SECTION 26 05 13
MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of the medium voltage cables, splices, and terminations. Cables to be pulled without splices.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirement and items that are common to more than one section of Division 26.

B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for medium voltage cables.

D. Section 31 20 11, EARTH MOVING (SHORT FORM).

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Medium voltage cables shall be thoroughly tested at the factory per NEMA WC 74 to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include cables, splices, terminations, and fireproofing tape product and installation information.

C. Samples: After approval and prior to installation, furnish the COTR with a minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the reels from which the samples were taken. The sample shall contain the manufacturer’s markings, showing all cable jacket information.

D. 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 COTR . Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.
2. Compatibility: Provide certification from the cable manufacturer that the splices and terminations are approved for use with the cable.
3. Field Test Reports: Test reports shall be in accordance with the paragraph entitled “Acceptance Checks and Tests.” After testing, submit four certified copies of each of the graphs specified under field testing, to the COTR.
4. After splices and terminations have been installed and tested, deliver four copies of a certificate by the Contractor to the COTR 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 splice and each termination was completely installed in a single continuous work period by a single qualified worker without any overnight interruption.
   c. A statement that field made splices and 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.

E. 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.

1.6 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):

B3-01 (R2007).....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

400-01.....Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems

400.2-05.....Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

400.3-06.....Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment

404-00.....Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500-500,000 Volts

C. National Electrical Manufacturers Association (NEMA):

WC 71-99.....Standard for Non-Shielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electrical Energy (ICEA S-96-659)

WC 74-06.....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):

70-08.....National Electrical Code (NEC)

E. Underwriters Laboratories (UL):

1072-06 ..... Medium-Voltage Power Cables

1.7 SHIPMENT AND STORAGE

A. 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 with manufacturer’s end caps and securely attached to the reel.

B. Cable stored and/or cut onsite shall have the cables ends turned down, and sealed with cable manufacturer’s standard cable end seals, or field-installed heat-shrink cable end seals.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLE

A. Medium voltage cable shall be in accordance with the NEC and NEMA WC 71, WC 74 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.
   b. Cable type abbreviation, CCLP: Anti-Tree Polyethylene insulation shall be thermosetting, light and heat stabilized, chemically crosslinked.

D. Conductors and insulation shall be wrapped separately with semiconducting tape.

E. Insulation shall be wrapped with non-magnetic, metallic shielding tape helically applied over semi-conducting insulation shield.

F. Heavy duty, overall protective jacket of chlorosulphonated polyethylene or polyvinyl chloride shall enclose every cable.

G. Cable temperature ratings for continuous operation, emergency overload operation and short circuit operation shall be not less than the NEC, NEMA WC 71, or NEMA WC 74 standard for the respective cable.

H. Manufacturer's name, cable type and size, and other pertinent information shall be marked or molded clearly on the overall protective jacket.

2.2 TERMINATIONS (WHERE SHOWN ON DRAWINGS)

A. The materials shall be compatible with the cables. Cables to be pulled without splices.

B. Terminations:

1. General:

a. Shall consist of materials designed for the cables being terminated and shall be suitable for the prevailing environmental conditions.

b. 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. Kits to be proven industry standard.

2. Terminations:

a. Shall comply with IEEE 48. Include shield ground strap for shielded cable terminations.

b. Class 3 terminations for outdoor use: Kit with stress cone and compression-type connector for cable terminations between main service switchgear and switchgear 1A/1B.

c. Dead-break terminations for indoor and outdoor use: Elbow-type unit with test point and 600-A continuous-current rating. For all cable splices in manholes and terminations at pad mounted switches.

2.3 FIREPROOFING TAPE

Fireproofing tape shall be a flexible, non-corrosive, self-extinguishing, arcproof and fireproof intumescent elastomer. Securing tape shall be glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and per cable manufacturer’s instructions.

B. Cable shall be installed in conduit above grade and duct bank below grade.

C. Splice the cables only in manholes and accessible pullboxes only.

D. Ground shields in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

E. Cable maximum pull length, maximum pulling tension, and minimum bend radius shall conform with the recommendations of the cable manufacturer.

F. Use suitable lubricating compounds on the cables to prevent pulling damage. Provide compounds that are not injurious to the cable jacket and do not harden or become adhesive.

G. Seal the cable ends prior to pulling to prevent the entry of moisture or lubricant.

3.2 PROTECTION DURING SPLICING OPERATIONS

Blowers shall be provided to force fresh air into manholes where free movement or circulation of air is obstructed. Pumps shall be used to keep manholes dry during splicing operations. Under no conditions shall a splice or termination be made with the interior of a cable exposed to moisture. A manhole ring at least 150 mm (6 inches) above ground shall be used around the manhole entrance to keep surface water from entering the manhole. Unused ducts shall be plugged and water seepage through ducts in use shall be stopped before the splice is started.

3.3 PULLING CABLES IN DUCTS AND MANHOLES

A. Cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, pulling eyes, and lubricants. Clean ducts before pulling cables.

B. Cables shall be pulled into ducts at a reasonable speed not in excess of maximum permissible pulling tension specified by the cable manufacturer. 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.

C. Splices in manholes shall be firmly supported on cable racks. No splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing.

D. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

3.4 SPLICES AND TERMINATIONS

A. Install the materials as recommended by their manufacturer including special precautions pertaining to air temperature and humidity during installation.

B. Installation shall be accomplished by qualified personnel journeymen and crew trained and experienced (minimum of five years latest) to accomplish medium voltage equipment installations. All instructions of the manufacturer shall be followed in detail.

C. Splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

D. Universal demountable terminations[GLHN1] shall be supported in such manner so as to minimize physical stress on the splice connections. Each cable end termination shall be supported using a pair of saddle type supports under the cable end termination and/or cable with a minimum 300 mm (12 inches) and a maximum 750 mm (30 inches) separation between the supports. Cable end termination and cable shall be secured to the supports in such a manner as to prevent movement of termination or cable at the support. Saddle type supports shall be installed on galvanized steel framing channel anchored to the wall or securely fastened to the cable tray or installed by other approved methods.

3.5 FIREPROOFING

A. Cover all cable segments exposed in manholes and pullboxes with fireproofing tape.

B. Apply the tape in a single layer, one-half lapped or as recommended by the manufacturer. Extend the tape not less than 25 mm (one inch) into each duct.

C. At each end of a taped cable section, secure the fireproof tape in place with glass cloth tape.

3.6 CIRCUIT IDENTIFICATION

In each manhole and pullbox, install permanent tags on each circuit's cables to clearly designate the circuit identification and voltage. Label where cable comes from and where cable goes to. Refer to drawing for cable labeling information. The tags shall be the embossed brass type, 40mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties. Position the tags so they will be easy to read after the fireproofing tape is installed.

3.7 ACCEPTANCE CHECKS AND TESTS

A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and electrical inspections.

B. Test equipment, labor and technical personnel shall be provided as necessary to perform the acceptance tests. Arrangements shall be made to have tests witnessed by the COTR.

C. Visual Inspection:
   1. Inspect exposed sections of cables for physical damage.
   2. Inspect shield grounding, cable supports, and terminations.
   3. Verify that visible cable bends meet manufacturer’s minimum published bending radius.
   4. Verify installation of fireproofing tape and identification tags.
   5. If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

D. Electrical Tests:
   1. Acceptance tests shall be performed on new and service-aged cables as specified herein.
   2. Test new cable after installation, splices, and terminations have been made, but before connection to equipment and existing cable unless otherwise directed for partial discharge testing.

E. New Cable:
   1. Acceptance tests shall be performed on new and service aged cables in accordance with IEEE 400.2 and as specified herein: Either high potential or partial discharge test as directed on the drawings.
   2. Test new cable after installation, splices, and terminations have been made. Hi-pot tests shall be made 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 Resident Engineer.

F. Service-Aged Cable Tests:
   1. Partial discharge tests or Hi-Potential tests (refer to test voltages for existing cables) shall be performed on service-aged cable.
   2. After new cable test and connection to an existing cable, test the interconnected cable. Disconnect cable from all equipment that might be damaged by the test.

G. Insulation-Resistance Test: Test all new and service-aged cables with respect to ground and adjacent conductors. Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, and leakage current readings versus time. Cable shall not be energized until insulation-resistance test results have been approved by the COTR. Test voltages and minimum acceptable resistance values shall be:

Voltage Class	Test Voltage	Min. Insulation Resistance
15kV	2,500 VDC	5,000 megohms

H. Online Partial Discharge Test: Comply with IEEE 400 and 400.3. Test all new and service-aged cables as indicated on the drawings. Perform tests after cables have passed the insulation-resistance test, and after successful energization.
   1. Testing shall use a time or frequency domain detection process incorporating radio frequency current transformer sensors, with a partial discharge detection range of 10khz to 300Mhz.
   2. A certified testing engineer shall evaluate the test results on site to the extent necessary to determine whether or not the cable is suitable to place into service. If not, then necessary replacements shall be made to make the cable service worthy before it is placed into service. Owner’s representative shall have on-site authority to approve/disapprove placing cable into service.
   3. Contractor to provide demonstration that shows compliance.

I. 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 Insulation Resistance 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 PVA cables a second dielectric test will be run on the HV cable system to ensure the cables have not been damaged by the hi-post test.

J. 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.

K. 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
2001-5000	8-1000	25
5001-8000	6-1000	35
8001-15000	2-1000	55
15001-25001	1-1000	100
25001-28000	1-1000	-
28001-35000	1/0-1000	-

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

L. 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 Resident 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.

M. 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.

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

O. Final Acceptance: Final acceptance shall depend upon the satisfactory performance of the cable under test. Provide a final comprehensive report that describes the cables tested, the test equipment used, and date tests were performed; identifies the persons who performed the tests; and identifies numerically and graphically the magnitude of partial discharge detected for each cable section tested. The report shall provide conclusions and recommendations for corrective action. Final test reports shall be provided to the COTR. Reports shall have a cover letter/sheet clearly marked with the system name, date, and the words “Final Test Report.”

4.0 OPERATION OF EQUIPMENT

The Contractor shall verify the existing phasing on all equipment being reconnected to new service or existing equipment prior to removing the equipment and shall connect the equipment back to match original phasing following completion of the installation of the new service.

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