SECTION 16120

WIRES AND CABLES LESS THAN 600 VOLTS

# GENERAL

## DESCRIPTION

### This section describes materials and installation of wires and cables rated 600 volts and below.

## RELATED WORK SPECIFIED ELSEWHERE

### Section 16010: General Electrical Requirements.

### Section 16450: Grounding.

## SUBMITTALS

### Submit shop drawings in accordance with the General Conditions.

### Submit material list for each conductor type. Indicate insulation material, conductor material, voltage rating, manufacturer and other data pertinent to the specific cable, such as shielding, number of pairs, and applicable standards.

## MEASUREMENT AND PAYMENT

### Payment for the work in this section shall be included as part of the lump-sum bid amount stated in the Proposal.

# MATERIALS

## LOW-VOLTAGE BUILDING WIRE

### Conductor material shall be stranded copper.

### Low-voltage building wire for use at 600 volts or less shall be 600-volt insulated, Type XHHW for below-grade runs and XHHW or THWN for above-grade runs, and rated for continuous operation at 75°C.

### No. 12 AWG minimum conductor size for power and lighting circuits.

### No. 14 AWG minimum conductor size for control circuits.

### Motor feeders from VFD’s to the motor shall be shielded VFD extra flexible type. Belden or equal. Refer to the conduit schedule.

## INSTRUMENT CABLE

### Twisted shielded cable, single-pair cables shall be two No. 18 AWG [and single-triad cables shall be three No. 18 AWG] stranded tinned-copper conductors individually insulated with fully color-coded PVC rated at 600 volts; insulated conductors twisted together and shielded with a spiral-wound metal foil tape overlapped for 100% shielding. Outer jacket shall be PVC.

### Ethernet cables shall be 4 pair, unshielded, 24 AWG TIA/EIA 568-B Category 5e with thixotropic gel semi-dry flooding material and polyethylene jacket. CAT 5e Ethernet Cable shall be, Mohawk M57561 or equal. Provide RJ45 connectors as recommended by the manufacturer.

### The Contractor is responsible for all Ethernet cabling and connections from field equipment back to the Ethernet Surge Protection Device (ESPD) mounted in the TCP. The Contractor is to provide and install an ESPD for all Ethernet connections at the respective equipment. The Contractor is to also furnish and install a short jumper from the ESPD to the equipment termination point. The jumper cables are to be stranded. The ESPD in the TCP will be provided and installed by the TCP provider. The Contractor is to terminate the cable into the TCP ESPD.

### Surge Protection Devices shall be, Transtector DPR-F140 or L-COM HGLN-CAT6J.

## MULTICONDUCTOR CABLE

### Conform to UL Type TC cable and UL 1277.

### Conductors shall be stranded copper and UL rated VW-1.

### Cable shall meet ICEA T-29-520 210,000 Btu/hour vertical tray flame test.

### Provide integral green ground wire in addition to wires shown in drawings.

### Multiple-pair cables shall have number of pairs specified with each pair being two No. 18 AWG stranded tinned-copper conductors individually insulated with PVC rated at 600 volts. Conductor pairs shall have insulation pigmented black and white with white conductor numerically printed for group identification. Each pair and its No. 20 AWG stranded tinned-copper drain wire shall be twisted together and shielded with an aluminum-polyester tape overlapped for 100% shielding. Provide a cable shield of 2.35-mil aluminum-polyester tape overlapped to provide 100% shielding and a No. 18 AWG copper drain wire. Provide a flame-retardant PVC jacket per UL 13, 105°C temperature rating.

### Manufacturer of multi conductor cables shall be Okonite, Southwire, or equal.

## DIRECT BURIAL AND AERIAL CABLES

### Direct burial and aerial cables for use at 600 volts and less shall have UL labeling "Type USE" and RHW insulation with black, neoprene sheath meeting the physical requirements and minimum thickness requirements of ICEA S 19-81.

## GROUNDING CONDUCTORS--BARE COPPER

### Refer to Section 16450 for bare copper grounding conductors.

## CONDUCTOR TAGS

### Provide individual or sleeved, nonmetallic, self-extinguishing heat shrink labels type. Grafoplast, Phoenix Contact, Thomas & Betts sleeve markers, or equal. Perform heating process to labels in the field. Confirm with Inspector prior to shrinking labels. The DISTRICT may opt to not shrink all labels.

## PROHIBITED MATERIALS

### Do not provide aluminum wire, cable, or connectors.

### Wrap on wire markings are not acceptable.

## PLASTIC ADHESIVES

### Plastic adhesives for color coding shall be 7-mil minimum thick, flame-retardant, weather-resistant tape, resisting abrasion, UL rays, moisture, alkalies, solvents, and acids. Adhesives shall meet the requirements of UL 510 and CSA C22.2.

# EXECUTION

## LOW-VOLTAGE BUILDING WIRE INSTALLATION

### Install wiring and cable in conduit and terminate unless otherwise noted.

### To reduce pulling tension in long runs, coat cables with non-hardening pulling compound recommended by the cable manufacturer before being pulled into conduits.

### Remove debris and moisture from the conduits, boxes, and cabinets prior to cable installation.

### Group conductors No. 1/0 and smaller in panelboards, cabinets, pull boxes, and switchboard wireways; tie with plastic ties; and fan out to terminals. Lace conductors No. 2/0 and larger with Ty-wraps

## IDENTIFICATION

### Color Coding of Low-Voltage Building Wire: Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Phase** | **240/120 Volts** | **208/120 Volts** | **240 Volts** | **480/277 Volts** |
| Phase A | Black | Black | Black | Brown |
| Phase B | Red | Red | Red | Orange |
| Phase C | --- | Blue | Blue | Yellow |
| Neutral | White | White | White | Gray |
| Ground | Green | Green | Green | Green |

### Phase conductors No. 10 AWG and smaller and neutral/ground conductors No. 6 and smaller shall have factory color coding with solid color insulation. Do not use onsite coloring of ends of conductors or apply colored plastic adhesives in lieu of factory color coding. Larger conductors may have onsite application of colored plastic adhesives at ends of conductors and at each splice.

### Control wires shall have colored insulation. Separate color codes for each wire shall be provided in each conduit that has up to seven wires. Conduits with more than seven wires shall have at least seven types of colored insulation.

### **Tagging of Conductors:** Tag all control wires and instrument cables in panels, pull boxes, and at control device. Tag control wires and instrument cables with a From/To style of nomenclature. Scheme to be approved by the DISTRICT prior to printing and installation.. Tag power wires in pull boxes where there is more than one circuit. Tag power conductors with motor control center or panelboard number and circuit numbers. See example of required wire tagging in Appendix 16120-A.

[Note to the Engineer: Add wire tagging example as appendix to this specification]

## LOW-VOLTAGE WIRE SPLICES

### **Stranded Conductors No. 8 and Larger:** Use T & B "Locktite" connectors, Burndy Versitaps and heavy-duty connectors, O.Z. solderless connectors, or equal.

### **Stranded Conductors No. 10 and Smaller:** Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors.

### Retighten bolt-type connectors 24 to 48 hours after initial installation and before taping. Tape connections made with non-insulated type connectors with rubber-type tape, one and one-half times the thickness of the conductor insulation, then cover with Scotch 33 tape.

### Do not splice wires in underground handholes or pull boxes unless explicitly indicated in the drawings. Seal splices in underground handholes and pull boxes and in light poles with individual sealing packs of Scotchcast Brand 400 Resin or equal.

## INSTRUMENT CABLE SPLICES

### Splices in instrument cables are not permitted. Cables shall be continuous from device to RTU/PLC unless shown otherwise on plans.

## LOW-VOLTAGE WIRE TERMINATIONS

### Terminate wires and cables at each end.

### Provide ring tongue, nylon- or vinyl-insulated copper crimp terminals for termination on screw-type terminal strips (if so supplied as an integral part of a device) and ferrules with insulating sleeves for terminal blocks, except for light switches and receptacles. Utilize installation tools recommended by the crimp manufacturer.

### Terminal lugs shall be UL listed and of the copper compression type, electro-tin plated. Provide color-coded system on terminal and die sets to provide the correct number and location of crimps. Permanent die index number shall be embossed on completed crimp for inspection purposes.

### Tighten screws and bolts to the tension value recommended by the manufacturer.

### TSP signal cable shall be terminated using a short piece of heat shrink tubing at the transition between outer jacket and exposed individual conductors.

## INSULATION RESISTANCE TESTS

### Perform insulation resistance test on all circuits and feeders with No. 4 size conductors and larger. Utilize a 1,000-volt d-c megohmmeter for 600-volt insulated conductors. See section 16080 for additional requirements.

### Test each complete circuit prior to energizing. Insulation resistance between conductors and between each conductor and ground shall not be less than 25 megaohms. Repair or replace wires or cables in circuits which do not pass this test and repeat the test.

### Evaluate ohmic values by comparison with conductors of same length and type.

### Inspect shielded cables for proper shield grounding, proper terminations, and proper circuit identifications.

### Inspect control cables for proper termination and proper circuit identification.

### In cables terminated through window-type CTs, verify that neutrals and grounds are terminated for correct operation of protective devices.

### Provide copy of test results to DISTRICT for review and approval.

**END OF SECTION**