps on primary winding.
- F. Winding Taps, Transformers 15 kVA and Larger: NEMA ST 20.
- G. Transformers 75 kVA and Larger: Provide 4.5 percent minimum impedance unless harmonic rated.
- H. Sound Levels: NEMA ST 20.
- I.
- I. Basic Impulse Level: 10 kV.
- J. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
- K. Mounting: Transformers 75 kVA and less suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA suitable for floor or trapeze mounting.
- L. Coil Conductors: Continuous windings with terminations brazed or welded.

- M. Enclosure:
  - 1. NEMA ST 20, Type 1: Provide lifting eyes or brackets.
  - 2. Heavy-gauge steel with wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
  - 3. On units rated 15 kVA and below, totally enclosed, nonventilated, NEMA 3R, enclosure construction, with lifting eyes.
  - 4. On units rated 30 kVA and above, ventilated, NEMA 2, dripproof enclosure construction with lifting holes. Protect ventilation openings against falling dirt.
  - 5. Isolate core and coil from enclosure using vibration-absorbing mounts.
- N. Electrostatic Shielding:
  - 1. Provide on isolation transformers when indicated.
  - 2. Provide on harmonic rated transformers.
  - 3. Place electrostatic shield consisting of single turn of aluminum between primary and secondary winding and grounded to transformer core.
- O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

## 2.3 ACCEPTABLE MANUFACTURERS – DRY-TYPE BUCK-AND-BOOST TRANSFORMERS

- A. Cutler-Hammer.
- B. General Electric.
- C. Square D Sorgel.
- D. Acme.

2.4

## 2.4 FACTORY TESTING

- A. Perform the following standard factory tests on equipment provided under this Section. Test in accordance with latest version of ANSI and NEMA standards.
  - 1. Ratio tests at rated voltage connection and at tap connections.
  - 2. Polarity and phase relation tests on rated voltage connection.
  - 3. Applied potential tests.
  - 4. Induced potential test.
  - 5. No-load and excitation current at rated voltage on rated voltage connection.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Set transformer plumb and level.

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- B. Use liquidtight, flexible conduit, 2-foot minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Avoid mounting of transformers in areas which tend to amplify noises, such as stairways, hall areas, and corners near ceilings. Avoid, where possible, nearby reflecting objects or enclosures which might resonate or echo.

### 3.2 TRANSFORMER TAPS

- A. Set initial transformer taps up one tap to increase secondary voltage.
- B. At project completion measure primary and secondary voltages and adjust taps.
- C. Keep 120V outputs between 120-125V and 277V outputs between 277-290V.

### 3.3 FIELD QUALITY CONTROL

- A. Check for damage.
- B. Clean transformer of debris inside and out.
- C. Tighten connections prior to energizing transformer.

### 3.4 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 22 00-01	Catalog cut-sheets, other descriptive literature	X	Per construction schedule
26 22 00-02	Layout with dimensions and openings	X	Per construction schedule
26 22 00-03	Weights	X	Per construction schedule
26 22 00-04	Capacities and Ratings: Voltage, kVA, impedance, tap configurations, insulation system type, and rated temperature rise	X	Per construction schedule
26 22 00-05	Mounting, including seismic	X	Per construction schedule
26 22 00-06	Performance Characteristics: Inrush current, loss data, and efficiency at 50, 75, and 100 percent rated load	X	Per construction schedule
26 22 00-07	Noise: Sound level and noise attenuation	X	Per construction schedule
26 22 00-08	Factory testing results	X	Per construction schedule

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ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 22 00-09	Operation and maintenance manuals	X	Per construction schedule

END OF SECTION

## SECTION 26 24 16

### PANELBOARDS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes:
  - 1. Service and distribution panelboards.
  - 2. Lighting and appliance branch circuit panelboards.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.
  - 2. Section 26 05 05 – Basic Electrical Materials and Methods.
  - 3. Section 26 05 53 – Identification for Electrical Systems.
  - 4. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

##### 1.2 SPARE PARTS

- A. Keys: Furnish two for each panelboard to Owner.
- B. Fuses: Furnish to Owner two spare sets of fuses of each type and rating installed.
- C. Fuse Pullers: Furnish two fuse pullers to Owner.

##### 1.3 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 ACCEPTABLE MANUFACTURES – PANELBOARDS

- A. General Electric Company.
- B. Cutler-Hammer.
- C. Square D.
- D. Siemens.
- E. ABB.



## 2.2 MAIN AND DISTRIBUTION PANELBOARDS

- A. Panelboards:
  - 1. Circuit breaker type.
  - 2. Type I, Class 1.
- B. Enclosure: NEMA PB 1, Type 1.
- C. Provide cabinet front with screw cover, and hinged door with flush lock. Finish in manufacturer's standard gray enamel.
- D. Provide panelboards with copper bus, ratings as scheduled on Drawings. Provide copper ground bus in panelboards. Provide isolated ground bus where indicated.
- E. Minimum Integrated Short-Circuit Rating: as shown on Drawings. Provide fully rated circuit breakers, series or cascade type ratings are not allowed.
- F. Molded-Case Circuit Breakers: Provide bolt-on type circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits. Handle lockable in off position.
- G. Molded-Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current-limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole. Handle lockable in off position.
- H. Current-Limiting Molded-Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Interrupting rating 100,000 symmetrical amperes shall protect molded-case circuit breakers downstream as shown on the Drawings.
- I. When indicated, provide 100 percent rated circuit breakers.
- J. Where indicated, provide neutral bus bar of the same material as the phase bus bars and a continuous current rating 200 percent of the phase bus bars. Provide at least one terminal screw for each branch circuit.
- K. Terminations: Provide mechanical setscrew-type lugs suitable for copper conductors. Provide lugs suitable for 75 degree C rated conductors.
- L. Provide full height structures and bussing to allow space for future devices, unless indicated on the Drawings.
- M. Provide modifications that allow device change-out by qualified worker while panelboard is energized.
- N. Provide bus connections of A-B-C left-to-right when facing the front of the panelboard.

- O. Provide panelboard and individual device nameplates in accordance with Section 26 05 53 – Identification for Electrical Systems.

## 2.3 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.
- B. Enclosure: Type 1.
- C. Cabinet Size: 5 3/4 inches deep; 20 inches wide.
- D. Provide flush or surface cabinet front (as shown on drawings) with typewritten directory, concealed trim clamps, concealed hinge and hinged door and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on Drawings. Provide copper ground bus in panelboards.
- F. Minimum Integrated Short-Circuit Rating: as shown on Drawings.
- G. Molded-Case Circuit Breakers: Bolt-on-type thermal magnetic trip circuit breakers with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD and HID for lighting circuits. Provide UL, Class A, ground fault interrupter circuit breakers where scheduled on Drawings. Provide 30 mA ground fault interrupter circuit breakers for heat trace loads. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits. Provide fully rated circuit breakers, series or cascade type ratings are not allowed.
- H. Current-Limiting Molded-Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Interrupting rating 100,000 symmetrical amperes shall protect molded-case circuit breakers downstream as shown on the Drawings.
- I. Provide lock-on devices for each continuous-duty circuit in each panelboard.
- J. Where indicated, provide neutral bus bar of the same material as the phase bus bars and a continuous current rating 200 percent of the phase bus bars. Provide at least one terminal screw for each branch circuit.
- K. Provide lock-off devices for each multipole circuit in each panelboard. Provide capability of accepting a single padlock on each device.
- L. Terminations: Provide hardware required to accommodate the type of connectors specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- M. Nameplates: Laminated plastic with engraved letters on each unit. See Section 26 05 53 – Identification for Electrical Systems.
- N. Provide standard circuit inventory holders.

- O. Refer to panel schedules on the Drawings for specific requirements.
- P. Provide isolated ground bus where indicated.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards plumb, vertical unless impractical (flush with wall finishes when indicated on drawings), and in conformance with NEMA requirements.
- B. Height: 78 inches to top.
- C. Adjust trim to cover openings.
- D. Provide filler plates for unused spaces in panelboards and load centers.
- E. Provide typed circuit directory for each branch circuit panelboard and load center. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Stub five empty 1-inch conduit to accessible location out of each recessed unit.

### 3.2 FIELD QUALITY CONTROL

- A. Measure steady-state load currents at each panelboard and load center feeder. Should the difference at any panelboard or load center between phases exceed 20 percent, rearrange circuits to balance the phase loads within 20 percent. Take care to maintain proper phasing for multiwire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

### 3.3 PROTECTION DURING CONSTRUCTION

- A. Store products specified in this Section in a dry location. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction.

### 3.4 GROUND BUS INSTALLATION

- A. Install ground bus in accessible location.
- B. Ground wires to be taken to individual terminals unless terminals are parallel rated.

### 3.5 SUBMITTAL SCHEDULE

<b>ITEM NO.</b>	<b>SUBMITTAL REQUIREMENT</b>	<b>WITH BID</b>	<b>AS INDICATED</b>
26 24 16-01	Electrical characteristics for circuit breakers, including voltage, frame size, trip ratings, integrated short-circuit ratings in rms symmetrical amperes, and time-current curves.	X	Per construction schedule
26 24 16-04	Characteristics, including dimensions, enclosure type, weight, outline and support point dimensions, main bus ampacity, integrated short-circuit current rating, circuit breaker and fusible switch arrangement, and sizes.		
26 24 16-05	Current limiting breaker data proving protection, showing both peak currents, and $I^2t$ energy.		
26 24 16-06	Operation and maintenance instructions including descriptive bulletins.		

END OF SECTION

## SECTION 26 27 26

### WIRING DEVICES

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Wall switches.
  - 2. Wall dimmers.
  - 3. Receptacles.
  - 4. Floor-mounted service fittings.
  - 5. Device plates and box covers.
  - 6. Cords and caps.

##### 1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

#### PART 2 PRODUCTS

##### 2.1 ACCEPTABLE MANUFACTURERS

- A. Wall Switches:
  - 1. Bryant.
  - 2. General Electric.
  - 3. Hubbell.
  - 4. Leviton.
  - 5. Pass and Seymour.
  - 6. Eagle.
  - 7. Arrow Hart.
- B. Wall Dimmers:
  - 1. Leviton.
  - 2. Lutron.
- C. Receptacles:
  - 1. Bryant.
  - 2. General Electric.
  - 3. Hubbell.
  - 4. Leviton.
  - 5. Pass and Seymour.
  - 6. Eagle.
  - 7. Arrow Hart.

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D. Floor-Mounted Service Fittings:

1. Bryant.
2. General Electric.
3. Hubbell.
4. Leviton.
5. Pass and Seymour.

E. Device Plates and Box Covers:

1. Bryant.
2. General Electric.
3. Hubbell.
4. Leviton.
5. Pass and Seymour.
6. Eagle.
7. Arrow Hart.

F. Cords and Caps:

1. Hubbell.
2. Leviton.
3. Pass and Seymour.
4. Arrow Hart.

## 2.2 MATERIALS

A. Wall Switches:

1. Wall Switches for Lighting Circuits and Motor Loads Under 1/2 Horsepower: NEMA WD 1; ac general-use snap switch with toggle handle, rated 20 amperes and 120 to 277 Vac, white handle in office areas, gray handle in other areas, screw-type terminals.
2. Pilot Light Type: Red pilot handle, handle lighted when switch is on.
3. Locator Type: Lighted handle.
4. Weatherproof: Switches as specified mounted in cast metal box with gasketed, weatherproof device plate as specified.

B. Wall Dimmers:

1. Linear slide type.
2. Rating: 600 watts minimum, larger size to accommodate load shown on Drawings.

C. Receptacles:

1. Convenience and Straight-Blade Receptacles: NEMA WD 1.
2. Locking-Blade Receptacles: Type indicated on Drawings.
3. Convenience Receptacle Configuration: Type 5-20R.
  - a. Plastic Face: white in office areas, gray in other areas.
  - b. Emergency Receptacles: Red plastic face with prewired neon glow lamp behind each pair of slots.
4. Weatherproof Receptacles: Receptacles as specified mounted in cast steel box with gasketed, weatherproof device plate as specified.

5. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter, NEMA Type 5-20R. Feed-through type for downstream device protection.
  6. Specific-Purpose Receptacles:
    - a. Configuration: Type as indicated on Drawings, black plastic face.
    - b. Pin-and-Sleeve Type: Number of poles and wires as indicated on Drawings. Provide back boxes where indicated. Provide gasketed cover and watertight sealing glands. Provide matching plug with cord-grip features for each receptacle.
    - c. Isolated Ground Type: Straight-blade Type 5-20R, orange plastic face.
    - d. CRE: Straight-blade Type 5-20R, with flanged inlet. Receptacle Face Color: Yellow.
    - e. Twist-Lock Type: NEMA configuration as shown on the Drawings. Provide one matching plug with cord-grip feature for each receptacle.
- D. Floor-Mounted Service Fittings:
1. Flush-Type Service Fitting for Convenience Receptacle: Satin aluminum housing with stainless steel device plates for two, back-to-back, duplex convenience receptacles.
  2. Flush-Type Service Fitting for Communications: Satin aluminum Housing with stainless steel plates with two, back-to-back, 1-inch-inside-diameter bushed openings.
  3. Flush Covers for Duplex Convenience Receptacle: Brass flush cover suitable for floor box with duplex flap opening. Provide brass-finish protective rings for use with threaded openings.
  4. Flush Covers for Communications: Brass flush cover suitable for floor box, with 2-1/8- by 1-inch combination threaded opening. Provide brass-finish protective rings.
- E. Device Plates and Box Covers:
1. Decorative Cover Plate satin-finish smooth stainless steel in office areas. Satin finish smooth stainless steel in other areas. Red smooth nylon for emergency receptacles. Orange smooth nylon for isolated ground receptacles. Provide isolated ground receptacle covers with phrase isolated ground in addition to circuit number.
  2. Cast Metal Plates: Use with cast metal box. Use steel plates with steel boxes and copper-free aluminum with aluminum boxes. Provide stainless steel screws.
  3. Raised Sheet Steel Plates: Use 1/2-inch-high zinc- or cadmium-plated covers with surface-mounted sheet steel boxes.
  4. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device covers.
  5. CRE Plates:
    - a. Switches: Where CRE switches are indicated on the plans, provide a yellow neoprene, bubble-type device plate with elastomer body, Hubbell Pressswitch Type 17CM81.

- b. Receptacles: Where CRE receptacles are indicated on the Drawings, provide a yellow neoprene device plate with cover caps held tightly in place with stainless steel springs, Hubbell Type 52CM21 or 74CM24.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install wall switches 48 inches above floor, off position down.
- B. Install wall dimmers 48 inches above floor. Derate ganged dimmers as instructed by manufacturer. Do not use common neutral.
- C. Install convenience receptacles 18 inches above floor, 44 inches above floor when over a counter, grounding pole on bottom.
- D. Install specific-use receptacles at heights shown on Drawings.
- E. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions.
- F. Corridor Convenience Receptacles: Hospital grade.
- G. Install decorative cover plates on switches, receptacles, and blank outlets in finished areas. Use jumbo-size plates for outlets installed in masonry walls.
- H. Install cast metal or galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- I. Install devices and wall plates flush and level.
- J. Install prefinished cord set where connection with attachment plug is indicated or specified or use attachment plug with suitable strain-relief clamps.



### 3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 27 26-01	Catalog cut-sheets, other descriptive literature	X	Per construction schedule

END OF SECTION

## SECTION 26 28 16

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install:
  - 1. Enclosed low-voltage circuit breakers.
  - 2. Disconnect switches.
  - 3. Fuses.
  - 4. Enclosures.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.
  - 2. Section 26 05 05 – Basic Electrical Materials and Methods.
  - 3. Section 26 05 53 – Identification for Electrical Systems.
  - 4. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

##### 1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

##### 1.3 SPARE PARTS

- A. Fuses: Furnish to Owner 3 sets of spare fuses of each type and rating installed.
- B. Fuse Pullers: Furnish 3 fuse pullers to Owner.

#### PART 2 PRODUCTS

##### 2.1 ACCEPTABLE MANUFACTURERS

- A. General Electric.
- B. Cutler-Hammer.
- C. Siemens.
- D. Square D.

## 2.2 MATERIALS

### A. Individually Mounted Enclosed Low-Voltage Circuit Breakers:

1. Enclosure:
  - a. NEMA Type 1.
  - b. Provide surface-mounted box with door; interlock door with circuit breakers so door may not be opened when circuit breaker is in closed position. Provide defeater so qualified personnel can open door when circuit breaker is in closed position. Provide ability to lock breaker in open position.
  - c. Finish: Provide manufacturer's standard gray enamel.
2. Minimum Integrated Short-Circuit Rating: 10,000 amps rms symmetrical for 240V and 14,000 amps rms symmetrical for 480V. Provide fully rated circuit breakers, series or cascade type ratings are not allowed.
3. Molded-Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers with common trip handle for all poles; Class 1. Provide UL, Class A, ground fault interrupter circuit breakers where shown on Drawings. Provide 30 mA ground fault interrupter circuit breakers for heat trace loads. Provide circuit breakers listed as Type HACR for air conditioning branch circuits and Types SWD and HID for lighting circuits.
4. Do not use tandem circuit breakers or single-pole units with handle ties where three-pole units are indicated.
5. Molded-Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current-limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.
6. Current-Limiting Molded-Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Interrupting rating 100,000 symmetrical amperes. Protect molded-case circuit breakers downstream as shown on Drawings.
7. Terminations: Provide hardware as required to accommodate type of connectors specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
8. Nameplates: Provide laminated plastic nameplates with engraved letters on each unit in accordance with Section 26 05 53 – Identification for Electrical Systems.
9. Finish: Provide manufacturer's standard gray enamel.

### B. Disconnect Switches:

1. Fusible Switch Assemblies: Quick-make, quick-break, load-interrupter, Type HD, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in on position. Handle lockable in off position; fuse clips.
2. Nonfusible Switch Assemblies: Type HD; quick-make, quick-break, load-interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in on position. Handle lockable in off position.
3. Enclosures: Type 1.

4. Terminations: Provide hardware as required to accommodate type of connectors specified in Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.
  5. Nameplates: Provide laminated plastic nameplates with engraved letters on each unit in accordance with Section 26 05 53 – Identification for Electrical Systems.
  6. Finish: Provide manufacturer's standard gray enamel.
- C. Fuses:
1. See Section 26 05 05 – Basic Electrical Materials and Methods, for detailed specifications.
  2. Fuses 600 Amperes and Less: Class J, current-limiting, time-delay, one-time fuse, volts.
  3. Fuses 601 Amperes and Larger: Current-limiting, time-delay, one-time fuse, 600 volts, UL, Class L.
  4. Interrupting Rating: 200,000 rms amperes.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install circuit breakers and disconnect switches where indicated on Drawings.
- B. Install fuses in fusible disconnect switches.
- C. Individually Mounted Enclosed Circuit Breakers and Disconnect Switches:
  1. Install enclosures plumb.
  2. Maximum Height: Top of enclosure at 78 inches AFF.
  3. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check for proper installation and tightness of connections.
  4. Mount vertical unless approved by JACOBS.

### 3.2 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 28 16-01	Catalog cut-sheets, other descriptive literature	X	Per construction schedule
26 28 16-02	Physical characteristics, including dimensions, enclosure type, openings	X	Per construction schedule
26 28 16-03	Weights	X	Per construction schedule

<b>ITEM NO.</b>	<b>SUBMITTAL REQUIREMENT</b>	<b>WITH BID</b>	<b>AS INDICATED</b>
26 28 16-04	Electrical characteristics for breakers including voltage, frame size, trip rating, integrated short-circuit rating	X	Per construction schedule
26 28 16-05	Electrical characteristics for switches including voltage, switch size, integrated short-circuit rating	X	Per construction schedule
26 28 16-06	Time-current curves for breakers and fuses	X	Per construction schedule
26 28 16-07	Current limiting test data proving protection, show peak currents and I <sup>2</sup> t energy	X	Per construction schedule
26 28 16-08	Operation and maintenance manuals	X	Per construction schedule

END OF SECTION

SECTION 26 29 13  
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install enclosed controllers not installed in motor control centers, including:
  - 1. Manual motor starters.
  - 2. Magnetic motor starters.
  - 3. Combination magnetic motor starters.
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.
  - 2. Section 26 05 05 – Basic Electrical Materials and Methods.
  - 3. Section 26 05 53 – Identification for Electrical Systems.

1.2 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Allen-Bradley.
- B. Cutler-Hammer.
- C. General Electric.
- D. Siemens.
- E. Square D.

2.2 MANUAL MOTOR STARTERS

- A. Integral Horsepower Motor Starter: Size and poles as indicated on Drawings; ac, general purpose, Class A, manually operated, non-reversing, full-voltage controller for induction motors rated in horsepower. Provide with manual overload reset. Class 10- or 20-type ambient compensated relay with adjustable (90 to 110 percent of respective rating) trip. Provide with SPST NC contact. Bimetallic type thermal elements. Provide red (run)

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green (off) transformer-type LED pilot lights, one NO auxiliary contact, and toggle] push-button operator with provisions for padlock.

- B. Fractional Horsepower Manual Motor Starter: Horsepower rating and poles as indicated on Drawing; ac, general purpose, Class A, manually operated full-voltage controller for fractional horsepower induction motors with adjustable thermal overload unit (bimetallic heaters). Provide red (run) green (off) transformer-type LED pilot lights and toggle with provisions for padlock operator.
- C. Enclosure: Type 1 unless indicated otherwise on Drawings.

## 2.3 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: ac, general purpose, Class A, magnetic controller for induction motors rated in horsepower, Size 1 minimum.
- B. Full-Voltage Starting: Non-reversing type.
- C. Coil Operating Voltage: 120 volts, 60 Hz.
- D. Size: As indicated on Drawings.
- E. Overload Relay: Provide with manual overload reset. Class 20-type ambient compensated relay with adjustable (90 to 110 percent of respective rating) trip. Provide with one SPST NO contact. Thermal bimetallic type elements.
- F. Enclosure: NEMA 1, unless indicated otherwise on Drawings.
- G. Combination Motor Starters: Combine motor starters with disconnecting means indicated on Drawings.
- H. Auxiliary Contacts: Minimum two normally open and two normally closed field convertible contacts in addition to seal-in contact, or as indicated on Drawings.
- I. Front Cover Control Devices: Heavy-duty, NEMA 13 control and indicating devices for NEMA 1 and 12 enclosures. Provide heavy-duty NEMA 4 type devices for NEMA 4 enclosures. Provide corrosion-resistant type for NEMA 4X applications as indicated on Drawings. Type indicated on Drawings.
- J. Indicating Lights: Transformer LED type mounted in front cover. Lens color(s), red run, green stop. Push-to-test-type indicating lights.
- K. Relays: Type indicated on Drawings.
- L. Reversing and Two-Speed Starters: Mechanical and electrical interlocks to prevent both contactors from operating at same time.

- M. Control Power Transformers: Secondary voltage as indicated on Drawings, 100-VA minimum, unless indicated otherwise on Drawings; protection as indicated on Drawings.

#### 2.4 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTION MEANS FOR COMBINATION STARTER

- A. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole. Provide interlock to prevent opening front cover with motor circuit protector in on position defeatable with screwdriver. Interrupting rating (starter as an assembly) as indicated on Drawings. Handle lockable in off position. Where required to achieve specified short-circuit rating, provide current-limiter attachment rated at 100,000-amps rms symmetrical interrupting current.
- B. Molded-Case, Thermal-Magnetic Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide interlock to prevent opening front cover with circuit breaker in on position defeatable with screwdriver. Handle lockable in off position. Interrupting rating (as an assembly) as indicated on Drawings. Where required to achieve specified short-circuit rating, provide current-limiter attachment rated at 100,000-amps rms symmetrical interrupting current.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install fuses in fusible switches.
- B. Select and install overload relay elements in motor starters based on actual motor nameplate ratings, such as full-load current, service factor, temperature rise, and ambient motor temperature. Coordinate with starter vendor to obtain starters early for install and overloads later when actual motor full load current is known.
- C. Motor Data: Provide self-adhesive, typed label attached inside each motor starter enclosure door identifying motor served by tag number and equipment name, nameplate horsepower, full-load amperes, motor code letter, service factor, and installed overload relay element catalog number.
- D. Set motor circuit protectors to minimum trip setting which will permit motor starting under normal conditions using procedures outlined in manufacturer's instructions booklet.
- E. Provide nameplates in accordance with Section 26 05 53 – Identification for Electrical Systems.

#### 3.2 SUBMITTAL SCHEDULE



<b>ITEM NO.</b>	<b>SUBMITTAL REQUIREMENT</b>	<b>WITH BID</b>	<b>AS INDICATED</b>
26 29 13-01	Catalog cut-sheets, other descriptive literature on motor starters, relays, control transformers, control devices, and overcurrent devices	X	Per construction schedule
26 29 13-02	Layout with dimensions, enclosure types, and openings	X	Per construction schedule
26 29 13-03	Weights	X	Per construction schedule
26 29 13-05	Wiring and schematic diagrams that identify devices, indicate connections, and identify terminal numbers (note devices furnished when options involved)	X	Per construction schedule
26 29 13-06	Time-current curves for overcurrent and overload devices	X	Per construction schedule
26 29 13-07	List of motors with the following: <ul style="list-style-type: none"> <li>• Nametag</li> <li>• Motor horsepower</li> <li>• Full load nameplate and actual amps</li> <li>• Service factor</li> <li>• Overload heater element part number</li> <li>• Overcurrent device rating and settings</li> </ul>	X	Per construction schedule
26 29 13-08	Operation and maintenance manuals	X	Per construction schedule

END OF SECTION

## SECTION 26 36 23

### AUTOMATIC TRANSFER SWITCHES

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section includes the requirements necessary to furnish and install automatic transfer switches (ATS).
- B. Related Sections:
  - 1. Section 26 05 01 – Basic Electrical Requirements.
  - 2. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
  - 3. Section 26 05 53 – Identification for Electrical Systems.

##### 1.2 QUALITY ASSURANCE

- A. ATS Manufacturer:
  - 1. Company specializing in transfer switches and emergency power control systems with 10 years' minimum experience.
  - 2. Maintain local service center capable of emergency service or routine preventative maintenance and offer preventative maintenance contracts. Maintain records of each switch by serial number for 10 years minimum.

##### 1.3 SYSTEM DESCRIPTION

- A. Inherently double-throw power transfer switch unit and control module interconnected to provide complete automatic operation.
- B. Electrically operated and mechanically held. Mechanically interlock to ensure only one of two possible positions, normal or emergency (standby).
- C. Provide inspection capability from front. Provide manual operating handle for maintenance, permitting operator to manually stop contacts at any point throughout entire travel, to properly inspect and service contacts.
- D. Provide control module to direct transfer switch operation. Control sensing and logic with built-in microprocessor for reliability, minimum maintenance, and inherent digital communications capability.
- E. Monitor each phase voltage of normal source with 85 to 100 percent adjustable pickup and 70 to 98 percent adjustable dropout, both in increments of 1 percent, fully field adjustable without use of tools, meters, or power supplies. Factory set to pick up at 90 percent, drop out at 85 percent.

- F. Provide emergency (standby) source voltage sensing with 85 to 100 percent adjustable pickup and 84 to 86 percent fixed dropout and frequency sensing with 90 to 100 percent adjustable pickup and 87 to 89 percent fixed dropout, fully field adjustable in 1 percent increments without use of tools, meters, or power supplies. Factory set to pick up at 90 percent voltage and 95 percent frequency.
- G. Control Module: Include time delays fully field adjustable in increments over entire range as follows:
  - 1. Time delay adjustable from zero to 6 seconds and factory set at 1 second to override momentary normal source outages to delay transfer switch and engine starting signals.
  - 2. Transfer to emergency standby) source time delay adjustable from zero to 5 minutes.
  - 3. Retransfer to normal source time delay, automatically bypassed if emergency (standby) source fails and normal source is acceptable, adjustable from zero to 30 minutes.
  - 4. Unloaded running time delay for standby engine generator cooldown, adjustable from zero to 60 minutes.
- H. Start Signal: Prevent dry cranking of generator by requiring generator to reach proper output and to run for cooldown duration setting, regardless of whether normal source restores before load is transferred.

#### 1.4 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of Part 3 for a list of submittal requirements for this Section.

### PART 2 PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Russelectric.
- B. ASCO .
- C. Cummins/ONAN.
- D. Zenith Controls Inc.

#### 2.2 AUTOMATIC TRANSFER SWITCHES

- A. Provide quantity indicated on Drawings, low-voltage automatic transfer switches (ATS) capable of switching resistive and inductive-type loads and providing control as to which source serves these loads.

- B. Nominal Voltage and Poles:  
 1. 480Y/277 volts, three phase, four wire, plus ground.
- C. Short-Circuit Withstand Capability:

<b>3-Cycle Closing and Withstand Rating, ATS Used with Molded- Switch Amperes Case Breaker, rms Symmetrical Amps</b>	
100 to 400	42,000
600 to 800	65,000
1,000 to 1,200	85,000
1,600-4000	100,000

- D. Continuous Current Rating: As indicated on the Drawings.
- E. Transfer Mechanism:  
 1. Single momentarily energized electric operator to activate double-throw switch.  
 2. Overcenter-type linkage to provide quick-make, quick-break action of switch contacts.  
 3. Capable of operating at 70 percent of nominal system voltage.  
 4. Interlock normal and emergency (standby) source contacts mechanically and electrically to prevent simultaneous closing.  
 5. Silver-tungsten alloy main contacts mechanically held without use of hooks, latches, magnets, or springs.  
 6. Separate arcing contacts and arc extinguishing chutes.
- F. Manual Operator: Capable of actuating switch with same action and speed as electric operator.
- G. Enclosure:  
 1. NEMA 1.  
 2. Finish: Manufacturer's standard color.  
 3. Door lock with provisions for padlocking.
- H. Lugs:  
 1. Wire Sizes No. 6 AWG and Smaller: Screw tight pressure type for copper conductors  
 2. Wire Sizes No. 4 AWG and Larger: Bolt type, tin plated, made of high strength aluminum alloy, UL approved and stamped for use with copper and aluminum conductors.

## 2.3 BYPASS ISOLATION SWITCH

- A. Fully rated, manually operated.
- B. Rated for same loads, withstands, and voltages as ATS with which it is used.
- C. Bypass to normal source only by use of permanently mounted external lever.
- D. Provide engine start switch for use when transferring to emergency (standby) source.
- E. Manual Bypass: Achieve without load break to source connected to load by ATS.
- F. Prevent bypass to dead source by use of solenoid-operated lockout mechanism.
- G. Prevent partial transfer using quick-make, quick-break overcenter contact action.

## 2.4 AUTOMATIC TRANSFER SWITCH ACCESSORIES

- A. Provide one each Form C contact rated 5A at 120 Vac for each of the following:
  - 1. Loss of normal voltage via voltage sensing relay on normal source for generator start signal.
  - 2. Loss of normal voltage via voltage sensing relay on normal source for facility monitoring use.
  - 3. Emergency (standby) source detected at line side of transfer switch via voltage-sensing relay on emergency (standby) source.
  - 4. Transfer switch in normal position.
  - 5. Transfer switch in emergency (standby) position.
  - 6. Failure to synchronize.
  - 7. Extended parallel, adjustable 0 to minus 5 seconds.
- B. Provide one red and one green indicating light on enclosure door.
  - 1. Illuminate green light when switch is in normal position.
  - 2. Illuminate red light when switch is in emergency (standby) position.
- C. Provide two amber indicating lights on enclosure door.
  - 1. Illuminate one light when normal source is present.
  - 2. Illuminate second light when emergency (standby) source is present.
  - 3. Operate lights from voltage-sensing relays, not directly from main busses.
- D. Identify control wire terminations with tubular sleeve-type markers.
- E. Provide schematic drawing under clear plastic on interior of enclosure door.
- F. Remote Control:
  - 1. Provide contact to cause transfer to emergency (standby).
  - 2. Provide contact to block transfer to normal or emergency (standby).
- G. Meters: 3-1/2 inches, 2 percent accuracy with phase selector switches.
  - 1. Volt meter, emergency (standby) bus.

2. Volt meter, normal bus.
  3. Ammeter.
  4. Frequency meter.
  5. Running time meter for generator operating time.
- H. Communication Network: Full-duplex RS 422 interface built into ATS control module to enable digital communications with remotely located annunciators and/or network supervisors. Enable remote annunciator to indicate and control the following functions via digital communications in control panel:
1. Indication:
    - a. Load connected to normal or emergency (standby) source.
    - b. Normal and/or emergency (standby) source available.
    - c. Transfer switch in test mode.
    - d. Transfer switch control panel in time-delay function.
  2. Control:
    - a. Simulate normal source failure to sensing controls.
    - b. Time-delay bypass.
- I. Provide annunciator/controller to monitor and control up to eight automatic transfer switches through daisy chain series connection. Provide for connection through twin pairs of 22-gauge wire in shielded, jacketed cable suitable for digital communications. Provide expandable system to include up to 12 switches in a series connection.
- J. Manual/automatic retransfer selector switch.
- K. Battery Charger:
1. SCR voltage regulated type with float and taper features.
  2. 10 amps at 24 Vdc with charging ammeter.
- L. Nameplates: Provide nameplates in accordance with Section 26 05 53 – Identification for Electrical Systems.

## 2.5 AUTOMATIC TRANSFER SWITCH CONTROL DEVICES

- A. Four-position switch mounted on enclosure door with four modes as follows:
1. Off:
    - a. Control relays de-energized, engine-start circuit open. No operation under any circumstance.
    - b. Provide white, door-mounted indicating light illuminated when in off position.
  2. Auto: Complete automatic operation as specified.
  3. Test: Simulate failure of normal source. Transfer to emergency (standby) as specified. Retransfer to normal after switch is returned to auto position after appropriate time delay. Provide momentary contact switch to override time delay from emergency (standby) to normal.
  4. Engine Start: ATS remains connected to normal source and initiates engine-start circuit. Transfer to emergency (standby) source only on failure of normal source and after appropriate time delay.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install ATS in accordance with manufacturer's instructions.

### 3.2 ADJUSTING AND CLEANING

- A. Adjust contactors, time delays, and functioning parts.
- B. Clean exterior and interior surfaces.

### 3.3 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner for minimum workdays listed below, travel time excluded:
  - 1. 2 workdays for installation assistance and inspection of installation.
  - 2. 2 workdays for functional and performance testing.
  - 3. 2 workdays plant startup.
  - 4. 1 workdays for instruction of 1 site personnel.

### 3.4 FIELD QUALITY CONTROL

- A. Test ATS in accordance with manufacturer's instructions and Section 26 05 01 – Basic Electrical Requirements.
- B. Test in accordance with requirements of authority having jurisdiction.

### 3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	WITH BID	AS INDICATED
26 36 23-02	Catalog cut-sheets, other descriptive literature	X	Per construction schedule
26 36 23-03	Layout with dimensions and openings	X	Per construction schedule
26 36 23-04	Weights	X	Per construction schedule
26 36 23-05	Capacities and ratings	X	Per construction schedule
26 36 23-06	Mounting, including seismic	X	Per construction schedule
26 36 23-07	Performance characteristics	X	Per construction schedule
26 36 23-08	Finishes	X	Per construction schedule
26 36 23-10	Model numbers	X	Per construction schedule
26 36 23-11	Data sheets	X	Per construction schedule
26 36 23-13	Electrical voltage, load, and interface for accessories	X	Per construction schedule
26 36 23-14	Wiring and schematic diagrams	X	Per construction schedule
26 36 23-15	Control interface	X	Per construction schedule
26 36 23-16	Software, files, databases	X	Per construction schedule
26 36 23-17	Field test results	X	Per construction schedule
26 36 23-18	Operation and maintenance manuals	X	Per construction schedule
26 36 23-19	Training	X	Per construction schedule
26 36 23-20	Description of equipment operation during startup, synchronization, paralleling, switchover, and shutdown	X	Per construction schedule
26 36 23-21	Manufacturer's specifications	X	Per construction schedule
26 36 23-22	Daily rate and expense rate for factory-trained field representative	X	Per construction schedule
26 36 23-23	Installation instructions	X	Per construction schedule

END OF SECTION



SECTION 28 31 51  
FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. This specification prescribes the basic minimum requirements for the Fire Alarm and suppression System. Work includes installation, programming, inspection, calibration and testing of the system and Owner training by the FAS Contractor. This specification and drawings represent the minimum requirements for a fully operational Fire Alarm and Suppression System. This is a combined fire and suppression FACU for two wet, one pre-action and two agent releasing systems.
- B. Section 21-22-00, Clean Agent Systems
- C. Section 26 05 19, Low-voltage Electrical Power Conductors and Cables
- D. Section 26 05 33 Raceway-Boxes for Electrical Systems

1.2 SYSTEM DESCRIPTION

- A. System to be a fully functional site FAS acceptable to the authority having jurisdiction (AHJ) and in accordance with National Fire Protection Association (NFPA) 72 consisting of the following elements:
  - 1. Addressable, intelligent, and networked fire alarm control units, visual notification appliances, audible notification appliances, addressable initiating devices, and auxiliary devices.
  - 2. Fiber optic style 7 communication network to allow data exchange between fire alarm control units fire alarm operator workstations.
  - 3. System shall perform the functions as designated in the Fire Alarm Matrix and per the site standards.
  - 4. Integral emergency voice/alarm communications with voice intelligibility.
  - 5. Coordinate fire alarm work with other trades.
- B. System should perform the following functions:
  - 1. Manual alarm signal initiation.
  - 2. Automatic alarm signal initiation.
  - 3. Activation of fire safety functions.
  - 4. Activation of alarm notification appliances.
  - 5. Heating, Ventilating, and Air Conditioning (HVAC) system interface.
  - 6. Monitoring of abnormal conditions in fire suppression systems.

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7. Elevator recall and shut down.
8. Emergency voice/alarm communications.
9. Annunciation of alarms using graphics on computer operator stations on the network.

### 1.3 DESIGN CRITERIA

- A. The following criteria to be followed:
  1. Each addressable loop to have remaining capacity of 25 percent after acceptance testing.
  2. NAC circuits shall have a min. of 25% (of circuit's capacity) spare load at the end of each circuit. Voltage drop calculations shall show starting voltage of 19.2V and spare loading shall be shown on voltage drop calculations.
  3. EOL shall be UL listed type not shipping restores.
  4. The FAS to be designed and installed to support zero network downtime during modifications and expansions.
  5. The network communications wiring to be style X
  6. The addressable loop signaling line wiring to be Class A with isolators every 50 devices.
  7. The indicating device and input circuit wiring to be Class B. Mount end-of-line resistor (EOL) in box with last device or separate box adjacent to last device in circuit. EOL shall not be mounted outside or in a location that requires a ladder taller than 3'.
  8. Notification appliance circuits to be min. 14 AWG, unless otherwise indicated on drawings.
  9. Addressable initiating device circuits to be min. 18 American Wire Gauge (AWG), unless otherwise indicated on drawings or as required by manufacture.
  10. Fire alarm circuits to be installed in dedicated fire alarm only conduit throughout the facility. Conduit shall be red in color.
  11. Wire nuts are not allowed on any fire alarm wiring including 120VAC.
  12. Wireways above and next to FACU's are required. No conduits are allowed for top entry in any FACU or NAC panel, only side.
  13. 120VAC entry into FACU shall be as short as possible and not wrapped around the inside the FACU. 120VAC circuit shall only enter the FACU not enter then exit and go to another fire alarm panel. All 120VAC in/out wiring shall be done in a dedicated 120VAC box outside the FACU.

### 1.4 REFERENCES

- A. Abbreviations and Acronyms:
  1. Alternating current (AC)
  2. American Disabilities Act (ADA)
  3. American Wire Gauge (AWG)
  4. Authority having jurisdiction (AHJ)
  5. Canadian Standards Association (CSA)
  6. Direct current (DC)
  7. Fire alarm control unit (FACU)
  8. Fire alarm panels (FAP)

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9. Fire alarm system (FAS)
10. Heating, Ventilating, and Air Conditioning (HVAC)
11. Infrared (IR)
12. Light emitting diode (LED)
13. National Electric Code (NEC)
14. National Fire Protection Association (NFPA)
15. Nonpower-limited fire-protective (NPLF)
16. Operating system (OS)
17. Personal computer (PC)
18. Power-limited fire-protective (FPL)
19. Single-pole, double-throw (SPDT)
20. Underwriters Laboratories Inc. (UL)

B. References Standards:

1. NFPA 72, "National Fire Alarm Code" 2016
2. Americans' With Disabilities Act (ADA) Accessibility Guidelines
3. NFPA 70, "National Electrical Code" (NEC)
4. NFPA 2001, "Standard on Clean Agent Fire Extinguishing Systems"
5. Underwriters Laboratories (UL)
6. International Fire Code (IFC)
7. International Building Code (IBC)
8. Authority Having Jurisdiction (AHJ)

## 1.5 SUBMITTALS

- A. Refer to the Submittal Schedule at the end of PART 3.5 for a list of submittal requirements for this Section.
- B. Submittals (datasheets, install manuals and shop drawings) to be provided in accordance with IBC and NFPA 72 Chapter 7, state fire marshal and local AHJ.
- C. Shop drawings shall be a point to point (shop every device and appliance) in the system
- D. Each device and appliance shall have an identifier on the plans and riser that match.
- E. Provide each addressable device's custom label for approval.

## 1.6 QUALITY ASSURANCE

- A. Provide the Work in accordance with NFPA 70 (National Electric Code - NEC), as applicable. Where required by AHJ, material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. (UL) shall conform to those standards and shall have an applied UL listing mark or label.

- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated as shown on the Electrical plans.
- D. Material and equipment must be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- E. Installer Qualifications: Personnel shall be trained and certified by fire alarm manufacture for installation of equipment required for this Project. Fire alarm contractor shall supply documentation of training. Training shall be on panel being installed and existing fire alarm network on site.
- F. System designer shall be a min. NICET III certificate.

## 1.7 EXTRA MATERIALS

- A. Provide spare parts as listed below:
  - 1. Two visual notification appliances of each type.
  - 2. Two keys of each type (software, hardware and equipment).
  - 3. Two audible notification appliances of each type.
  - 4. Two addressable actuating devices of each type.
  - 5. Two addressable initiating devices of each type.
  - 6. Two power supplies of each type.

## 1.8 WARRANTY AND ASSISTANCE

- A. Provide written warranty jointly signed by manufacturer and installer agreeing to replace assemblies, which fail in material or workmanship during warranty period of 1 year from date of final system acceptance test. Warrant all hardware and software against faulty or inadequate design, improper assembly, defective workmanship or materials, breakage, or other failure for one (1) year after formal system acceptance by the Owner. Should system or system components fail to perform according to terms of warranty, replace system or components at the Owner's site at no charge or expense. All system software shall be upgraded to the manufactures latest version prior to the expiration of the system warranty.
- B. In addition to Fire Alarm System's warranty requirements for operation and maintenance, provide on-site assistance, when requested within one year of Substantial Completion, in adjusting systems' parameters to suit actual occupied conditions. Include provisions for up to three, 8 hours each, requested visits to Project site for this purpose at no additional cost to the Owner.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Fire Alarm system to be Siemens Designo type and be networkable with existing Siemens fire alarm control units (FACU) on site now.

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## 2.2 FIRE ALARM CONTROL UNITS (FACUs)

- A. FACU to support fire alarm devices and fire alarm/fire safety functions shown on the drawings already listed under “Design Criteria”
- B. FACU shall be listed for Releasing service.
- C. FACUs (panels) to be equipped with the following:
  - 1. An incoming ac power disconnect.
  - 2. Separate battery enclosure(s) and backup batteries.
  - 3. Wall-mount enclosures with key-locked doors.
  - 4. Multiplexed audio riser capability.
  - 5. Backup battery and power supply supervisory and fault condition capability.

## 2.3 ADDRESSABLE INITIATING DEVICES

- A. Hazardous locations are to use devices, materials, and methods rated for the locations’ classification.
- B. Manual Pull Stations:
  - 1. Stations to be of Laxan/Plastic or rugged die-cast construction designed for surface or semi-flush mounting. Wet or solvent locations to use a weatherproof box.
  - 2. Stations shall be red in color.
  - 3. Station operation shall comply with American Disabilities Act (ADA) requirements.
  - 4. Stations to be of the break-glass rods or push design, and must be opened to be reset.
  - 5. It should be possible, for testing purposes, to initiate an alarm without breaking the glass. Stations of the break-glass design to be furnished with a spare glass rod.
- C. Heat Detectors:
  - 1. Fixed temperature detectors to respond to temperatures exceeding 135 degrees F. The detector to be white and have a low-silhouette profile to blend into the ceiling decor. The detector to utilize a separate mounting base wired into the system with screw terminals. The detector to plug into the mounting base for easy replacement without tools.
  - 2. Combination temperature / rate-of-rise detectors to respond to temperatures exceeding 135 degrees F, and/or a temperature rise of 15 degrees F per minute. The detector color to be white and have a low-silhouette profile to blend into the ceiling decor. The detector to utilize a separate mounting base wired into the system with screw terminals. The detector to plug into the mounting base for easy replacement without tools.
  - 3. Consideration should be made before placing a detector in an environment that may cause nuisance alarms.
- D. Smoke Detectors:

1. Photoelectronic analog smoke detectors to contain an optical sensing chamber that meets or exceeds nominal sensitivity of 2.3 percent per foot obscuration.
  2. Duct mounted photoelectric smoke sensors to operate over an air velocity range from 300 to 4,000 fpm. Each to be equipped with an air inlet sampling tube, which completely traverses the duct width. Installation of tube through duct to be airtight. Test the differential pressure between sample tube and ambient to verify manufacturer's requirements.
  3. Consideration should be made before placing a detector in an environment that may cause nuisance alarms.
- E. Multi Sensor Detectors:
1. Multi sensor detectors must meet the criteria of the detectors above for each of the sensing elements.
  2. Multi sensor detectors must be able to distinguish and identify the element which it is sensing.
  3. Consideration should be made before placing a detector in an environment that may cause nuisance alarms.
- F. Monitoring and Control Devices:
1. Monitor modules, control modules and control relays to be mounted within a junction box or cabinet and to contain diagnostic light emitting diodes (LEDs). Connections to be screw terminals. Operating voltage and output contact voltage to be rated for its intended use.
  2. Control switches to provide LED indication of status. They are to be labeled with the function they perform.

## 2.4 NOTIFICATION APPLIANCES

- A. Hazardous locations to use devices, materials and methods rated for the locations' classification.
- B. Use surface mount skirt for surface mounting devices
- C. Alarm Bells: UL-listed; direct current (DC) polarized; mounts in 4-inch-square back box; surface mount; semiflush mount; weatherproof back box; under dome type single strobe or vibrating.
- D. Alarm Horns: UL-listed; DC polarized; mounts in 4-inch square back box; electronic type with selectable wattage, high dB output and low current draw. The housing to be [white] red die-cast metal re-entrant style with vandal-resistant grill. The horn to be provided with strobe where indicated on drawings and capable of being surface, semiflush, or flush mounted as indicated on drawings

## 2.5 .AUXILIARY DEVICES

- A. Magnetic door holders, 24VDC to release self-closing fire and smoke doors automatically. Each unit to have a holding force of 15 pounds minimum at 85 percent of rated voltage, and 50 pounds maximum at 110 percent of rated voltage per UL

requirements. Door holders to be provided with mounting boxes for floor and surface installations as shown on the plans.

B. Input Devices:

1. The input device to provide an addressable input for N.O. contact devices such as manual stations, water flow switches, sprinkler supervisory devices, etc.
2. The input device to provide a supervised initiating circuit. An open-circuit fault to be annunciated at the operator's workstation and printer.
3. The device to contain an LED that blinks upon being scanned by the FACU. Upon determination of an alarm condition the LED is to be latched on.

C. Output Devices:

1. Output devices to have an addressable output for a separately powered alarm indicating circuit or for a control relay.
2. Output devices to provide a supervised indicating circuit where indicated on the drawings. An open-circuit fault to be annunciated at the operator's workstation and printer.
3. Output devices to be provided with a control relay where indicated on the drawings. The relay contacts to be single-pole, double-throw (SPDT) (Form C) rated at 10 amps at 28 Vdc.
4. Output devices to have an LED that blinks upon being scanned by the FACU. Upon activation of the device, the LED to be latched on.
5. Output devices to be capable of being mounted in a standard electrical box.

D. Fault Isolator Device:

1. The fault isolator device to detect and isolate a short-circuited segment of a fault-tolerant loop.
2. The device to automatically determine a return to normal condition of the loop and restore the isolated segment.

E. Auxiliary Relays: For control of 120-Volt circuits (air-handling unit shutdown, elevator shutdown, and beacon light activation), interposing relays to be provided. The relays to be system interconnected and to be operable by a system control module or manually. Relays to be fitted with Form C contacts and to be rated at 120 Vac, minimum 2 amps inductive.

## 2.6 FIRE ALARM WIRE AND CABLE

- A. Provide cable/wire in sizes and types as recommended by, National Electrical Code and the equipment manufacturer for indicated applications. Sizes and types shall be based on the NEC, load voltage drop, line loss calculations and the equipment. Provide cable/wire that meets or exceeds the appropriate requirement for the areas in which it is installed. Outer jacket shall be continuous, free from holes, splits, and inclusions.
- B. Provide lightning/surge protection devices for all data, signal, low voltage power circuits, and all AC power circuits leaving and or entering a building or installed outdoors as recommended by the equipment manufacturer.

- C. Provide 120VAC Circuit breaker lock from SPACE AGE model ELOCK-FA for each circuit breaker on site. As per NFPA 72-(2013) 10.6.5.4.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install system in accordance with manufacturer's instructions.
- B. Install notification appliances and detectors at mounting heights, locations and spacing according to NFPA 72 and the drawings.
- C. AC Power for FAS equipment will be provided by others where indicated within the drawings. Any additional AC power required for the fire alarm system shall be provided from a dedicated circuit for each individual panel or equipment by the FAS Contractor.
- D. Connections to Other Systems: Make conduit and wiring connections to sprinkler-flow switches, sprinkler valve tamper switches, fire suppression system control panels, HVAC motor starter circuits, electrical shunt trip circuit breakers, and elevator control panels as indicated on the drawings. Unless otherwise noted, mount all monitor and input/output modules at 5 ft. above the finished floor to the bottom of device. Hard wire to the monitored device. Locate the EOL resistor across the contact/switch terminals in the monitored device enclosure.
- E. Installation of equipment to be such that adequate ventilation is permitted for equipment operation.
- F. The fire alarm system shall be interfaced to the Security System electromagnetic lock power supplies so that power to the locks will be interrupted during alarm events on the fire alarm system.
- G. All field devices shall be marked with SLC, NAC and or Relay on the exterior of the device as shown on the FACP display.
- H. Install breaker locks on all new and existing barkers feeding 120VAC to FAS equipment.

### 3.2 FIELD QUALITY CONTROL

- A. The Contractor to perform electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, smoke detectors to be tested to the maximum stable sensitivity setting. This must be performed with the detector at its operational environmental conditions in the area. Bench settings are not acceptable. A checkout report to be prepared by the installation technician. The report to include, but not be limited to:
  - 1. A complete list of equipment installed and wired.



2. Indication that equipment is properly installed and functions and conforms to these Specifications.
  3. Test of individual zones as applicable.
  4. Serial numbers/device addresses, locations by zone, and model number for each installed detector.
  5. Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
  6. Duct detector cfm readings with HVAC system operating.
  7. Technician's name, certificate number, and date.
  8. Completed NFPA 72 System Record of Completion
- B. Test in accordance with NFPA 72 and local fire department requirements in the presence of the Owner, AHJ if requested and under the supervision of the manufacturer's representative. The Contractor is responsible for completing documentation for system approval and acceptance as required in NFPA 72, including the most current certificate of completion form. Contractor is also responsible for filling out the most current inspection and testing records forms from NFPA 72. Contractor to submit originals to the Owner for acceptance.

### 3.3 TRAINING

- A. Provide training to the Owner's maintenance personnel, dedicated for system operating procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide minimum of one 4 hours training sessions for 4 people, using the approved final version of the operation and maintenance manual as a training aid. Schedule the training with the Owner, with at least 7 days advance notice. If requested record the final training session and turn over to the owner a copy of the recording to a DVD or an approved format.

### 3.4 RECORD DRAWINGS AND OPERATION and MAINTENANCE MANUALS

- A. Submit four sets of record drawings and documents to the "As-Built" condition (a clean and legible set of drawings to depict exact final conditions of the Fire Alarm System) in both printed and soft copy forms within 30 days after formal system acceptance by the AHJ, Engineer and the Owner. Follow the Owner CAD Drafting Standards in the design drawings for each system. Drawings shall be a min. of "D" 24X36 size on bond paper. Keep an accurate field record of FAS work as actually installed. These documents shall also include conduit sizes, number and type of conductors in each conduit, conductor description, manufacturer's name and catalog numbers, device identification, terminal numbers, equipment model numbers and quantities, and location of equipment as installed. Upon completion of the project, the FAS Contractor shall deliver electronic copies and all original field drawings, calculations, specifications and other information generated during the course of the project to the Owner. All record documents shall be reproducible. Include the following:
- B. Identify all required modifications in original shop drawings to include all deletions and additions of devices, equipment and wiring for FAS as installed. Record actual locations and sizing of all system devices, raceways and all panels. Include wire, cable, conduit size and number and types of cables in each raceway.

- C. Submit a complete FAS bill of materials.
- D. Submit Manufacturer's original technical literature (cut-sheets) for all equipment, including cables, cable trays and wire ways. Clearly indicate make and model number.
- E. Submit documentation including system configuration, sensitivity, and calibration settings.
- F. Submit system programming in soft copy form. Provide copy of the programming database incorporated in an updated database file.
- G. Submit finalized system verification and acceptance tests document in accordance with NFPA 72 requirements that all devices, wiring, terminations and system functionality have been tested to the Owner.
- H. Training Manual:
  - 1. Submit printed operations and maintenance training manuals one week before scheduled training classes.
- I. Operation and Maintenance Data:
  - 1. Submit five (2) copies of manufacturer's printed, recommended operating instructions and maintenance and repair data to the Owner.
- J. Submit a list of recommended spares and expendable items for the FAS. Include complete part numbers and current prices.
- K. Warranty:
  - 1. Submit product warranty.
- L. All items to be turned over to Owner at the completion of the project in CD-ROM or USB flash drive format.

### 3.5 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	AS INDICATED
28 31 51 01	Manufacturer's Letter stating that system is operational	Before final inspection
28 31 51 02	NFPA 72 Inspection Forms (signed)	At end of final inspection
28 31 51 03	Spare Parts List with Pricing	With submittal's
28 31 51 04	Shop Drawings	With submittal's
28 31 51 05	Record Drawings and Warranty Letter	30 days max after final inspection
28 31 51 06	Installer's Training AND nicet certificate	With submittal's

ITEM NO.	SUBMITTAL REQUIREMENT	AS INDICATED
28 31 51 07	Installer's and System Designer's NICET certificate	With submittal's

END OF SECTION