

**SECTION 26 05 13  
MEDIUM-VOLTAGE CABLES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of the high voltage cables.

**1.2 RELATED WORK**

- A. General electrical requirement and items that are common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Conduits for high voltage cables: Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- C. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

**1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include splice and termination kit information prior to purchase and installation.
  - 3. Provide cable minimum bend radius, and flammability data.
- B. Certifications:
  - 1. Factory test reports: Prior to installation of the cables, deliver four copies of the manufacturers certified NEMA WC 71 or WC 74, standard factory test reports to the Project Engineer. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.
  - 2. Field Test Reports: Test Reports on the following shall be in accordance with the paragraph entitled "Field Tests for High Voltage Cables" and include the following tests:
    - a. High Potential Tests
    - b. Dielectric Absorption Tests
    - c. Radiographic Tests

After testing, submit four certified copies of each of the graphs specified under field testing, to the Project Engineer. Adequate information shall be included identifying the cable locations, types, voltage rating and sizes.

3. Terminations, after having been installed and tested, deliver four copies of a certificate by the Contractor to the Project Engineer which includes the following:
  - a. A statement that the materials, detail drawings and printed instructions used, are those contained in the kits approved for this contract.
  - b. A statement that each termination was completely installed without any overnight interruption.
  - c. A statement that field made terminations conform to the following requirements:
    - 1) Pencil the cable insulation precisely.
    - 2) Connector installations:
      - a) Use tools that are designed for the connectors being installed.
      - b) Round and smooth the installed connectors to minimize localized voltage stressing of the insulating materials.
    - 3) Remove contaminants from all surfaces within the splices and terminations before installing the insulating materials.
    - 4) Solder block throughout stranded grounding wires that will penetrate the splicing and terminating materials.
    - 5) Use mirrors to observe the installation of materials on the backsides of the splices and terminations.
    - 6) Eliminate air voids throughout the splices and terminations.
    - 7) Stretch each layer of tape properly during installation.
  - d. List all of the materials purchased and installed for the splices and terminations for this contract including the material descriptions, manufacturer's names, catalog numbers and total quantities.
- C. Installer Approval:
  1. Employees who install the splices and terminations and test the cables shall have not less than five years of experience splicing

and terminating cables which are equal to those being spliced and terminated, including experience with the materials in the kits.

2. Furnish satisfactory proof of such experience for each employee who terminates the cables.

D. Cable Voltage Ratings

1. Medium voltage power cables shall include multiple and single-conductor cable rated as follows:
  - a) 15,000 V cable shall be used on all distribution systems with voltages ranging from 4,800 V to 15,000 V.

E. Shipment:

1. Cable shall be shipped on reels such that cable will be protected from mechanical injury. Each end of each length of cable shall be hermetically sealed and securely attached to the reel.

**1.4 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the designation only:

1. American Society for Testing and Materials (ASTM):

B3-2001.....Standard Specification for Soft or Annealed  
Copper Wire

- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

386-95 (R2001).....Separable Insulated Connector Systems for Power  
Distribution Systems above 600 V

400.2-2005.....Guide for Field Testing of Shielded Power Cable  
Systems

404-2000.....Extruded and Laminated Dielectric Shielded  
Cable Joints Rated 2500-500,000 Volts

- C. National Electrical Manufacturers Association (NEMA):

WC 74-2000.....5-46 KV Shielded Power Cable for Use in the  
Transmission and Distribution of Electrical  
Energy (ICEA S-93-969)

- D. National Fire Protection Association (NFPA):

70-2005.....National Electrical Code (NEC)

- E. Underwriters Laboratories (UL):

1072-2006 ..... Medium-Voltage Power Cables

**PART 2- PRODUCTS**

**2.1 MATERIAL HIGH VOLTAGE CABLE**

- A. High voltage cable shall be in accordance with the NEC and NEMA WC71, WC74 and UL 1072.
- B. Shall be single conductor stranded copper conforming to ASTM B3.
- C. Insulation:
  - 1. Insulation level shall be 133 percent.
  - 2. Types of insulation:
    - a. Cable type abbreviation, EPR: Ethylene propylene rubber insulation shall be thermosetting, light and heat stabilized.
- D. Conductors and insulation shall be wrapped separately with semiconducting tape.
- E. Heavy duty, overall protective jackets of chlorosulphonated polyethylene, neoprene or polyvinyl chloride shall enclose every cable.
- F. Cable temperature ratings for continuous operation, emergency overload operation and short circuit operation shall be not less than the NEC, NEMA WC71 or NEMA WC74 Standard for the respective cable.
- G. Manufacturer's name and other pertinent information shall be marked or molded clearly on the overall outside surface of the jackets, or incorporated on marker tapes within the cables at reasonable intervals.

**2.2 MATERIAL AND TERMINATIONS**

- A. The materials shall be compatible with the conductors, insulations and protective jackets on the cables and wires.
- B. Terminating Fittings: Shall be in accordance with IEEE 386, 404.
  - 1. Shall be heavy duty, pressure type fittings, which will assure satisfactory performance of the connections under conditions of temperature cycling and magnetic forces from available short circuit currents.
  - 2. The fittings shall be suitably designed and the proper size for the cables and wires being terminated. Terminations to bus shall be with two hole lugs.
  - 3. Where the Government determines that unsatisfactory fittings have been installed, contractor shall replace the unsatisfactory installations with approved fittings at no additional cost to the Government.

C. Terminating Kits:

1. General:

- a. Shall be assembled by the manufacturer or supplier of the materials and shall be packaged for individual terminations or for groups of terminations.
  - b. Shall consist of materials designed for the cables being terminated and shall be suitable for the prevailing environmental conditions.
  - c. Shall include detail drawings and printed instructions for each type of termination being installed, as prepared by the manufacturers of the materials in the kits.
  - d. Detail drawings, and printed instructions shall indicate the cable type, voltage rating, manufacturer's name and catalog numbers for the materials indicated.
  - e. Voltage ratings for the terminations shall be not less than the voltage ratings for the cables on which they are being installed.
  - f. Shall include shielding and stress cone materials.
2. Taped terminations with insulating and semi-conducting rubber tapes shall withstand 200 percent elongation without cracking, rupturing or reducing their electric and self-bonding characteristics by more than 5 percent.

**2.3 SEPARABLE INSULATED CONNECTORS**

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture. Elbow connectors shall be 25KV class with voltage rating of 25kV RMS phase-to-phase and 15KV RMS phase-to-ground. For terminating cables at 4.16KV voltage level, the connectors shall be rated 15KV RMS phase-to-phase. Connectors ampacity shall be 200 amps if used on cables rated 2/0 AWG.
- B. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- C. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting;

coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

#### **2.4 ARC-PROFFING MATERIALS**

- A. Arc-Proofing Tape: Fireproof tape, flexible, conformable, in tumescent to 0.3 inch thick, compatible with cable jacket.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION, HIGH VOLTAGE CABLE**

- A. Installation shall be in accordance with the NEC, and as shown on the drawings.
- B. Contractor shall ensure that radii of bends fittings, cable risers, and other conditions are suitable for the cable and conform with the recommendations of the cable manufacturer.
- C. Cable shall be installed in underground conduit.
- D. Use suitable lubricating compounds on the cables and wires to prevent damage to them during pulling-in. Provide compounds that are not injurious to the cable and wire jackets and do not harden or become adhesive.
- E. In underground raceways and other outdoors locations:
  - 1. Seal the cable ends prior to pulling them in to prevent the entry of moisture.
  - 2. For ethylene propylene rubber and polyethylene insulated cables, use bags of epoxy resin that are not less than 6 mm (1/4 inch) larger in diameter than the overall diameter of the cable. Clean each end of each cable before installing the epoxy resin over it.

#### **3.2 PULLING CABLES IN DUCTS, MANHOLES AND UTILITY TUNNELS**

- A. Medium-voltage cables shall be pulled into ducts and utility tunnels with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.
- B. Cable reel shall be set up at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member.

- C. Pulling force for a cable grip on lead-sheathed cable shall not exceed manufacturer's recommendation. A dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded. Pulling force for a nonmetallic-sheathed cable shall not exceed the smaller of 4400 Newton (1,000 pounds) or a value computed from the following equation:

$$TM = 0.008 \times N \times CM$$

Where: TM = maximum allowable pulling tension in Newton pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in square millimeter circular mils.

- D. Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a //pulling eye// suitable cable grip permitted only on cables less than 60 mm (200-feet) long and less than 50 mm (2 inches) in diameter//.
- E. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.
- F. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.
- G. Pulling eyes and cable grips shall be used together for nonmetallic sheathed cables to prevent damage to the cable structure.
- H. Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall be used only on lead-sheathed cables. Nonmetallic sheathed cables shall be covered with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.
- I. Cables shall be pulled into ducts at a reasonable speed not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

- J. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture. Nonleaded cables shall be sealed with rubber tape wrapped down to 75 mm (3 inches) from the cable end. Rubber tape shall be cover-wrapped with polyvinylchloride tape. Lead-Covered cables shall be sealed with wiping metal making a firm bond with the end of the sheath or with a disk of lead fitted over the end and wiped to the sheath.

### **3.3 INSTALLATION AND TERMINATIONS**

- A. Install the materials as recommended by their manufacturer including special precautions pertaining to air temperature during installation.
- B. Cross-Linked Polyethylene (XLPE), Ethylene Propylene Rubber and Polyethylene Insulated Cables:
1. Cables rated 5000 volts or less: Install epoxy resin splices and terminations, or pre-molded rubber splices and terminations.
  2. Cables rated more than 5000 volts: Install taped splices and terminations, or pre-molded rubber splices and terminations.
- C. Installation shall be accomplished by qualified personnel trained to accomplish high voltage equipment installations. All instructions of the manufacturer shall be followed in detail.

### **3.4 INSTALLATION, FIREPROOFING**

- A. Cover all power cables located in manholes, handholes and junction boxes with arc proof and fireproof tape.
- B. Apply the tape in a single layer, one-half lapped or as recommended by the manufacturer. Install the tape with the coated side towards the cable and extend it not less than 25 mm (one inch) into each duct.
- C. Secure the tape in place by a random wrap of glass cloth tape.

### **3.5 FIELD TESTS FOR HIGH VOLTAGE CABLE**

- A. New Cable:
1. Acceptance tests shall be performed on new and service aged PE XLPE, PVC and paper cables in accordance with IEEE 400.2 and as specified herein.
  2. Test new cable after installation, splices, and terminations have been made, but before connection to equipment and existing cable.
  3. Test equipment, labor and technical personnel shall be provided as necessary to perform the electrical acceptance tests. Arranges shall be made to have tests witnessed by the Project Engineer.



- B. Dielectric Absorption Test: Both new and service aged power cable shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed. Each cable shall be given a full dielectric - absorption test with a 5000v insulation resistance test set. Test shall be applied for a long enough time to charge the cable. Readings shall be recorded every 15 seconds during the first 3 minutes of test and at 1 minute intervals thereafter. Test shall continue until three equal readings 1 minute apart are obtained. Minimum readings shall be 200 megohms at an ambient temperature 20 degrees C (68 degrees F). Readings taken at other temperatures shall be corrected accordingly.
- C. High Potential Test: High potential test shall not be applied to the XLPE new or service aged cables. All other cables shall be subjected to the test but only upon successful dielectric absorption test.
1. Leakage current test shall be by high potential dc step voltage method.
  2. High potential test shall measure the leakage current from each conductor to the insulation shield. Use corona shields, guard rings, taping, mason jars, or plastic bags to prevent corona current from influencing the readings. Unprepared cable shield ends shall be trimmed back 25 mm (1 inch) or more for each 10 kV of test voltage. Upon the successful completion of the high potential test on new and service aged PE CCLP, PC PVC cables a second dielectric test will be run on the HV cable system to ensure the cables have not been damaged by the hi-pot test
- D. Safety Precautions:
1. Exercise suitable and adequate safety measures prior to, during, and after the high potential tests, including placing warning signs and preventing people and equipment from being exposed to the test voltages.
- E. Test Voltages:
1. New shielded EPR and CCLP cable dc test voltages shall be as follows:

Rated Circuit Voltage Phase-to-Phase Volt	Wire Size AWG or MCM	Test Voltage KV
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2001-5000	8-1000	25
5001-8000	6-1000	35
8001-15000	2-1000	65
15001-25001	1-1000	100
25001-28000	1-1000	-
28001-35000	1/0-1000	-

2. Existing cable of all types interconnected to a new cable shall be tested at 1.7 times the existing cable rated voltage (maintenance test).

**F. High Potential Test Method:**

1. Apply voltage in approximately 8 to 10 equal steps.
2. Raise the voltage slowly between steps.
3. At the end of each step, allow the charging currents to decay, and time the interval of decay.
4. Read the leakage current and plot a curve of leakage currents versus test voltage on graph paper as the test progresses. Read the leakage current at the same time interval for each voltage step.
5. Stop the test if leakage currents increase excessively or a "knee" appears in the curve before maximum test voltage is reached.
  - a. For new cable, repair or replace the cable and repeat the test.
  - b. For existing cable interconnected to new cable, notify the Project Engineer for further instructions.
6. Upon reaching maximum test voltage, hold the voltage for five minutes. Read the leakage current at 30 second intervals and plot a curve of leakage current versus time on the same graph paper as the step voltage curve. Stop the test if leakage current starts to rise, or decreases and again starts to rise. Leakage current should decrease and stabilize for good cable.
7. Terminate test and allow sufficient discharge time before testing the next conductor.

**G. Test Data:** Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

**H. Final Acceptance:** Final acceptance shall depend upon the satisfactory performance of the cable under test. No cable shall be energized until

recorded test data have been approved by the Project Engineer. Final test reports shall be provided to the Project Engineer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Report" Forward to the Project Engineer for inclusion in the Maintenance Database.

- I. The contractor shall furnish the instruments, materials and labor for these tests.

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