

Section 16126

INSTRUMENTATION CABLE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Specifications for instrumentation cable.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM B3: Soft or Annealed Copper Wires.
 - 2. ASTM B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft.
 - 3. ASTM B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. Institute of Electrical and Electronics Engineers (IEEE), IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
- C. Insulated Cable Engineers Association (ICEA).
 - 1. ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).
 - 2. ICEA S-66-524: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-7).
 - 3. ICEA S-68-516: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8).
- D. Underwriters' Laboratories (UL).
 - 1. UL 44: Rubber Insulated Wires and Cables.
 - 2. UL 83: Thermoplastic Insulated Wire and Cables.

- E. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA No. 70 - National Electrical Code (NEC), Chapter No. 3 - Wiring Methods and Materials, Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits.

1.03 SUBMITTALS

- A. Submit the following under the provisions of Section 01330 – Submittal Procedures:

1. Completed engineer's data sheets from this specification or manufacturer's data sheets, cut sheets, and catalog data.
2. Installation, terminating and splicing procedure (including bending radius and pulling tension data).
3. Instruction for handling and storage.
4. Dimensions and weight.

1.04 QUALITY ASSURANCE

- A. Tests

Cable shall be tested at the factory to confirm that the cable complies with requirements of ICEA Section 7.7.9 of S-66-524 or 7.5.9 of S-68-516. Refer to data sheet for additional test requirements.

Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

1.05 DELIVERY, STORAGE AND HANDLING

Ship cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Alpha Wire Corporation

Belden Division, Cooper Industries, Inc.

Cablec Continental Cables Company

General Cable Company

Manhattan Electric Cable Corporation

Okonite Company

2.02 MATERIALS AND EQUIPMENT

- A. Design. Provide cable with the following design characteristics. The cable shall consist of multiple conductors. The cable assembly shall be UL listed, flame, oil and sunlight resistant, and certified for continuous operation at the temperature specified on the Instrumentation Cable Data Sheets in wet or dry locations while installed in underground duct, conduit, or cable tray. The number and size of conductors supplied in each cable shall correspond to the quantities specified on the Instrumentation Cable Data Sheets. Each conductor shall be individually insulated. Pairs and triads shall have conductors which are twisted together with a drain wire, shielded, and covered with a jacket. Multi-pair/triad cables shall consist of the required number of electrically isolated, shielded pairs or triads, which are bundled together and covered by an overall jacket as specified on the Instrumentation Cable Data Sheets.
- B. Conductors. Provide conductors which are Class B, concentric stranded, annealed tinned copper whose physical and electrical properties comply with ASTM B3, B8 or B33 and Part 2 of ICEA S-61-402, S-66-524, or S-68-516, unless otherwise specified on the Instrumentation Cable Data Sheets.
- C. Insulation. Each conductor shall be insulated as specified on the Instrumentation Cable Data Sheets in compliance the requirements of Part 3 of ICEA S-61-402, S-66-524, or S-68-516. The average insulation thickness shall not be less than the dimensions shown in Table 7-32 or 7.5.1 of ICEA S-66-524 or S-68-516 for 600-volt insulation unless otherwise specified on the Instrumentation Cable Data Sheets. The minimum insulation thickness shall not be less than 90 percent of the value given in the table.
- D. Drain Wire. Provide drain wire which is Class B, seven-stranded, tin-coated copper in accordance with ASTM B3, B8, or B33 and as specified on the Instrumentation Cable Data Sheets. The drain wire shall not be less than two AWG sizes smaller than the insulated conductor's size, except for multiple

- pair triad drain wires, which shall not be less than the insulated conductor size.
- E. Shielding. Provide shielding consisting of laminated, nonburning, mylar-backed aluminum tape applied helically around a twisted pair or triad with the aluminum side in continuous contact with the drain wire unless otherwise specified on the Instrumentation Cable Data Sheet. Wrap the tape around each twisted pair or triad with a 25 percent minimum overlap unless otherwise specified on the Instrumentation Cable Data Sheets.
 - F. Jacket. The physical and electrical properties of the jacket used to cover single or multi-pair or triad cables shall meet the requirements of section 7.7.7 or ICEA S-66-524 or section 7.5.6 of ICEA S-68-516. Jacket material is specified on the Instrumentation Cable Data Sheets. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516. The jacket material is specified on the Instrumentation Cable Data Sheets. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516.
 - G. Armor. Where requested, use instrumentation cables protected by an interlocked metal tape armor coating made of galvanized steel which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524, unless otherwise specified on the Instrumentation Cable Data Sheets.
 - H. Conductor Identification. Use individual conductors in single-pair and single-triad cables which are color coded black and white; and black, white and red, respectively. Multi-pair-triad cables shall have one conductor in each pair or triad colored white, and all other conductors are color coded in sequence according to Table L-2 of Appendix 2 of ICEA S-66-524, and as specified on the Instrumentation Cable Data Sheets.
 - I. Cable Marking. Print cable marking information on the jacket of each cable at 2-foot intervals. Use a permanent printing method with color sharply contrasting the jacket color. See the Instrumentation Cable Data Sheets for the minimum information required.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete cable raceway systems, underground duct banks and cable support systems before installing cables.
- B. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.

- C. Check the length of the cable raceway system against the length of cable on the selected reel.
- D. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 degrees F.
- E. Clean conduits of foreign matter before cables are pulled.
- F. Provide at least 30 percent spare conductors or pairs.

3.02 INSTALLATION

A. Cable in Conduit and Ductbank

- 1. Install cables in accordance with the manufacturer's instructions and NEC Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling and Power Limited Circuits. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.
- 2. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation or cable jacket.
- 3. Conduits carrying low level signal cables shall be PVC-coated rigid steel.

B. Cable in Tray. Install instrument and signal cable in cable tray only when the tray is dedicated for this type cable and cables are approved for tray installation.

C. Termination

- 1. Do not splice conductors. For termination use crimp-on type ring tongue non-insulated tin plated copper lugs.
- 2. For shielded control cable, terminate the shield and ground it at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables.
- 3. If splicing is required, maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.

4. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring tongue terminal has been installed. Extend the marker over the crimp or base of the terminal.

D. Tests

1. Before connecting the cables, test insulation integrity and conductor continuity.
2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.

- E. Termination. After the 600-volt cable has been tested with satisfactory results, the cable can be terminated at both ends to their designated terminal points.

END OF SECTION

DATA SHEET 1 of 4

IDENTIFICATION

1. _____
 2. CLIENT _____ MANUFACTURER _____
 3. PROJECT _____ MODEL NO. _____
 4. JOB NO. _____ SIZE _____
 5. PLANT/LOCATION _____ SERIAL NO. _____
 6. ITEM NO. _____ INQUIRY NO. _____
 7. SERVICE _____ P.O. NO. _____
 8. QUANTITY REQUIRED _____
 9. _____

NOTE: [] INDICATES INFORMATION TO BE COMPLETED BY MANUFACTURER

ENVIRONMENTAL CONDITIONS

13. TEMPERATURE RANGE: MAX _____ °C, MIN _____ °C
 14. INSTALLATION: _____ ENCLOSED _____ OUTDOORS _____ INDOORS _____
 15. _____ UNDERGROUND _____ UNDERWATER _____
 16. EXPOSURE: _____ MOISTURE _____ DIRT _____ OZONE _____
 17. _____ RADIATION _____ CHEMICALS:(PLEASE LIST) _____
 18. _____
 19. SOILS: (PLEASE LIST) _____ ELECTROSTATIC INTERFERENCE _____
 20. ELECTROMAGNETIC INTERFERENCE DISTURBANCES _____ RODENTS _____
 21. OTHER: _____
 22. _____
 23. _____

PHYSICAL REQUIREMENTS

26. FLEXIBILITY: _____ VERY FLEXIBLE _____ FLEXIBLE _____ NOT CRITICAL _____
 27. RESISTANCE TO: _____ ABRASION _____ IMPACT _____ CRUSH _____
 28. _____ DEFORMATION _____ CUT THROUGH, COLD FLOW _____
 29. TERMINATION METHOD: _____
 30. _____
 31. _____
 32. STRIPPABILITY: _____ MANUAL _____
 33. _____ AUTOMATIC EQUIPMENT TYPE _____
 34. _____

ELECTRICAL REQUIREMENTS

36. _____ FREQUENCY (HZ) _____ CROSS TALK (ISOLATION IN DB AT FREQ) _____
 37. _____ CURRENT (MILLIAMPERE) _____ DC RESISTANCE (OHMS/1000 FT) _____
 38. _____ CAPACITANCE (PF) _____ VOLTAGE BREAKDOWN (VOLTS/MILL) _____
 39. _____ ATTENUATION (DB/100 FT) _____ INSULATION RESISTANCE (MEGOHMS/1000 FT) _____
 40. ADDITIONAL REQUIREMENTS: _____
 41. _____
 42. _____
 43. _____
 44. _____
 45. _____
 46. _____
 47. _____
 48. _____
 49. _____
 50. _____

ITEM NO. _____

DATA SHEET 2 of 4

1. **CONSTRUCTION**
2. **CONDUCTORS**

3. SIZE (AWG): _____
 4. _____ COPPER _____ STEEL _____ TINNED
 5. _____ BARE _____ SOLID _____ COPPER COATED
 6. _____ STRANDED _____ SILVER COATED
 7. NUMBER OF CONDUCTORS: _____ NUMBER OF PAIRS _____
 8. _____ NUMBER OF TRIADS _____
 9. ADDITIONAL REQUIREMENTS: _____
 10. _____

11. **INSULATION**

12. RUBBER: _____ SBR _____ NATURAL _____ SYNTHETIC _____ BUTYL POLYBUTADIENE
 13. _____ NEOPRENE _____ NBR _____ EPDM/EPR
 14. _____ CHLOROSULFONATED POLYETHYLENE _____ SILICONE
 15. PLASTIC: _____ PVC _____ LOW-DENSITY POLYETHYLENE _____ CELLULAR POLYETHYLENE _____
 16. _____ TEFLON _____
 17. _____ HIGH-DENSITY POLYETHYLENE _____ POLYPROPYLENE _____ POLYURETHANE
 18. _____ NYLON _____ OTHER: _____
 19. VOLTAGE RATING: _____ AC _____ DC _____ WALL THICKNESS _____
 20. LAY LENGTH PER INCH OF PAIRS: _____ LAY _____ TWIST _____
 21. DRAIN WIRE: _____ SIZE _____ STRANDED _____ SOLID _____ BARE COPPER _____ TIN-COATED COPPER
 22. COLOR _____
 23. TEMPERATURE RATING: _____ 60° - 75°C (WET-DRY) _____ 75°C - 90°C (WET-DRY)
 24. _____ 90°C (WET-DRY) _____ OTHER: _____
 25. SPECIAL REQUIREMENTS: _____
 26. _____

27. **SHIELDING**

28. TYPE SHIELDING: _____ BRAIDED _____ CONDUCTIVE PLASTIC
 29. _____ CONDUCTIVE COTTON _____ SPIRAL-SERVED
 30. _____ MYLAR FILM-ALUMINUM FOIL _____ POLYESTER FILM-ALUMINUM FOIL
 31. _____ OTHER: _____
 32. _____
 33. POLYESTER FILM-ALUMINUM LOCATION: _____ INSIDE _____ OUTSIDE _____ PAIR SHIELD ISOLATED
 34. _____ SEPARATOR _____ FILTER
 35. _____

36. **SHIELD COMBINATION**

37. OVERSHIELD: _____ POLYESTER FILM-ALUMINUM _____ BRAID _____ SERVED
 38. _____ OTHER: _____
 39. BRAID SHIELD: _____ TYPE STRANDS _____ % COVERAGE _____ TINNED
 40. _____ BARE _____ COPPER _____ ALUMINUM
 41. OVERALL TYPE: _____ POLYESTER _____ PAPER _____ OTHER: _____
 42. _____

44. **JACKET**

45. TYPE: _____ POLYVINYL CHLORIDE _____ POLYETHYLENE
 46. _____ HEAVY DUTY NEOPRENE _____ CHLOROSULFONATED POLYETHYLENE
 47. _____ NYLON _____ OTHER: _____
 48. _____
 49. _____
 50. _____

ITEM NO. _____

DATA SHEET 3 of 4

JACKET (Cont)

1. _____
 2. THICKNESS (MILS OR MM) _____
 3. COLOR: _____ BLACK _____ OTHER: _____
 4. SPECIAL REQUIREMENTS: _____
 5. _____
 6. _____

ARMORING

7. _____
 8. TYPE: _____ INTERLOCKED (POSITIVE) OTHER: _____
 9. MATERIAL: _____ GALVANIZED STEEL _____ ALUMINUM _____
 10. _____ OTHER: _____
 11. COVERING: _____ POLYVINYL CHLORIDE _____ OTHER: _____
 12. COLOR: _____ BLACK _____ OTHER: _____
 13. SPECIAL REQUIREMENTS: _____
 14. _____
 15. _____

MARKING

CONDUCTOR IDENTIFICATION

16. _____
 17. _____
 18. SINGLE-CONDUCTOR: _____
 19. MULTI-CONDUCTOR: _____
 20. _____

CABLE MARKING

21. _____
 22. REQUIRED: _____ MANUFACTURER _____ CONDUCTOR SIZE
 23. _____ NO. OF CONDUCTORS _____ VOLTAGE RATING
 24. _____ UL LABEL _____ NEC TYPE
 25. _____ TEMPERATURE RATING _____ MONTH/YEAR OF MANUFACTURE
 26. _____ OTHER: _____
 27. _____

FACTORY TESTING/DOCUMENTATION

28. _____
 29. _____ PHYSICAL _____ FLAME TESTS (SPECIFY STANDARDS) _____
 30. _____
 31. _____ ELECTRICAL _____ OTHER TESTS: _____
 32. _____ MEGGER _____
 33. _____ OTHER: _____
 34. _____
 35. _____
 36. _____

QUALITY ASSURANCE

37. _____
 38. _____ NO ADDITIONAL REQUIREMENTS _____ ATTACHED SPECIFICATION _____
 39. _____

PACKAGING

40. _____
 41. _____ DOMESTIC _____ EXPORT _____
 42. _____

SHIPPING

43. _____
 44. REEL TYPE: _____ RETURNABLE _____ NON-RETURNABLE _____ LENGTH PER REEL _____
 45. ADDITIONAL REQUIREMENTS: _____
 46. _____
 47. _____
 48. _____
 49. _____
 50. _____

ITEM NO. _____

DATA SHEET 4 of 4

- 1. **MANUFACTURER DATA**
- 2. CABLE DIMENSION (O.D. IN.) _____ SHIPPING TIME _____
- 3. CABLE CROSS-SECTIONAL AREA _____ OTHER _____
- 4. CABLE WEIGHT (LBS/FT) _____
- 5. CABLE MIN BENDING RADIUS _____
- 6. TENSILE STRENGTH _____
- 7. GROSS WEIGHT/REEL (LBS) _____
- 8. TOTAL CUBIC FEET/REEL _____
- 9. SHORT CIRCUIT WITHSTAND CURVES _____
- 10. CABLE TESTING REQUIREMENTS _____

- 11. _____
- 12. **NOTES**
- 13. _____
- 14. _____
- 15. _____
- 16. _____
- 17. _____
- 18. _____
- 19. _____
- 20. _____
- 21. _____
- 22. _____
- 23. _____
- 24. _____
- 25. _____
- 26. _____
- 27. _____
- 28. _____
- 29. _____
- 30. _____
- 31. _____
- 32. _____
- 33. _____
- 34. _____
- 35. _____
- 36. _____
- 37. _____
- 38. _____
- 39. _____
- 40. _____
- 41. _____
- 42. _____
- 43. _____
- 44. _____
- 45. _____
- 46. _____
- 47. _____
- 48. _____
- 49. _____
- 50. _____

ITEM NO. _____

THE FOLLOWING ITEMS SHOULD BE CHECKED FOR COORDINATION DURING DESIGN:

- A. Coordinate this specification with other specifications including the following related Sections.

- Section 16111 - Conduit
- Section 16122 - 600-Volt Power Cable
- Section 16125 - Thermocouple Extension Cable
- Section 16131 - Device, Pull and Junction Boxes
- Section 16195 - Electrical Identification
- Section 16402 - Underground Duct Banks
