

SECTION 16120

LOW VOLTAGE WIRE AND CABLE

PART 1 - GENERAL

1.1 Description

- A. Provisions: Applicable provisions of Section 16010 become a part of this section as if repeated herein.
- B. Related Work Described Elsewhere: All 17000 Sections.

1.2 Reference Standards

- A. American Society for Testing and Materials (ASTM):
 - 1. B3-74 Specification for Soft or Annealed Copper Wire
 - 2. B8-77 Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 3. B173-71 Specification for Rope Lay Stranded Copper Conductors Having Concentric Stranded Members
- B. Insulated Cable Engineers Association (ICEA):
 - 1. S-66-524 Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable
- C. International Electrical Testing Association (NETA);
 - 1. ATS Acceptance Testing Specifications
- D. Underwriters Laboratories (UL) Standards:
 - 1. 44 Rubber Insulated Wire and Cable
 - 2. 62 Flexible Cords and Fixture Wire
 - 3. 83 Thermoplastic-Insulated Wires and Cables
 - 4. 510 Insulating Tape
 - 5. 719 Non-Metallic Sheath Cable
 - 6. 1063 Stranded Conductors for Machine Tool Wire

1.3 Submittals

Submit material or equipment data in accordance with Section 01080 and Section 16010 of these Specifications.

1.4 Locations

- A. Refer to Section 16010, GENERAL ELECTRICAL REQUIREMENTS, for definitions of types of locations.

PART 2 - PRODUCTS

2.1 Conductors

- A. General: All conductors shall be copper [unless specifically shown otherwise on the Drawings or in the circuit schedule]. Wire or cable not specifically shown on the Drawings or specified, but required, shall be of the type and size required for the application and in conformance with the applicable code. All insulated conductors shall be identified with printing colored to contrast with the insulation color.
- B. Power and Control Conductors, 600 Volts and below:
 - 1. Stranded copper wire shall be 600 volt Type THWN, Class B stranding, sizes #14 AWG and larger.
- C. VFD Cable
 - 1. VFD cable shall be provided by the District from one of the manufacturers shown on the drawings.

2.2 Splices and Terminations of Conductors

- A. Splices:
 - 1. Wire and Cable Splicing Materials and Applications:
 - a. All Equipment: Crimp type connectors shall be insulated type, suitable for the size and material of the wires and the number of wires to be spliced and for use with either solid or stranded conductors. They shall be UL listed.
 - b. Division 16 Equipment and Power Conductors: Bolted pressure connectors shall be suitable for the size and material of the conductors to be spliced. They shall be UL listed and of the split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor.
 - c. Provide Terminal Cabinets (J-boxes) as shown on the Drawings. Termination system shall include Insulated, crimp-type connectors. Coordinate the lug and boards for correct fit. All terminations shall include marker sleeves.
- B. Terminations:
 - 1. Low Voltage Terminations:
 - a. Crimp type terminals shall be UL listed, self-insulating sleeve type, with ring or rectangular type tongue, suitable for the size and material of the wire to be terminated, and for use with either solid or stranded conductors.
 - b. Terminal lugs shall be UL listed and of the split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor. Tongues shall have NEMA standard drilling.
 - c. Crimp with manufacturer recommended ratchet-type tool with calibrated dyes. Hand crimping tools are not acceptable.
- C. Tape used for splices and terminations shall be compatible with the insulation and jacket of the cable and shall be of plastic material. Tape shall conform with UL 510.
- D. Wire markers shall be heat shrink type (Raychem, T&B, or approved substitute. Wire numbers shall be permanently imprinted on the markers.

PART 3 - EXECUTION

3.1 Conductor Installation

- A. Provide the following types and sizes of conductors for the uses Indicated for 600 volts or less:
1. Stranded Copper. Size #14 AWG and Larger, Individual Conductors or multi-conductor: As shown on the Drawings for the control of motors or other equipment. Size #14 shall not be used for power supplies to any equipment.
 2. Stranded Copper. Sizes #12 AWG and Larger: As shown on the drawings for motors and other power circuits.
- B. Color Coding: Provide color coding for all circuit conductors. Insulation color shall be white for neutrals and green for grounding conductors. An isolated ground conductor shall be identified with an orange tracer in the green body. Ungrounded conductor colors shall be as follows:
1. 120/208 Volt, 3 Phase: Red, black and blue.
 2. 277/480 Volt, 3 Phase: Yellow, brown and orange.
 3. 120/240 Volt, I Phase: Red and Black.
- Color coding shall be in the conductor insulation for all conductors #10 AWG and smaller; for larger conductors, color shall be either in the insulation or in colored plastic tape applied at every location where the conductor is readily accessible (e.g., enclosures, pullboxes, and junction boxes).
- C. Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking, putting undue stress on the cables or otherwise abrading them. No grease will be permitted in pulling cables. Only UL listed pulling compound will be permitted. The raceway construction shall be complete and protected from the weather before cable is pulled into it. Swab and mandrel conduits before installing cables and exercise care in pulling, to avoid damage to conductors.
- D. Cable bending radius shall be per applicable code. Install feeder cables in one continuous length.
- E. Provide an equipment grounding conductor, whether or not it is shown on the Drawings, in any flexible conduit or any raceway in which all or any portion of a run consists of non-metallic duct or conduit. For flexible conduit, an external bonding jumper is an acceptable alternative.
- F. In panels, bundle incoming wire and cables, No.6 AWG and smaller, lace at intervals not greater than 6 inches, neatly spread into trees and connect to their respective terminals. Allow sufficient slack in cables for alterations in terminal connections. Perform lacing with plastic cable ties. Where plastic panel wiring duct is provided for cable runs, lacing is not necessary when the cable is properly installed in the duct.
- G. For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not exceeding 12, and arrange so that they will be protected from chafing and excess flexing when the hinged member is moved. Cover cables crossing the hinge with plastic spiral sleeves.
- H. VFD Cable Installation - In addition to the above cable pulling requirements, the following requirements shall apply to the VFD cable installation.
1. Manufacturer's installation recommendations shall be followed.
 2. Contactor shall review the conduit routing to determine the pulling direction that will minimize the pulling tension.
 3. Pulling eyes shall be used to pull in the cable. Cable basket grips are shall not be used.

4. Cable shall not be pulled continuously through the pullboxes. Cable tension shall be relieved at the pullbox and re-fed into the box for the next segment of the pull.
5. Cable tension shall be monitored and recorded during each pull. Pulling tension records shall be submitted to the District.
6. After installation, cable shields shall be checked for continuity using an ohmmeter. Resistance records shall be submitted to the District.

3.2 Conductor Splices and Terminations

- A. Splices: install all conductors without splices unless necessary for installation, as determined by the District. Splices, when permitted, and terminations shall be in accordance with the splice or termination kit manufacturer's instructions. Splice or terminate wire and cable as follows:
- B. Terminations:
 1. Terminate stranded #14 wire using crimp type terminals where not terminated in a box lug type terminal. Terminals must be coordinated with type of terminal board where provided.
 2. VFD cable shall be terminated with termination kits as shown on the Drawings. Terminal lugs shall be designed for extra flexible stranded conductors. Conductors shall not be trimmed or strands removed to fit into a lug or termination.

3.3 Conductor Identification

- A. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pullbox, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the District.
- B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

3.4 Field Tests

- A. Insulation Resistance Tests: For all circuits 150 volts to ground or more and for all motor circuits over 1/2 horsepower, test cables per NETA. The insulation resistance shall be 20 megohms or more. Any cable with insulation resistance less than 20 megohms shall be replaced. Submit results for review. See also Section 16010, 3.07 FIELD TESTS.
- B. Phase Rotation: The phase rotation of all circuits shall be clockwise in sequence. The Contractor shall verify that each three-phase service, feeder and branch circuits meet this requirement. A record shall be kept at each circuit tested and, on completion, given to the District for review.

** END OF SECTION **