SECTION 16120

WIRE, CABLE, AND ACCESSORIES

PART 1 - GENERAL

1.1 Description

A. This Section includes furnishing and installing (including terminations) of all electrical wire, cable, and accessories.

B. Related Work Specified Elsewhere

Lighting.....Section 16500
Grounding .....Section 16450
Field Testing..... Section 16950
Instruments and Controls..... Sections 16900-16950

1.2 References

1. American Society for Testing and Materials (ASTM)

ASTM B3 - Soft or Annealed Copper Wire.

ASTM B8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

ASTM B33 - Tinned Soft or Annealed Copper Wire for Electrical Purposes.

ASTM B172 - Rope-Lay-Stranded Copper Conductors, Having Bunch Stranded Members, for Electrical Conductors.

ASTM B189 - Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.

2. Insulated Cable Engineers Association (ICEA)

S-19-81 - Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

S-61-402 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

S-66-524 - Cross-Linked Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

S-68-516 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

S-81-570 – 600-Volt Rated Cables of Ruggedized Design for Direct Burial.

S-105-692 – 600Volt Single Layer Thermoset Insulated Utility Underground Distribution Cables.

T-29-520 – Vertical Cable Tray Flame Tests at 210,000 Btu.

3. National Electric Manufacturers Association (NEMA) and Insulated Cable Engineers Association (ICEA)

WC55/S-82-552 – Instrumentation Cables and T.C. Wire.

WC57/S-73-532 – Standard for Control Cables.

WC70/95-658 - Non-Shielded Power Cables Rated 2000V or Less.

4. Institute of Electrical and Electronic Engineers (IEEE)

48 - Test Procedures and Requirements for High Voltage Alternating-Current Cable Terminations.

5. National Fire Protection Association

National Electrical Code (NEC) NFPA-70.

Standard for Electrical Safety in the Workplace, NFPA 70E

6. Underwriters Laboratories, Inc. (UL)

44 - Rubber-Insulated Wires and Cables.

83 - Thermoplastic-Insulated Wires and Cables.

263 - Fire Tests of Building Construction and Materials.

854 - Service Entrance Cables.

1277 - Electrical Power and Control Tray Cables with Optional Optical Fiber Members.

7. National Electrical Safety Code, IEEE C2.

8. Occupational Safety and Health Administration, OSHA.

9. All electrical and control equipment and material shall bear the recognized Underwriters Laboratories, Inc. (UL) seal of approval. It is Vendor's responsibility to obtain local inspection approval for all non-UL labeled equipment and pay all fees in connection with the same.

1.3 Submittals

A. Submit as specified in Section 1330.

B. Includes, but not limited to, the following:

1. Data sheets for each wire and cable type specified.

2. Data sheets for wire and cable accessories.

3. Cable manufacturer's approval of splicing and terminating materials.

4. Cable manufacturer's approval of pulling compounds.

5. Cable manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radii, etc.

6. Other equipment and materials to be used.

PART 2 - MATERIALS

2.1 Acceptable Manufacturers

A. Wire and Cable

Acceptable manufacturers for each wire and cable type will be manufacturers that have been manufacturing the specified cable for a minimum of five years and meet all the requirements listed on the Wire and Cable Specification Sheets.

B. Wire and Cable Accessories

1. Cable Connectors for Control and Instrument Cable

a. AMP Special Industries.

b. Hollingsworth Solderless Terminal Company.

c. Panduit Corporation.

d. Minnesota Mining and Manufacturing (3M).

e. Thomas and Betts Company, Inc.

2. Cable Connectors for Power Cable

a. AMP Special Industries.

b. Thomas and Betts Company, Inc.

c. Minnesota Mining and Manufacturing (3M).

d. Panduit Corporation.

3. Termination and Splice Kits

a. Minnesota Mining and Manufacturing (3M).

b. Raychem.

4. Tape and Insulation Putty: Minnesota Mining and Manufacturing (3M).

5. Cable Ties

a. AMP Special Industries.

b. Dennison Manufacturing Company.

c. Panduit Corporation.

d. Minnesota Mining and Manufacturing (3M).

e. Thomas and Betts Company, Inc.

6. Cable Supports

a. O-Z/Gedney Company.

b. Hubbell, Kellems Grips.

7. Terminal Blocks

a. Allen-Bradley.

b. Buchanan.

c. Phoenix Contact.

d. Weidmuller.

8. Cable Identification Tags

a. Allen Marking Products, Kansas City, MO.

b. Floy Tag and Manufacturing Co., Seattle, WA.

c. Panduit Corporation (Panduit).

d. Specialty Products Company, Rock Hill, SC.

e. Thomas and Betts Company, Inc. (Thomas and Betts).

9. Cable Fire and Smoke Stop Fittings

a. Crouse Hinds.

b. Nelson Electric.

c. O-Z/Gedney Company.

2.2 Wire and Cable

A. Building Wires

1. Conductors: stranded for 12 AWG and larger. Minimum size: 12 AWG.

2. Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

B. MC, Metal Clad Cables

1. Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

2. Insulation: Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.

3. Inner jacket.

4. Armour: continuous aluminum.

5. Overall covering: flame retardant polyvinyl chloride material meeting requirements of Vertical Tray Fire Test.

C. Instrument Cable – Shielded Twisted Pairs/Triads

1. Conductors: stranded for 16 AWG and larger. Minimum size: 16 AWG.

2. Copper conductors: size as indicated, with 600 V insulation of PVC material rated RW90. Color code shall use pigmented compounds, white and black for pairs, white, black and red for triads. Each conductor shall include sequential numbers printed on surface of conductors.

3. Conductor jacket: nylon.

4. Shields: aluminized mylar or polyester tape with tinned copper drain wire.

5. Jacket: Polyvinyl chloride (PVC).

D. Control Cables

1. Class B or C soft annealed stranded copper conductors, sized as indicated, with cross-linked thermosetting polyethylene, outer PVC jacket rated for outdoor use.

2. 600 V type: with cross-linked polyethylene type, RW90 (x-link) and overall jacket.

E. Temperature Rating

Cables shall be suitable for operation with a maximum conductor temperature of 90ºC, continuous, wet or dry locations.

F. Insulation and Jacket Thickness

See references, Section 1.2.

G. Factory Tests

See references, Section 1.2, including the flame test requirement, ICEA T-29-520 and UL 1277.

H. Certification

Cables shall be certified to be in conformance with all applicable codes and standards as referenced.

All cables shall include surface identification showing manufacturer's name, insulation type, conductor size, conductor type, voltage rating and UL label.

2.3 Connectors

A. General Requirements

1. Designed and sized for specific cable being connected.

2. Solderless, pressure-type connectors constructed of non-corrodible tin-plated copper.

3. Rated current-carrying capacity equal to or greater than the cable being connected.

4. Application tooling for connectors shall contain die or piston stops to prevent over-crimping and cycling or pressure relief to prevent under-crimping. Dies of all application tooling shall provide dot or wire size coding for quality control verification. All tooling shall be manufactured by the connector manufacturer.

B. Power Connectors (10 AWG and Smaller) 600V and Below

1. "Scotchlok" preinsulated spring wire connectors.

2. Buchanan open-end copper splicing caps, applied with "Lok-Seal" tool, with nylon snap-on insulators.

C. Power Connectors (sizes 8-4 AWG) 600V and Below

1. Noninsulated ring-tongue type.

2. Ring tongue sized to match terminal stud size.

3. Brazed barrel seam.

4. Application tooling designed to crimp the wire barrel (conductor grip) with a one-step crimp.

D. Power Connectors (sizes 2 AWG - 750 kcmil) 600V and Below

1. Non-insulated one-hole rectangular tongue for sizes 2 AWG through 3/0 AWG and two-hole rectangular tongue for 4/0 AWG through 750 kcmil.

2. Application tooling shall be hydraulically operated.

E. Control, Instrument, and Specialty Cable Connectors

1. Tin-plated copper.

2. Vinyl preinsulated spring-type spade terminals. (Hollingsworth "Mini Spring Spades"; Thomas and Betts "Locking-Fork"; Panduit "Locking Fork.")

3. Sized to match terminal stud size.

4. Have insulation grip sleeve to firmly hold to cable insulation.

5. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned-back strands.

6. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve with a one-step crimp.

2.4 Motor Lead Termination/Splice (Low-Voltage, 600v and Below, Power Cable)

A. Splices shall be made using compression-type connectors bolted together. The compression-type connectors shall be properly sized for the cables.

B. Splice to be covered with heat-shrinkable tubing connector insulators or slip-on rubber boot or sleeve.

C. Splicing shall be done in accordance with the instructions provided with the Raychem brand MCK Motor Connector Kit or 3M Company 5300 Series Motor Lead Splice Kit.

2.5 Cable Supports

A. Cable supports for cables in vertical conduit risers shall be O-Z/Gedney Type "R" wedging plug type or approved equal.

B. Kellems basket type wire mesh grip for cables in vertical installations.

2.6 Cable Ties

A. Nylon self-locking type.

B. Have a normal service temperature range of -40^{o}C to 85^{o}C.

C. Be weather-resistant and sun-light resistant type for outdoor use.

D. Meet requirements of Military Specifications MIL-S-23190D.

E. AMP Special Industries "AMP-TY," Dennison Manufacturing Company "BAR-LOK," Panduit Corporation "PAN-TY," Thomas & Betts "TY-RAP," or Minnesota Mining and Manufacturing 3M Brand cable ties.

2.7 Terminal Blocks

A. For mounting in terminal boxes (TBs)

1. Designed and sized for the cables being terminated.

2. Block rated 600V.

3. Binding screw-type terminals for power cables and strap screw or tubular clamp terminals for control and instrument cables.

4. Rated current carrying capacity equal to or greater than the cable being terminated.

5. Marking strip.

B. For Mounting in Cabinets, Panels, Control Boards, Etc.

1. Designed and sized for the cables being terminated.

2. Block rated 600V.

3. Binding screw type terminals for power cables and current transformer circuits and strap screw or tubular clamp terminals for control and instrument cables.

4. Rated current carrying capacity equal to or greater than the cable being terminated.

5. Marking strip on blocks for power cables and control and instrument cables.

6. Short-circuit strips with one shorting screw for each terminal for current transformer circuits.

2.8 Cable Identification Tags

A. Designed to provide a permanent wire and cable identification system.

B. Show complete cable number. Cable numbers are defined in the Cable Schedule and/or Contract Drawings.

C. Cable numbers may be stamped or typed in a legible and permanent manner. Hand-lettering is not acceptable.

D. Character size for cable numbers shall be a minimum of 1/8-inch.

E. Material shall be nonmetallic and impervious to moisture and resistant to fading in sun-light.

F. Be securely attached to cables and accessible for inspection.

G. Cable identification tags, marking and attachment methods shall be subject to approval of the Engineer.

2.9 Fastenings

1. One hole malleable iron straps to secure surface cables 2 inch diameter and smaller. Two hole steel straps for cables larger than 2 inches.

2. Channel type supports for two or more cables.

3. Threaded rods: 3/8 inch dia. stainless steel to support suspended channels.

PART 3 – EXECUTION

3.1 Installation

A. Wire and Cable

1. General Requirements

a. Install in conduit, duct system or tray as indicated.

b. Do not subject cable to pulling tensions or sidewall pressures in excess of manufacturer's recommendations.

c. Attach pulling grips over the cable sheath to prevent slipping of the insulation.

d. Do not subject cable to bending radius less than those recommended by the cable manufacturer or as noted below (whichever is greater) during or after installation:

(1) Eight times the cable outside diameter for 600V or lower rated cables.

e. Install intermediate splices only as indicated or as required to avoid subjecting cable to excessive pulling tension or sidewall pressures. Cable splicing locations

shall be approved by Engineer prior to cable installation.

f. Support cables at connections or termination points such that any strain on cable will not be transmitted to the connection or termination.

g. Install cable supports in vertical runs of conduit, at boxes and at terminations in equipment, and as required to meet intermediate support requirements of National Electrical Code (NEC).

h. All pulling compounds shall be approved by wire and cable manufacturer as being compatible with cable materials.

i. Attach a cable identification tag to each cable at all termination or end points.

j. Install fire and smoke stop fittings at all cable penetration of fire rated walls, floors and ceilings.

2. Power (600V and Below), Control, Instrument, and Specialty Cable

a. Install metallic barrier in all tray and boxes to separate power, control and instrumentation from low-level signal (50V or less) instrumentation circuits where run in the same box.

b. Cables in vertical trays shall be secured every 3 feet or less.

c. Tie together with cable ties all single conductor cable on each individual circuit in each junction box, and equipment at intervals not to exceed 6 feet.

d. Attach a cable identification tag to each cable.

(1) At each terminal to identify the circuit and cable.

(2) Use nylon ties and identification tabs color coded as follows:

(a) 480V circuits - Red.

(b) 277, 240, or 208Vac circuits - Orange.

(c) 120V circuits - White.

(d) Control cables - Natural Nylon.

e. Insulation Color Coding

(1) Conductors shall be coded or numbered over the entire length.

(2) Colors shall not be changed between source and device. No white wire shall be used in lighting and convenience outlets except as a grounded neutral conductor.

f. Tag each individual conductor or wire with wire markers as follows:

(1) With terminal designation indicated on schematic diagrams or given on manufacturer's equipment drawings.

(2) At each terminal.

(3) In addition to specified circuit tags.

g. Terminate and ground, control, instrument, and specialty cable shields as indicated and recommended by the manufacturer of the equipment being connected. In general, ground the shields at the control boards for control cables and at the receiving end equipment for instrumentation and specialty cables.

h. Control and instrument cable splices shall be as follows:

(1) Made only in junction or terminal boxes.

(2) Made on terminal blocks with marking strips.

(3) Conductor color coding shall be maintained.

(4) For shielded cables, shield continuity and isolation shall be maintained.

i. Power cable (600V or below) splices and motor terminations shall be as follows:

(1) Made only in junction or terminal boxes.

(2) Splices shall be made using compression type connectors bolted together.

(3) Splice to be covered with a heat-shrinkable connector insulator.

j. Lighting Cable: Install as specified in this Division.

k. Ground Cable: Install as specified in this Division.

l. Install fire and smoke stop fittings at all cable penetrations of fire-rated walls, floors, and ceilings.

3. Cable Connections and Terminations

a. Make up clean and tight to assure a low-resistance joint.

b. Make only in terminal boxes, equipment or other accepted enclosures and not in conduit.

c. Install all connectors with tooling manufactured by the connector manufacturer and as specified.

3.2 Field Quality Control

A. Manufacturer's Field Services: Provide as specified in DIVISION 1.

B. Field Testing: Specified in Section 16950.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

A. No measurement will be made for this item.

4.2 Payment

A. Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

**** END OF SECTION 16120 ****