

SECTION 20 70 26

COMMON MATERIALS AND METHODS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Connectors and insulating tapes
- B. Switches
- C. Receptacles
- D. Cover plates
- E. Disconnecting devices
- F. Individual control relays
- G. Nameplates

1.02 INTERFACE AND COORDINATION

- A. Interface and coordinate the work of this Section with the other Sections and other Divisions of these Specifications, as required to provide a complete and operable electrical installation.
- B. Interface and coordinate also with Division 20 - Facility Services Sections, which require electrical equipment and services as part of the mechanical installation.
- C. Interface and coordinate electrical services and work with the jurisdictional utility company and the District, as applicable.
- D. Interface and coordinate with work completed or in progress or to be performed under other sections of these Specifications or by other contractors. Make indicated connections to previously completed work. Where future connections to or extensions of the work are indicated, provide safe and convenient provisions for such future connections and extensions.

1.03 MEASUREMENT AND PAYMENT

General: Common materials and methods for electrical systems, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for the related items of work as indicated in the Bid Schedule of the Bid Form.

1.04 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM D1000 Test Method for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
 - 2. ASTM D1518 Test Method for Thermal Transmittance of Textile Materials

- 3.. ASTM D3005 Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
 4. ASTM D5034 Test Methods for Breaking Strength and Elongation of Textiles Fabrics (Grab Test)
 5. ASTM 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
- B. Institute of Electrical and Electronics Engineers (IEEE):
1. IEEE C37.35 Guide for the Application, Installation, Operation, and Maintenance of High-Voltage Air Disconnecting and Interrupter Switches
- C. National Electrical Manufacturers Association (NEMA):
1. NEMA KS 1 Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 2. NEMA WC 7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 3. NEMA WD 1 General Requirements for Wiring Devices
- D. National Fire Protection Association (NFPA):
1. NFPA 130 Standard for Fixed Guideway Transit Systems
- E. Underwriters Laboratories Inc. (UL):
1. UL 20 General-Use Snap Switches
 2. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 3. UL 486C Splicing Wire Connectors
 4. UL 498 Attachment Plugs and Receptacles
 5. UL 514A Metallic Outlet Boxes

1.05 DESCRIPTION

- A. The Contract Drawings show raceways, wiring, and electrical facilities diagrammatically and do not show offsets, fittings, and accessories that may be required because of obstructing structural features and architectural finishes, interfering pipelines, ducts, and facility services equipment. The Contractor shall be responsible for investigating all such conditions and for determining the need for routing electrical raceways around such obstructions and interferences. The Contractor shall provide all such additional fittings, appurtenances, and accessories as required for routing

raceways and wiring around obstructions and interferences and for providing complete and operable electrical systems and installations.

1.06 REGULATORY REQUIREMENTS

- A. In addition to the foregoing referenced standards, the regulatory requirements that govern electrical work of these Specifications include the following codes and regulations:
1. California Code of Regulations:
 - a. Title 8, Industrial Relations, Division 1, Chapter 4, Subchapter 4, Construction Safety Orders
 - b. Title 8, Industrial Relations, Division 1, Chapter 4, Subchapter 5, Electrical Safety Orders
 - c. Title 19, Public Safety, State Fire Marshal
 - d. Title 24, Part 2, California Building Code
 - e. Title 24, Part 3, California Electrical Code
 - f. Title 24, Part 6, California Energy Code
 - g. Title 24, Part 9, California Fire Code
 2. General Orders and Regulations of the State of California, Public Utilities Commission.
 3. National Electrical Safety Code (NESC)

1.07 SUBMITTALS

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. List of Materials: At least 30 days before beginning the work of this Section, submit a list of materials and equipment proposed for use together with applicable standards. Give name of manufacturer, brand name, and catalog number of each item. Submit the list complete at one time, with items arranged and identified in numerical sequence by Specification Section and Article number.
- C. Compliance with Applicable Standards:
1. Where equipment or materials are specified to conform to the standards of organizations such as ANSI, ASTM, IEEE, NEMA, and UL, submit evidence of such conformance for review and record purposes.
 2. The label or listing of the specified agency will be acceptable evidence.
 3. Instead of the label or listing, the Contractor may submit a written certificate from an approved, nationally recognized testing organization, adequately equipped and competent

to perform such services, stating that the items have been tested and that the units conform to the specified standard.

4. Submit evidence of compliance to seismic safety requirements of the California Building Code and the California Electrical Code.
- D. **Factory Test and Inspection Certification:**
1. Except as otherwise specified herein, where factory tests and inspections for materials and equipment for which tests and inspections specified in referenced documents are waived, provide certified copies of reports for tests performed on previously manufactured identical materials or equipment within the previous 12 months.
 2. Accompany test reports by signed statements from the manufacturer certifying that the previously tested material or equipment is physically, mechanically, and electrically identical to that proposed for the project. Include wiring and control diagrams.
- E. **Shop Drawings:** Submit Shop Drawings showing conduit layout and the exact location and arrangement of conduits stubbed into future equipment, cabinets, pull boxes and assigned spaces, conduit sleeves for future exposed conduits, and for fabricated work being furnished and installed under these Specifications. Submit such drawings before rough-in work, fabrication, and within ample time to prevent delays in the Work. Include electrical diagrams for equipment and equipment installation.
- F. **Field Test Reports:** Submit certified field test reports of field tests, verifying compliance of equipment and systems with Specification requirements.
- G. **Operation and Maintenance Manuals:** Submit operation and maintenance instructions and data, in accordance with the requirements of Section 01 78 23 - Operation and Maintenance Data. Include recommended maintenance materials and spare parts list for all installed equipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish materials and equipment of design, sizes, and ratings as indicated.
- B. Furnish materials and equipment bearing label or classification listing of a national recognized testing laboratory where UL standards exist and such product labeling or listing is available. Electrical materials shall comply with the California Electrical Code.
- C. Methods of fabrication, assembly, and installation are optional unless otherwise indicated.
- D. Provide products that are free from defects that may impair performance, durability, or appearance.
- E. Materials manufactured for use as raceways (except PVC conduit), boxes, cabinets, equipment enclosures, and their surface finish material shall be capable of being subjected to temperatures up to 932 degrees F (500 degrees C) for one hour and shall not support combustion as specified in NFPA 130, Section 2.4.1.1.

2.02 CONNECTORS AND INSULATING TAPES**A. Splice and Terminal Connectors:**

1. Provide termination fittings for use with the cable furnished, NEMA standard, and conforming to UL 486A.
2. Termination and splice fittings for No. 10 AWG and smaller conductors shall be compression type. Wires to be connected shall be grouped together and fitted into an appropriately sized tin plated copper sleeve. After compressing with an appropriate tool, the connector shall be covered with a nylon-insulating cap. Wire splices shall comply with UL 486C. Screw-on and spring pressure type connectors are prohibited.
3. Termination and splice fittings for No. 8 AWG and larger conductors shall be tool-applied compression connectors of material and design compatible with the conductors for which they are used.
4. Terminal connectors for conductors size No. 4/0 and larger shall be long-barrel, double-compression type, and shall be furnished with two NEMA standard bolting holes in the pad.
5. Provide heat-shrinkable insulator for every compression type connector.

B. Insulating Material for Splices and Terminations:

1. Provide insulating material for splices and terminations of type accepted by the Engineer for the particular use, location and voltage.
2. Plastic electrical insulating tape for general use shall be vinyl plastic with rubber based pressure sensitive adhesive, and shall be pliable at temperature of minus 18 degrees C to 105 degrees C. When tested in accordance with ASTM D3005, the tape shall have the following minimum properties:
 - a. Thickness: 7 mils.
 - b. Breaking Strength: 15 pounds per inch.
 - c. Elongation: 200 percent.
 - d. Dielectric Strength: 10 kV/mil.
 - e. Insulation Resistance (Direct method of electrolytic corrosion): 10 MΩ.
3. Rubber electrical insulating tape for protective over-wrapping shall be silicone rubber with a silicone pressure-sensitive adhesive. When tested in accordance with ASTM D1000, the tape shall have the following minimum properties:
 - a. Elongation: 525 percent.
 - b. Dielectric Strength: 13 kV.

- c. Insulation Resistance (Indirect Method of Electrolytic Corrosion): 10 MΩ.
- 4. Arc-proof tape shall be flexible, conformable organic fabric, coated one side with a flame-retardant flexible elastomer, self-extinguishing, with the following minimum properties:
 - a. Thickness, ASTM D1000: 55 mils.
 - b. Tensile Strength, ASTM D5034: 50 pounds per inch.
 - c. Thermal Conductivity, ASTM D1518: 0.0478 Btu (h/ft²/°F).
 - d. Electrical Arc Resistance: Withstand 200 A arc for 40 seconds.
- 5. Mark each tape package to indicate shelf-life expiration date.

2.03 SWITCHES

- A. Provide ac tumbler-toggle switches conforming to minimum requirements of UL 20 and the requirements herein specified, of specification grade and heavy-duty type. Switches mounted outdoors shall be weatherproof.
- B. Provide switches that operate in any position and are fully enclosed with entire body and cover of molded phenolic, urea or melamine. Do not use fiber, paper, or similar insulating material for body or cover.
- C. Equip switches with metal mounting yoke with plaster ears, insulated from the mechanism and fastened to the switch body by bolts, screws, rivets, or other substantial means that meet test requirements.
- D. Provide a green-colored equipment grounding screw on the yoke.
- E. Provide the section of the yoke normally intended to bear on the surface outside the box with a minimum over-all dimension of 3/4 inch, measured at right angles to the longitudinal axis of the yoke.
- F. Switch contacts shall be silver or silver alloys.
- G. Switches shall be back or side wired with terminals of screw or combination screw-clamp type.
- H. Terminal screws shall be No. 8 or larger, captive or terminal type.
- I. Provide wiring terminals capable of receiving and holding wire sizes as follows:

<u>SWITCH RATING</u>	<u>WIRE SIZE, AWG NO.</u>
20 A	12 and/or 14
30 A	10

- J. Switches for use on incandescent or fluorescent lighting circuits shall be fully rated 20 A at 120 V or 277 V.

- K. Switches controlling straight resistance loads may be snap switches as specified herein, of the proper rating up to 30 A at 120 - 277 V.
- L. Provide 120 - 277 V ac snap switches capable of withstanding tests as outlined in NEMA WD 1, Paragraphs WD 1-2.04, WD 1-2.05A, WD 1-2.05C, WD 1-2.05E2, WD 1-2.05F2, and WD 1-2.05G. If requested by the Engineer, submit evidence that the types of switches proposed have satisfactorily withstood these tests.

2.04 RECEPTACLES

- A. Receptacle Standards: Connector and outlet receptacles shall conform with UL 498 and NEMA WD 1 for heavy-duty general use type.
- B. Convenience-Outlet Receptacles:
 - 1. Provide receptacles with fire-resistant non-absorptive hotmolded phenolic composition bodies and bases and with metal plaster ears integral with supporting member. Receptacles shall be flush type, except where otherwise indicated.
 - 2. Wall receptacles shall be NEMA 20R configuration single or duplex receptacles as indicated.
 - 3. Provide receptacles and plugs (caps) with light-colored terminal facilities for neutral connections, amber or brass-colored for phase conductor connections, and green-colored hexagonal machine screws for the equipment grounding conductor or connections.
 - 4. Contacts of the receptacles, including the grounding contact, shall be double-grip bronze type with spring steel backup clips so that both sides of each male prong of the plug will be in firm contact.
 - 5. Provide receptacles with self-grounding clip or mounting strap screws.
- C. GFCI Receptacles: Ground fault circuit interrupter (GFCI) duplex receptacles shall be 120 V, 60 Hz, 20 A with built-in test, reset buttons, and ground fault tripped indication. They shall interrupt the circuit within 1/30 second on a five-milliampere earth leakage current. They shall be designed for end of run installation or with provisions for feeding through to protect other outlets on the circuit. Maximum circuit capacity for the latter shall be 20 A. The receptacles shall be furnished with necessary wire connectors, clips, mounting screws, and instructions. Provide GFCI duplex receptacles conforming to California Electrical Code in public areas and trainways.
- D. Clock Receptacles:
 - 1. Provide receptacles for clocks, recessed so that male cap will be flush with the wall to permit the clock to cover the outlet.
 - 2. Provide plates, including finishes, as specified for cover plates, adapted to the recessed receptacles and with substantial hooks to support the clocks.

3. Receptacles for surface-mounted clocks shall be connected to the building 120 V electrical system.
4. Where clock receptacles are indicated or specified, furnish the grounded type, and provide with a ground jumper.

2.05 COVER PLATES

- A. Provide cover plates for each switch, receptacle, and special purpose outlet.
- B. Provide multi-gang plates for multi-gang boxes.
- C. Provide cover plates conforming to UL 514A.
- D. Provide cover plates of brushed stainless steel in ancillary spaces, mechanical rooms, fan rooms, electrical closets, ac switchboard rooms, traction power substations, and unfinished areas.
- E. For special purpose outlets commercially produced using special material, configuration and size, provide plates of brushed stainless steel and of a design for the particular application.
- F. Provide stainless steel cover plates of 0.040 inch thickness for flush devices.
- G. Provide cover plates in public areas of die cast copper free aluminum, UL listed for wet locations and self-closing spring door.

2.06 DISCONNECTING DEVICES

- A. Safety Switch Type Disconnecting Devices: Provide safety switch disconnecting devices, enclosed, conforming to IEEE C37.35.
- B. Heavy-duty Safety Switches (600 V ac):
 1. Provide heavy-duty safety switches having electrical characteristics, ratings, and accessories as indicated.
 2. Provide switches with NEMA 12 industrial duty enclosures, with nameplates conforming to the requirements described elsewhere in this section. Nameplates shall be mounted on the enclosure front, and shall contain identification of switch type, catalog number, and hp ratings.
 3. Provide handle with visible blades; reinforced fuse clips; non-teasible, positive, quick-make quick-break mechanism; and padlockable in the OFF and ON positions.
 4. Provide switches meeting NEMA KS 1 requirements.

2.07 INDIVIDUAL CONTROL RELAYS:

- A. Control relays shall have convertible contacts rated a minimum of 10 A, 600 V. Verify coil voltage, and number and type of contacts. Furnish in NEMA 1 enclosures.

2.08 NAMEPLATES

- A. Provide nameplates for identification of switchboard assemblies, motor control centers, equipment, and devices with the following characteristics:
 1. Nameplates for indoor installations shall be 1/16-inch thick lamincoid, with beveled edges, black background, and white letters. Nameplates shall be mounted using stainless steel rivets, or attached using permanent adhesive.
 2. Nameplates for outdoor installations shall be metallic sheet with enamel painted white letters on black background. Nameplates shall be mounted using stainless rivets.
 3. Nameplate sizes:
 - a. Switchboard and motor control center assemblies nameplates shall be four-inch wide with 2-1/2 inch lettering.
 - b. Individual cabinet and major equipment nameplates shall be 2-1/2 inch wide with 1/2-inch lettering.
 - c. Nameplates for switches, relays, and other devices mounted inside cabinets shall be 3/4-inch wide with 3/16-inch lettering.
 4. Nameplate legends shall be submitted for District approval.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Install electrical materials, equipment, appurtenances, and accessories in locations as indicated, rigid and secure, plumb and level, and in alignment with related and adjoining work to provide a complete and operable system. Do not weld electrical materials for attachment or support.
- B. Provide anchor bolts and anchorage items as required, and field check to ensure proper alignment and location. Provide templates, layout drawings, and supervision at the jobsite to ensure correct placing of anchorage items in concrete. Check embedded items for correctness of location and detail before concrete is placed.
- C. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, and angles as required to set and connect the work rigidly. Conform with the seismic restraint requirements of the California Building Code and the California Electrical Code.
- D. Control erection tolerance requirements so as to not impair the strength, safety, serviceability, or appearance of the installations. Determine exact locations of conduit. Route conduit parallel to building lines unless otherwise indicated.
- E. The trade size, type, and general routing and location of conduits, raceways, and boxes shall be as indicated or specified.

- F. Install exposed conduit so as to avoid conflicts with other work. Install horizontal raceways close to the ceiling or ceiling beams, and above water or other piping wherever possible.
- G. Install individual conductors and multiple-conductor sheathed cables in conduits, raceways, cable trays, ducts, and trenches as indicated to complete the wiring systems.
- H. Install switches, receptacles, special purpose outlets, and cover plates complete in a neat manner in accordance with the California Electrical Code and local electrical codes. Plug unused openings in boxes, cabinets, and equipment.
- I. Use of explosive fasteners is prohibited.
- J. All electrical equipment, panels, telephone, and fire alarm panels shall be sealed against dust, whenever dusty conditions are present inside the rooms or outside, during the construction period.

3.02 CONDUIT AND FITTINGS

- A. Provide as indicated and required in accordance with the requirements of Section 20 50 13 - Raceways for Facility Services

3.03 EQUIPMENT, APPURTENANCES, AND INSTALLATION ACCESSORIES

- A. Provide conduit hangers and inserts, pull cords, outlet boxes, junction and pull boxes, metal and plastic cable tray systems, and underfloor ductwork as indicated and required in accordance with the requirements of Section 20 50 13 - Raceways for Facility Services.

3.04 WIRING

- A. Wiring Requirements:
 1. Provide wiring as indicated and required in accordance with the requirements of Section 26 05 24 - Low Voltage Wires and Cables.
 2. Furnish wires and cables to the site in unbroken standard coils or reels to which shall be attached a tag bearing the manufacturer's name, trade name of the wire, and the UL label for 600 V wire and cable.
 3. Provide wiring complete as indicated. Provide ample slack wire for motor loops, service connections, and extensions. In outlet or junction boxes provided for installation of equipment by others, tape ends of wires and install blank covers.
 4. Measure insulation resistance of the wiring system before connection to terminal blocks, motors, switchboards, motor control centers, transformers, panelboards, and control cabinets.
 5. Do not bend cables during installation, either permanently or temporarily, to radii less than 12 times the outer diameters, except where conditions make the specified radius impracticable and shorter radii are permitted by the California Electrical Code and NEMA WC 7, Appendix N.

6. Secure and neatly bundle with nylon straps cables inside panelboards, control cabinets, switchboards, motor control centers, terminal cabinets, junction boxes, and pull boxes.
 7. Identify wiring as specified in Section 26 05 24 - Low Voltage Wires and Cables.
- B. Cable Supports: Install cable supports for vertical feeders in accordance with the California Electrical Code.
- C. Splices and Terminations:
1. Make wire and cable splices only in outlet, junction or pull boxes, or in equipment cabinets. Splices in conduit or raceway will not be permitted. Make splices by means of compression type connectors, and cover with tape to an insulation level equal to that of the cable.
 2. Use positive type connector installation tools as recommended by the manufacturer.
 3. Mechanical hand tools, with dies for each conductor size as recommended by the manufacturer, may be used on conductor sizes through 6 AWG.
 4. For conductor sizes larger than 6 AWG, use hydraulic tools with hexagonal or circumferential installing dies for each conductor size, as recommended by the manufacturer.
 5. For inspection purposes, clearly mark die numbers on the installed connectors.
 6. Before installation, apply anticorrosion electrical joint compound to conductors and terminal bolting pads.
 7. Wire and cable shall be continuous from power source to equipment. Where splices are required, they shall be made only in approved fittings or junction boxes and shall be subject to approval by the Engineer. Follow manufacturer's instructions in splicing wire and cable.
 8. Fixture Wire: Make splices in lighting circuits with insulated crimp-type connectors.
 9. Control Cables: Each wire held with screw-type terminals shall be terminated using insulated sleeve (nylon), ring tongue-type or locking spade-type, crimp-on lugs. For wires sizes below 10 AWG terminating into tubular clamp-type terminals, the conductor shall be stripped and terminated bare.
 10. Heat-shrinkable insulator shall be centered over the compression sleeve of the connector and shrunk tight to cover the connector sleeve.

3.05 WIRING DEVICES

- A. Locate switches 4 feet above finished floor and general-purpose duplex convenience receptacles 15 inches above finished floor, except as otherwise indicated.
- B. Attach receptacles rigidly to outlet boxes by means of two stainless steel screws.

- C. For exterior and damp locations, surface or embedded, mount receptacles in watertight cast metal outlet boxes with threaded hubs or bosses and equipped with gasketed spring cover.
- D. Provide NEMA 3R locking type male plugs for equipment permanently connected to exterior GFCI type receptacles and subject to spray or hose cleaning.

END OF SECTION 20 70 26