

SECTION 33 72 43 11 – SUBSTATION WIRE, CABLE AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

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

1.02 RELATED REQUIREMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Section 13 34 23.23 - Fabricated Substation Control Enclosures
- C. Section 23 75 00 – Substation Enclosure HVAC Equipment
- D. Section 26 24 16 - Panelboards
- E. Section 26 51 23 - Substation Interior Lighting and Receptacles
- F. Section 26 36 00 – Power Switching and Control Devices
- G. Section 33 72 33 36 – Cable Tray and Wireway for Utility Substations
- H. Section 33 72 33 33 – Raceway and Boxes for Utility Substations
- I. Section 33 72 33.16 - Relay Switchboards

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (conform to all standards applicable to each item utilized) shall be the latest revisions, supplements, and amendments to the following:
 - 1. ASTM International (ASTM):
 - a. ASTM B3 - Soft or Annealed Copper Wire.
 - b. ASTM B8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - c. ASTM B33 – Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
 - d. ASTM B172 - Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors.
 - e. ASTM B189 - Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.
 - 2. Association of Edison Illuminating Companies (AEIC):
 - a. AEIC CS5 - Specifications for Cross-Linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV.
 - b. AEIC CS6 - Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV.
 - c. AEIC G5 - Underground Extruded Power Cable Pulling Guide.
 - 3. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 48 - Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
 - b. IEEE 404 - Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV.
 - c. IEEE 525 – IEEE Guide for the Design and Installation of Cable Systems in Substations
 - d. IEEE 1210 – Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.
 - 4. National Electrical Manufacturers Association (NEMA) and Insulated Cable Engineers Association (ICEA):
 - a. NEMA WC 26 – Binational Wire and Cable Packaging Standard

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- b. NEMA WC 57 / ICEA S-73-532 – Control, Thermocouple Extension, and Instrumentation Cables.
- c. NEMA WC 70 / ICEA S-95-658 – Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
- d. NEMA WC 71 / ICEA S-96-659 – Nonshielded Cables Rated 2,001-5,000 Volts in the Distribution of Electrical Energy.
- e. NEMA WC 74 / ICEA S-93-639 – 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
- f. ICEA S-97-682 – Standard for Utility Shielded Power Cables Rated 5 through 46kV.
- 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
- 6. Underwriters Laboratory (UL):
 - a. UL 13 - Power-Limited Circuit Cables.
 - b. UL 44 - Thermoset-Insulated Wires and Cables.
 - c. UL 83 - Thermoplastic-Insulated Wires and Cables.
 - d. UL 854 - Service-Entrance Cables.
 - e. UL 1072 - Medium-Voltage Power Cables.
 - f. UL 1277 - Electric Power and Control Tray Cables with Optional Optical-Fiber Members.
 - g. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.04 SUBMITTALS:

- A. Include, but are not limited to, the following:
 - 1. Action Submittals:
 - a. Data sheets for each wire and cable type.
 - b. Data sheets for wire and cable accessories.
 - c. Cable manufacturer's approved splicing and terminating materials.
 - d. Cable manufacturer's approved pulling compounds.
 - e. Cable manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radii, etc.
 - f. Other equipment and materials to be used.
 - g. Unpriced Wire and cable purchase orders.
 - 2. Informational Submittals:
 - a. Wire and cable certification sheets shall be submitted as specified on each individual Wire and Cable Specification Sheet.

1.05 QUALITY ASSURANCE:

- A. Wire and Cable shall be manufactured under an established quality assurance program.
- B. Wire and cable manufacturer shall be engaged in the production of such wire and cable for a minimum of five (5) years.
- C. Factory Tests:
 - 1. Factory tests shall be conducted on wire and cable as specified on each individual Wire and Cable Specification Sheet contained in this Section.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Wire and Cable:

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1. Aetna Insulated Wire.
2. Belden.
3. Cerro Wire.
4. Corning Cable.
5. Dekoron Wire & Cable.
6. Encore Wire.
7. General Cable.
8. Houston Wire & Cable.
9. Lake Cable.
10. Okonite.
11. Prysmian Cable.
12. Rockbestos-Suprenant.
13. Service Wire.
14. Southwire.
- B. Wire and Cable Accessories:
 1. Control, Instrument, and Specialty Cable Connectors:
 - a. AMP Special Industries.
 - b. Burndy.
 - c. Panduit Corporation.
 - d. Thomas and Betts Company, Inc.
 - e. Minnesota Mining and Manufacturing (3M).
 2. Cable Connectors for Power Cable:
 - a. AMP Special Industries.
 - b. Burndy.
 - c. Panduit Corporation.
 - d. Thomas and Betts Company, Inc.
 - e. Minnesota Mining and Manufacturing (3M).
 3. Termination and Splice Kits (Shielded Medium-Voltage Power Cable):
 - 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. Thomas and Betts Company, Inc.
 - e. Minnesota Mining and Manufacturing (3M).
 6. Cable Supports:
 - a. Hubbell, Kellems Grips.
 - b. O. Z. Gedney Company.
 7. Modular Blocks:
 - a. Entrelec.
 - b. Phoenix Contact.
 - c. Weidmuller.
 8. Terminal Blocks:
 - a. General Electric.
 - b. Stanwick Electrical Products Company.
 - c. States Company.
 9. Cable Identification Tags:

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- a. Allen Marking Products, Kansas City, Missouri.
- b. Floy Tag and Manufacturing, Seattle, Washington.
- c. Panduit Corporation.
- d. Specialty Products Company, Rock Hill, South Carolina.

2.02 WIRE AND CABLE:

- A. The Cable Schedule defines the type, size, end points, and routing of each wire or cable for panel to panel wiring. It is the Suppliers responsibility to determine wiring for control enclosure wiring including but not limited to lighting, convenience power, HVAC, building alarms, and grounding cables. The Cable Schedule will be provided after PO award.

2.03 CONNECTORS:

- A. General Requirements:
 1. Designed and sized for specific cable being connected.
 2. Solder-less, 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 (Sizes 12 to 4 AWG):
 1. Vinyl or nylon pre-insulated ring-tongue type.
 2. Ring tongue sized to match terminal stud size.
 3. Have insulation grip sleeve or ring to firmly hold to cable insulation.
 4. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve or ring with a one-step crimp.
 5. Acceptable manufacturers are listed in the *Acceptable Connector Manufacturers' Cross-Reference Chart* at end of this Article.
- C. Power Connectors (Sizes 2 AWG to 750 MCM):
 1. Uninsulated two-hole rectangular tongue.
 2. Application tooling shall be hydraulically operated.
 3. Acceptable manufacturers are listed in the *Acceptable Connector Manufacturers' Cross-Reference Chart* at end of this Article.
- D. Control, Instrument, and Specialty Cable Connectors:
 1. Vinyl or nylon pre-insulated ring-tongue type. Spade lugs will not be permitted.
 2. Ring tongue sized to match terminal stud size.
 3. Have insulation grip sleeve to firmly hold to cable insulation.
 4. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned back strands.
 5. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve with a one-step crimp.
 6. Acceptable manufacturers are listed in the *Acceptable Connector Manufacturers' Cross-Reference Chart* at end of this Article.

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Acceptable Connector Manufacturers' Cross-Reference Chart						
Type	Size (AWG or MCM)	Amp Special Industries	Thomas & Betts	Panduit Corp.	Burndy	3-M
Control	22-18	PIDG	RA18	PN18	TP16	MNG-18
	16-14	PIDG	RB14	PN14	TP14	MNG-14
	12-10	PIDG	RC10	PN10	TP10	MNG-10
Power (600V and Below)	12-10	PIDG	C10	P10	TP10	M10
	8	Amplibond	D8	P8	YAEV	M8
	6	Amplibond	E6	P6	YAEV	M6
	4	Amplibond	F4	P4	YAEV	M4
	2	Amplibond	G2	LCA	YAEV	30000 Series
	1-750	Ampower	54200 Series	LCC	YA-2LN YA39-2LN	31100 Series

2.04 CABLE SUPPORTS:

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

2.05 CABLE TIES:

- A. Heavy-Duty Nylon self-locking type.
- B. Have a normal service temperature range of -40°C to 85°C.
- C. Be weather resistant for outdoor use.
- D. Be AMP Special Industries "AMP-TY," Dennison Manufacturing Company "BAR-LOK," Panduit Corporation "PAN-TY," or Thomas and Betts "TY-RAP", or Minnesota Mining and Manufacturing 3M Brand cable ties.

2.06 TERMINAL BLOCKS:

- A. For Mounting in Terminal Boxes (TBs):
 - 1. Designed and sized for the cables being terminated.
 - 2. Phenolic block rated 600V.
 - 3. Binding-screw-type terminals for power cables and straight-strap stud 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. General Electric Type CR2960SY139 for power cables and States Company Type NT Model M-251 for control and instrument cables.
- B. For Mounting in Cabinets, Panels, Control Boards, etc.:
 - 1. Designed and sized for the cables being terminated.
 - 2. Phenolic block rated 600V.
 - 3. Binding-screw-type terminals for power cables and current transformer circuits and sliding link stud type 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.

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7. General Electric Type CR2960SY139 or approved equivalent for power cables. States Company Type NT Model M-250, or Stanwick Type SLS for control and instrument cables. General Electric Type EB-27 for current transformer circuits.

2.07 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 shall be legible and permanent, hand lettered, stamped or typed.
- D. Character size for cable numbers shall be a minimum of 3/16 inch if hand lettered or 1/8 inch if stamped or typed.
- E. Material shall be nonmetallic and impervious to moisture.
- 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 Owner.

PART 3 - EXECUTION

3.01 INSTALLATION :

- A. Install wire and cable in raceway system as indicated in Contract Documents.
- B. Include Cable Ripper to ease installation.
- C. Do not subject cable to pulling tensions or sidewall pressures in excess of manufacturer's recommendations.
- D. Attach pulling grips over the cable sheath to prevent slipping of the insulation.
- E. Do not subject cable to inside bending radius less than those recommended by the cable manufacturer or as noted below (whichever is greater) during or after installation:
 1. Twelve times the cable outside diameter for 5 kV or higher rated cables.
 2. Eight times the cable outside diameter for 600V or lower rated cables.
- F. Do not splice cables.
- G. Support cables at connections or termination points such that any strain on cable will not be transmitted to the connection or termination.
- H. Install cable supports in vertical runs of tray or conduit, at boxes and at terminations in equipment, and as required to meet intermediate support requirements of NEC.
- I. All pulling compounds shall be approved by wire and cable manufacturer as being compatible with cable materials.
- J. Attach a cable identification tag to each cable at all terminations, splices, and end points.
- K. Utilize a load cell tension monitoring device to confirm that cable pulling tension limits are not being exceeded. Additionally, monitor and record individual cable pulls as requested by the Owner to adhere to the cable limitations as published by the cable manufacturer.
- L. All wire and cable installation shall comply with the applicable parts of the National Electrical Code (NEC).
- M. Test each wire for ground or shorts after installation but before any connections are made.
- N. There shall be at least 12 inches of excess control or low-voltage wire remaining at all terminal blocks for the purpose of making connections or splices.

3.02 POWER (600V AND BELOW), CONTROL, INSTRUMENT, AND SPECIALTY CABLE:

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

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- B. Secure with cable ties in cable tray risers at intervals not to exceed three feet.
- C. Tie together with cable ties all single-conductor cable on each individual circuit in each junction box, equipment, or manhole and in cable tray or trench at intervals not to exceed 6 feet.
- D. Control and instrument cable splices shall be as follows:
 - 1. Made only in junction or terminal boxes.
 - 2. Made on terminal blocks.
 - 3. Conductor color coding shall be maintained in accordance with K2 color code.
- E. Terminate and ground control, instrument, and specialty cable shields as indicated in Contract Documents and recommended by the manufacturer of the equipment being connected.

3.03 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 or cable tray.
- C. Install all connectors with tooling manufactured by the connector manufacturer and as specified.

END OF SECTION 33 72 43 11