

SECTION 34 42 16

TRAIN CONTROL WIRES AND CABLES

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Conductors
- B. Control wires
- C. Control cables
- D. Power cables
- E. Signal cables
- F. Bond cables

1.02 RELATED SECTIONS

- A. Interface and coordinate the work of this Section with Section 20 70 26, Common Materials and Methods for Electrical Systems, Section 26 05 24, Low and Medium Voltage Wires and Cables, Section 20 50 13, Raceways for Facility Services, and Section 20 70 23, Electronic Circuits Wires and Cables.

1.03 MEASUREMENT AND PAYMENT

- A. General: Train control wires and cables, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump sum price for Automatic Train Control System Work as indicated in the Bid Schedule of the Bid Form.

1.04 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA):
 - 1. AREMA Signal Manual
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 2. ASTM B33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
 - 3. ASTM B172 Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

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

- C. California Code of Regulations (CCR):
 - 1. CCR Title 24, Part 3, California Electrical Code

- D. Insulated Cable Engineers Association, Inc. (ICEA):
 - 1. ICEA T-28-562 Test Method for Measurement of Hot Creep of Polymeric Insulations

- E. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA HP 100.2 High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers

 - 2. NEMA WC5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

 - 3. NEMA WC7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

 - 4. NEMA WC8 Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.05 SUBMITTALS

- A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

- B. Submittal Requirements: Before installation of wires and cables, submit the following information for each type and size of wire and cable.
 - 1. Manufacturer of wire and cable, and certificate of compliance;

 - 2. Number and size of strands composing each conductor;

 - 3. Conductor insulation composition type in accordance with California Electrical Code, and thickness in mils;

 - 4. Average overall diameter of finished wire and cable;

 - 5. Minimum insulation resistance in megohms per 1000 feet at 30 degrees C ambient;

 - 6. Jacket composition and thickness in mils;

 - 7. Total number of conductors per cable;

- 8. Shield material, if any, and thickness;
- 9. Conductor resistance and reactance in ohms per 1000 ft. at 25 degrees C ambient; and,
- 10. Conductor ampacity at 30 degrees C ambient.

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Conductors: Conductors shall be of soft or annealed copper and shall be coated with tin, lead, or lead-alloy in accordance with ASTM B33, or ASTM B189 unless otherwise indicated. Stranding of conductors shall conform to the following table unless otherwise indicated:

Exterior power cables, audio frequency track circuit cables, ac track circuit cables, speed command loop cables, switch-and-lock movement cables, wayside signal cables, wayside equipment ground cables, and ground drop lead cables.	ASTM B8, Class C
Crossbond cables, impedance bond or track shunt connections, propulsion bond cables, switch bond cables, and ground bus jumper cables.	ASTM B172, Class K

- B. Multi-conductor Cables: Assembly of multi-conductor cables shall conform to the AREMA Signal Manual, Part 10.3.13 and NEMA WC8 as applicable.
- C. Insulation: Insulation material for wire-wrap hook-up wire shall be Kapton. Insulation material for rack wires, rack-to-rack cables, chassis and signal ground drop lead cables, and interior power cables shall be ETFE conforming to NEMA HP 100.2. Insulation material for exterior power cables, crossbond cables, impedance bond cables, audio frequency track circuit cables, ac track circuit cables, speed command loop cables, switch-and-lock movement cables, switch-and-lock power cables, wayside signal cables, station-to-station cables, ground bus jumper cables, and signal bond cables, shall be either ethylene propylene rubber (EPR), or cross-linked polyethylene (XLPE), or other synthetic elastomer conforming to the requirements of Part 10.3.16 of the AREMA Signal Manual.
 - 1. Kapton Insulation Thickness: Insulation shall be 1 mil kapton tape with 1 mil teflon binder.
 - 2. EPR or XLPE Insulation Thickness: The thickness of insulation shall conform to Part 10.3.16 of the AREMA Signal Manual.
 - 3. Physical and Electrical Properties of EPR and XLPE insulated cables: The physical and electrical properties of EPR shall conform to Part 10.3.19 of the

AREMA Signal Manual. The physical and electrical properties of XLPE shall conform to Part 10.3.22 of the AREMA Signal Manual.

- D. Jacket: Jacket material for single or multi-conductor cables insulated with ETFE shall conform to these Specifications. Jacket material for cables insulated with EPR or XLPE shall be thermoset and low smoke, flame retardant, zero halogen material, meeting the specifications contained herein.

1. Jacket Thickness (ETFE): The average thickness of the jacket on multi-conductor cables jacketed with ETFE shall be not less than the values given in the following table. The minimum thickness shall not be less than 80 percent of the values given in the table.

Diameter of Cable Core (inches)	Jacket Thickness (inches)
Zero to 0.250	0.015
0.251 to 0.425	0.025
0.426 to 0.700	0.030
0.701 and larger	0.050

2. Jacket Thickness: The average thickness of the jacket (other than ETFE) on cables shall not be less than the values given in the following tables. The minimum thickness at any point shall not be less than 80 percent of the values given in the tables.

- a. Common overall jacket of multi-conductor cables:

Diameter of Cable Core (inches)	Jacket Thickness (inches)
Zero to 0.425	0.045
0.426 to 0.700	0.060
0.701 to 1.500	0.080
1.501 to 2.500	0.110
2.500 and larger	0.140

- b. Outer jacket of single conductor cables:

Conductor Size AWG/kcmil	Jacket Thickness (inches)
No. 16 to No. 2	0.050
No. 1 to 500 kcmil	0.065
500 kcmil to 1000 kcmil	0.080

3. Physical Properties (Other than ETFE): Jacket shall meet the following requirements:

Tensile strength, psi, minimum	1,500
Elongational at rupture, percent, minimum	150
After oven aging for 168 hours at 121 degrees C:	
Tensile strength, minimum percent of unaged value	85
Elongation at rupture, minimum percent of unaged value	60

Oil immersion, for 18 hours at 121 degrees C, ASTM No. 2 oil:	
Tensile strength, minimum percent of unaged value	60
Elongation at rupture, minimum percent of unaged value	60
Moisture absorption, gravimetric method mg/in., maximum,	
168 hours at 70 +/- 1 degrees C	35
Cold bend, 24 hours at minus 25 degrees C	No cracks

E. Hot Creep Elongation Test: Jacket material shall conform to ICEA T-28-562, modified as follows:

Temperature	200 degrees C
Maximum elongation at 29 psi stress, weight	25 percent
Maximum set	10 percent

F. Color Coding of Conductors. Color coding of conductors shall be in accordance with Section 26 05 24, Low and Medium Voltage Wires and Cables, and the following:

1. Multi-conductor Switch-and-Lock Movement Control and Indication Cables: Color sequence shall be in accordance with NEMA WC5, Appendix K, Method 3 or 4.
2. Two-Conductor Switch-and-Lock Movement: Color shall be black.

2.02 SPECIFIC REQUIREMENTS

- A. Intra-Cabinet Wires. Intra-cabinet wires used for signal circuits shall be stranded-conductor wire No. 16 AWG, minimum, and shall be rated at 600 volts. This wire shall be provided for crimped or soldered connections within the cabinets only.
- B. Inter-Cabinet Cables. Inter-cabinet cables shall be stranded, single or multi-conductor cable, No. 16 AWG, minimum, for single-conductor cable and size No. 20 AWG, minimum, for multi-conductor cable and shall be rated at 600 volts for both signal and power circuits.
- C. Interior Power Cables. Interior power cables shall be stranded, single or multi-conductor cable, No.12 AWG minimum, and shall be rated at 600 volts. This cable shall be provided only for power circuits installed indoors.
- D. Exterior Power Cables. Exterior power cables shall be stranded, single or multi-conductor cable, No.12 AWG, minimum, and shall be rated at 1,000 volts. This cable shall be provided only for power circuits installed outdoors.
- E. Crossbond Cables. Crossbond cables shall be stranded class H, single-conductor cable, size 500 kcmil and shall be rated at 2000 volts DC.
- F. Impedance Bond Cables. Impedance bond cables shall be stranded class H, single-conductor cable, size 500 kcmil, and shall be rated at 2000 volts DC. This cable

shall be provided for connection between the impedance bond and the rail or between impedance bonds.

- G. Audio Frequency Track Circuit Cables. Audio frequency track circuit cables shall be stranded, twisted pair, No. 16 AWG minimum, and shall be rated at 1000 Volts. Cable may be shielded as required by the circuit design.
- H. AC Track Circuit Cables. AC track circuit cables shall be stranded, single or multi-conductor cable, No. 6 AWG minimum, and shall be rated at 1000 volts.
- I. Speed Command Loop Cables. Speed command loop cables shall be stranded, single conductor cable, No. 10 AWG minimum, and shall be rated at 1000 volts.
- J. Switch-and-Lock Movement Control Cables. Switch-and-lock movement control and indication circuit cables shall be stranded, multi-conductor cable, No. 14 AWG minimum, and shall be rated at 1000 volts.
- K. Switch-and-Lock Movement Power Cables. Switch-and-lock movement power cables shall be stranded, three-conductor cable, No. 6 AWG minimum, rated at 1000 volts.
- L. Wayside Signal Cables. Wayside signal cables shall be stranded, single- or multi-conductor cable, No. 14 AWG minimum, and shall be rated at 1000 volts.
- M. Signal Bond Cables. Signal bond cables shall be stranded, single conductor cable, No. 6 AWG minimum, and shall be rated at 1000 volts.
- N. Rail Head Bonds. Rail head bonds shall be C type, cadmium bronze, conforming to the AREMA Signal Manual, Part 8.1.30. Each wire making up the bond shall have a nominal diameter of 0.0125 inches. The finished cable shall have a nominal diameter equivalent to 250 kcmil.
- O. Chassis and Signal Ground Drop Lead Cables. Chassis and signal ground drop lead cables shall be stranded, single-conductor cable, size No. 6 AWG, and shall be rated at 1,000 volts.
- P. Wayside Equipment Ground Cables. Wayside equipment ground cables shall be stranded, single-conductor cable, size No. 6 AWG minimum, and shall be rated at 1,000 volts.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Coordinate installation of train control wires and cables with the requirements of Section 20 70 26, Common Materials and Methods for Electrical Systems, Section 20 50 13, Raceways for Facility Services, Section 26 05 24, Low and Medium Voltage Wires and Cables, Section 20 70 13, Common Materials and Methods for Electronic Services, and Section 20 70 23, Electronic Circuits Wires and Cables.

3.02 IDENTIFICATION

- A. Identification of wires and cables shall be in accordance with Section 26 05 24, Low and Medium Voltage Wires and Cables, and Section 20 70 23, Electronic Circuits Wires and Cables.

3.03 TESTING

- A. General: Testing shall be in accordance with Section 01 45 24, Testing Program Requirements.
- B. Testing: Physical and electrical properties of ETFE shall be tested in accordance with NEMA HP 100.2. Physical and electrical properties of EPR shall be tested in accordance with NEMA WC8 and Part 10.3.19 of the AREMA Signal Manual. Physical and electrical properties of XLPE shall be tested in accordance with NEMA WC7 and Part 10.3.22 of the AREMA Signal Manual.

END OF SECTION 34 42 16