

SECTION 260519
LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the requirements for the power and control cables, instrumentation cables and multi-conductor cable, and wire connections and related devices.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the following:
 - 1. National Electrical Code
 - 2. Institute of Electrical and Electronic Engineers
 - 3. Instrument Society of America
 - 4. National Fire Protection Association

1.4 SUBMITTALS

- A. Product Data for Wire and Cable, Wire Connections and Related Devices

1.5 QUALITY ASSURANCE

- A. Certificates:
 - 1. Deliver conductors to the site in their original unbroken packages or on their original cable reels.
 - 2. Mark or tag all conductor packages and cable reels plainly with UL label, AWG or circular mil size, voltage rating, insulation type, type of stranding, manufacturer's name, trade name and month and year when manufactured.
- B. Codes and Standards:
 - 1. ICEA S-61-402: Thermoplastic insulated wire and cable for the transmission and distribution of electrical energy.
 - 2. ICEA S-19-81: Rubber insulated wire and cable for the transmission and distribution of electrical energy.
 - 3. UL 83 for thermoplastic insulated wires.
 - 4. UL 1063 for machine tool wires and cables.
 - 5. UL 758 for 221 deg F appliance wiring materials.
 - 6. Fed Spec. J-C 30A.
 - 7. Shield instrument cable: UL listed as ITC/PLTC in compliance with UL 2250 and UL 13.
- C. Provide new conductors manufactured within 1 year of the date of delivery to the site. Store conductors out of the weather and where not subject to damage or deleterious conditions.

- D. Assembly and testing of cable shall comply with the applicable requirement of ICEA Publication No. S-68-516. MATERIALS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Power and Control Cable Manufacturers:

1. Cablec.
2. General Cable.
3. Rome Cable.
4. Okonite.
5. Triangle.
6. American Insulated Wire Corporation.
7. Diamond Wire and Cable.

B. Acceptable Instrumentation Cable Manufacturers:

1. Belden.
2. Carol.
3. Alpha.
4. Southwire

2.2 MATERIALS

A. Power and Control Conductors:

1. Unless specifically indicated otherwise, conductor sizes are for soft drawn, minimum 98% conductivity, minimum insulation rating of 600 volts. All wire shall be copper.
2. Except as indicated, provide conductors of No. 12 AWG minimum size.
3. Conductors No 16 AWG and smaller: TFFN insulation, unless otherwise indicated.
4. Conductors No 14 AWG and larger: Stranded with Type THHN/THWN dual rating insulation, unless otherwise indicated
5. Provide conductors with Type THHN/THWN dual rating for No. 14 and No. 12. Provide solid conductors for use on toggle switches and receptacles.
6. Wire No. 10 and smaller shall be factory color-coded.
7. Wire No. 8 and larger shall be color-coded by field painting or color taping the entire length of exposed ends or 12 inches of exposed end, whichever is less.
8. For all sizes, conductors with mineral filled cross-linked thermosetting polyethylene insulation, UL Type XHHW rated 75° C in wet or dry locations, may be used.
9. Where ambient temperatures are within 18°F of the maximum allowable operating temperature of the insulation of a conductor, provide conductors with insulations (such as Type AVA) suitable for the temperatures and other conditions to be encountered.

10. Stranded wire is to be used for all control circuits No. 14 THHN/THWN unless otherwise noted.
11. Use only stranded wire for all motor connections minimum size No. 12 THHN/THWN unless otherwise noted.
12. Solid wire shall be used on all receptacle outlets and toggle switches.
 - a. Contractor may use stranded wire on toggle switches and receptacles if all terminations are made with compression type ring tongue terminals.
13. Class B or Class C stranded or solid, annealed, uncoated per UL 83 or 1063.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Techniques:
 1. Where a common neutral is run for two or three home run circuits, phase conductors shall be connected to breakers in the panel, which are attached to separate phase legs in order that the neutral conductors will carry only the unbalanced current.
 - a. Neutral conductors shall be of the same size as the phase conductors unless specifically noted otherwise.
 - b. Receptacle circuits in office areas must have a separate neutral for each phase circuit, common neutrals are not allowed for receptacle circuits in office areas.
 2. Install wires only in approved raceways.
 3. Pull in wire with an approved wire-pulling lubricant as recommended by cable manufacturer for all wire No. 4 and larger, or where necessary.
 - a. Use Ideal "Yellow," EFCOR WGY, polywater, or equal.
 - b. Do not use oil, grease or similar substances.
 4. Do not install wire in:
 - a. Incomplete conduit runs.
 - b. Until after the concrete work and plastering is completed.
 - c. Until after all moisture is swabbed from conduits.
 5. Install and terminate all wire in strict accordance with manufacturer's recommendations.
 6. Install all control wiring in accordance with manufacturer's recommendations and control system requirements for complete operating system.
 - a. All wires including field and internal panel wires are to be numbered at both ends as per manufacturer's control drawings.
 - b. Mark all control wires prior to termination.
 7. Strip insulation in a manner that voids the nicking of wires.
 8. Install instrumentation cables in separate raceway systems and not with power cables.
 9. Provide all wiring and equipment for heating, air conditioning and ventilation systems, and telephone and security systems.

10. Before installing conductor, remove debris and moisture from conduit and equipment enclosures.
 11. All control lines are to be continuous with no splices. Keep splices to a minimum on power circuits.
 12. All shielded cables are to be continuous with no splices between instrument element and controller.
 13. Solid conductors shall be terminated at equipment terminal screws with proper care that the conductor is tightly wound around the screw.
 - a. The conductor will not protrude beyond the screw head.
 14. Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within the lug.
 15. Use ring type lugs where equipment box lugs have not been provided.
 16. Conductors No. 1-gage and smaller shall be hand pulled. Larger conductors may be installed using power wire pulling winches.
 17. Minimum power wire size to be No 12 unless otherwise indicated.
 18. Minimum control wire size to be No 14 unless otherwise indicated.
- B. Cabling: Neatly arrange and lace conductors in switchboards, panel boards, gutters and terminal cabinets by means of:
1. T&B "Ty-Rap" ties
 2. Panduit Wire Ties
 3. Approved equal
- C. Color Coding:
1. The following color code shall be followed for all 208/120-volt systems.
 - a. Phase A - Black
 - b. Phase B - Red
 - c. Phase C - Blue
 - d. Neutral - White
 - e. High Phase or Wild Leg - Orange
 - f. Equipment Ground - Green
 2. The following color code shall be followed for all 480/277 volt systems:
 - a. Phase A - Brown
 - b. Phase B - Orange
 - c. Phase C - Yellow
 - d. Neutral - Gray
 - e. Equipment Ground - Green
 3. All 120 volt control wiring shall be violet for power and white for neutral.

4. Color shall be integral with the jacket material.
5. General-purpose D.C. control circuits shall be light blue for negative, pink for positive.
6. Switch legs shall be violet.
7. Color coding and phasing shall be consistent throughout the site.
 - a. Bus bars at panel boards, switchboards, and motor control centers shall be connected A-B-C, top to bottom, or left to right, facing connecting lugs.

D. Splices:

1. Splices in 600-volt wire, which are not pre-insulated, shall be insulated with four layers of tape each half-lapped.
2. Splices in below grade pull boxes or in any box subject to flooding shall be made watertight using either:
 - a. A heat shrink insulating system listed for submersible applications.
 - b. An epoxy resin splicing kit.

E. Control Connections:

1. Connect control wiring as indicated and in accordance with the wiring diagrams furnished by the equipment manufacturer
2. Number all wires in accordance with control wiring diagram at each end of the wire.
3. Use insulated ring type wire terminators for connections to all screw terminals manufactured by:
 - a. T-B Stakon
 - b. 3M & Corp.
 - c. Or approved equal
4. CONTRACTOR is responsible for working from manufacturer's drawings for process equipment connections

F. Medium Voltage Systems:

1. Splices:
 - a. Permanent in line splice.
 - b. Suitable for submersible, direct burial applications.
 - c. Power cable splices for shielded solid dielectric plastic cables shall be factory-engineered kits containing all necessary components to reinstate primary cable insulation, metallic shielding/grounding system and overall gasket.
 - d. Splice shall be of a uniform cross section heat shrinkable polymeric construction consisting of a linear stress relief system, a high dielectric strength insulating material and an integrally bonded outer conductive layer for shielding.
 - 1) The original cable jacket shall be replaced with a heavy wall heat shrinkable sleeve with a waterproof mastic seal on both ends
 - e. The splice shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances

- f. When assembled on cables the splice shall be capable of passing the electrical test requirements of:
 - 1) IEEE--48-1975
 - 2) IEEE--404-1977
 - 3) ANSI--C119.2-1974
 - g. As manufactured by Ray Chem.
2. Live Front Terminators:
- a. Terminators for shielded solid dielectric plastic cables shall be factory engineered kits containing all necessary components to terminate the primary cables and shield systems.
 - b. All locations exterior of buildings shall be considered outdoors and appropriate heat shrinkable skirts of a non-tracking material shall be installed.
 - c. Terminators shall be of a material that will relieve the associated voltage stresses at the point of termination.
 - d. Non-tracking.
 - e. Ultra-violet, ozone, sulphur dioxide resistant.
 - f. Terminator shall be of a uniform cross section heat shrinkable polymeric construction consisting of a linear stress relief system.
 - g. The terminator shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances.
 - h. When assembled on cables the terminator shall be capable of passing the electrical test requirements of IEEE--48-1975.
3. Dead Front Terminators -- 600 Amperes:
- a. Terminators for shielded solid dielectric plastic cables shall be factory engineered kits containing all necessary components to terminate the primary cables and shield systems.
 - b. Modular pre-molded dead system.
 - c. Fully shielded dead front operation.
 - d. Submersible.
 - e. Capable of mating with any manufacturer interface complying with ANSI 386-1977.
 - f. All aluminum crimp connector using standard compression tools to join the conductor to the interface.
 - g. To be used as an elbow or a "T".
 - h. Cable adapters to connect the cable insulation to the dead front terminator.
 - i. Terminator is to be bolted to the bushing or connector plug with an insulating plug for the connection.
 - j. Conductive cap covering the insulating plug.
 - k. Conductive shield to provide reliable continuity between jacket of cable and connector.

- l. Conductive insert to prevent corona.
 - m. With a capacitive test point on the insulating plug to allow circuit testing without disturbing the connection.
- G. Firestopping: Apply Firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire resistance of assembly. Coordinate with the requirements related Division 7 sections of the Specifications.

3.2 FIELD QUALITY CONTROL

- A. Test: Perform meggar tests in conformance with related Division 26 Sections of the Specifications.

3.3 SCHEDULES

- A. General Installation Sequence:

1. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry.
2. Number all wires at each end after being installed in the conduit and prior to meggar testing and termination.
3. Meggar all wires prior to final connection of devices.

- B. Medium Voltage Cables Special Sequence:

1. Submit cable pulling tension calculations prior to conduit installation.
2. Swab clean conduits prior to cable installation.
3. Pre-lubricate conduits as required.
4. Install cable under the observation of the ENGINEER, ENGINEER shall witness cable dynamometer during cable installation to compare pulling tension with calculated and maximum values.
5. Phase conductors, fire tape, and install terminators.
6. Conduct HI-Pot test in the presence of ENGINEER and OWNER. Provide minimum of 5 days advanced notice of testing.

END OF SECTION 260519