

SECTION 260513 – MEDIUM VOLTAGE CONDUCTORS – 15 KV CLASS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Work under this section includes but is not limited to the following:
 - 1. Medium voltage power cables, splices and terminations – 15 KV Class.

1.2 RELATED WORK ELSEWHERE

- A. Underground Ductbank System: Refer to Section 260543.

1.3 APPLICABLE CODES AND STANDARDS:

- A. The following standards, in their most recent issue at time of project bidding date, shall apply to work specified in this section.
 - 1. Association of Edison Illuminating Companies (AEIC):
 - a. AEIC CS6 - Ethylene Propylene Rubber Insulated Shielded Power Cable Rated 5 through 69 KV
 - 2. American National Standards Institute (ANSI):
 - a. ANSI C2 - National Electrical Safety Code
 - 3. American Society for Testing and Materials (ASTM):
 - a. ASTM B 1 - Hard-Drawn Copper Wire
 - b. ASTM B8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 4. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE Std 48 - High-Voltage Alternating-Current Cable Terminations
 - b. IEEE Std 404 - Cable Joints for use with Extruded Dielectric Cable Rated 5000-138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500-500,000V.
 - 5. National Electrical Manufacturer's Association (NEMA):
 - a. NEMA WC 8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

6. International Electrical Testing Association (NETA):
 - a. NETA ATS - Electrical Power Distribution Equipment and Systems
7. National Fire Protection Association (NFPA):
 - a. NFPA 70 2008 National Electrical Code
 - b. NFPA 70B - Electrical Equipment Maintenance
8. Underwriters Laboratories (UL):
 - a. UL 83 - Thermoplastic-Insulated Wires and Cables
 - b. UL 467 - Grounding and Bonding Equipment
 - c. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - d. UL 510 - Chloride, Polyethylene, and Rubber Insulating Tape
 - e. UL 514B - Fittings for Cable and Conduit

1.4 DEFINITIONS:

- A. In the text of this section, “medium voltage cable splices,” and “medium voltage cable joints” are used interchangeably and have the same meaning.

1.5 SUBMITTALS:

- A. Product Data:
 1. Medium Voltage Cable
 2. Medium Voltage Cable Joints
 3. Medium Voltage Cable Terminations
 4. Medium Voltage Cable Manufacturer’s allowed maximum pull tension
 5. Acceptance Checks and Tests
- B. Identify each medium voltage cable tests. When testing grounding electrodes and systems, identify each electrode and system for each test, as well as the resistance and soil conditions at the time the measurement were made.
- C. Certificates:
 1. Cable Splicer/Terminator
 2. Cable Splicer Qualifications
- D. Thirty calendar days before making splices or terminations, submit names of the cable splicers to be employed, together with proof that splicer has at least 3 years experience in splicing the type and rating of cables specified. Submit certification for each splicer by the cable joint kit manufacturer in the use of manufacturer’s kits.

E. Manufacturer's Instructions:

1. Ground Megger
2. "UL Listed" Kit
3. Termination Kit
4. Medium-Voltage Joints

F. Manufacturer's Field Reports:

1. Arc-proofing test for cable fireproofing tape
2. Medium voltage cable tests
3. Factory engineered heat shrinkable joint kit.

1.6 QUALITY ASSURANCE:

A. Certificate of Competency for Cable Terminator

1. Certification of the qualification of the cable splicer/terminator shall be submitted, for approval, 30 days before splices or terminations are to be made in medium voltage (5 kV to 35 kV) cables. The certification shall include the training, and experience of the individual on the specific type and classification of cable to be provided under this contract. The certification shall indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. The certification shall also list a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Owner, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice/termination kit, and detailed manufacturer's instructions for the cable to be spliced. The Owner and the A/E reserve the right to require additional proof of competency or to reject the individual and call for certification of an alternate cable splicer.
2. Upon approval by the engineer in writing, the contractor may proceed with this portion of the work.

B. Test Instrument and Procedure:

1. Submit for use of ground megger with proposed method indicated.

C. Splice Manufacturer's Tests:

1. Submit the manufacturer's test report indicating that performance of the heat shrinkable joint kit is equivalent to the cable rating, in accordance with the applicable sections of IEEE Std 48, IEE Std 404, and AEIC CS1.

1.7 FACTORY TESTS:

- A. The cable shall be tested at the factory. The contractor shall be required to furnish a CERTIFIED MANUFACTURER'S TEST REPORT for the "Master Reel" of each cable length shipped, for approval by the engineer. The test report shall include:
 - 1. A high voltage test (A.C. and D.C.)
 - 2. Insulation resistance values.
 - 3. Corona test.
 - 4. Leakage current curves submitted for each minute up to 10 minutes at test voltage.
- B. The manufacturer's test report shall be sent to the A/E and to the Owner.

1.8 WARRANTY:

- A. The cable manufacturer shall warrant to the Owner each reel of cable to be free from defects in material, design and workmanship and will provide reliable performance for a twenty-five (25) year life from the date of project final acceptance.
- B. The warranty assumes the cable is installed, terminated and maintained in accordance with manufacturer's recommendations.
- C. Cable shop drawings shall include said described warranty from the cable manufacturer properly signed, and having the manufacturer's corporate seal affixed thereto.
- D. Defective cable shall be replaced at no cost to the Owner.
- E. When the manufacturer and the Owner mutually determine a portion of or all of the cable is defective, the cable manufacturer shall furnish replacement of said cable without charge.
- F. The replacement cable shall comply with these requirements and be delivered to the original delivery point free of any charge to the Owner or the State of North Carolina.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLE CONSTRUCTION:

- A. Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length.
- B. Conductors shall be soft drawn, Type MV-105, Class "B", concentric compact or compressed, stranded copper, single conductor shielded cable. The shielding process shall be true triple extrusion (done simultaneously, in a common extrusion head which does not exposed the EPR insulation to the atmosphere). The cable shielding shall consist of the semi-conducting strand shield, the EPR insulation and semi-conducting insulation shield. Double extrusion process is also acceptable for the non-conducting cable shield and the insulation; the non-conducting cable

shield shall be continuously tested for 2kv DC test while the shield is over the conductor and prior to the insulation being applied. The EPR insulation and the insulation shield shall be of semi-conducting material.

- C. Cable shall be capable of operating at a normal continuous conductor temperature of 105 degrees C, an emergency overload conductor temperature of 130 degrees C, and a short circuit conductor temperature of 250 degrees C.
- D. Insulation shall be a discharge resistant, ethylene-propylene rubber (EPR).
- E. Cable shall be shielded with 5 mil metallic uncoated copper tape helically applied with 25% nominal overlap.
- F. The EPR insulation shall be compounded by the manufacturer in its own facility (in-house) using a closed system to insure maximum cleanliness.
- G. The overall jacket or sheath shall be oil, acid, alkali, and sunlight-resistant PVC compound which shall be rated for use in conduit or aerial construction. Cable identification shall be printed on this jacket using indelible ink. The cable identification shall indicate “the manufacturer, the plant number, cable size, the year of manufacture, insulation thickness, insulation type, voltage rating, KV% insulation level and sequential footage number.”
- H. Primary cable ratings: The primary cable ratings shall be 15,000 volts; nominal 220 mils thickness. Cable thickness shall meet or exceed AEIC and ICEA requirements and shall have 133% insulation. The cable shall be provided with 600 volts grounded neutral.
- I. Cable shall pass the flame test in accordance with the IEEE 1202, CSA FT4& ICEA T-29-250.
- J. The cable shall meet or exceed the following standards: ICEA S-93-639, NEMA WC 74, AEIC CS-8, ASTM B-496, UL-1072 (type MV-105) for all cables, IEEE 383 for cables 250KCM and larger.
- K. The Quality Assurance Program and the ISO certification shall be provided to State Construction Office upon request.
- L. The cable supplied must have been manufactured within 12 months prior to date of order placement.

2.2 MANUFACTURERS:

- A. Cable shall be manufactured by Kerite (Marmon Wire & Cable), Okonite, General Cable or an approved substitute by engineer, 10 days before bid date.

2.3 MEDIUM VOLTAGE CABLE TERMINATIONS:

- A. IEEE Std 48 Class. Provide terminations including stress control terminator, ground clamp, connectors, and lugs. Terminator shall be the product of one manufacturer, suitable for the type and materials of the cable terminated. Furnish components in the form of a "UL listed" kit, including complete instructions which shall be followed for assembly and installation. Provide terminator as specified herein for terminating single conductor, solid insulated, nonmetallic jacketed type cables for service voltage up to 35 KV indoor and outdoor. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.4 FIREPROOFING TAPE:

- A. Fireproofing tape shall be approximately 30 mils thick by 3 inches wide and shall consist of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. Tape shall be non-corrosive to cable sheath. Tape shall not give off a smoke when subjected to flame or support combustion. Tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.5 GROUNDING AND BONDING EQUIPMENT:

- A. UL 467. Ground rods shall be copper clad steel with diameter adequate to permit driving to full length of the rod, but not less than 3/4 inch in diameter and 10 feet long unless otherwise indicated.

2.6 CABLE TAGS:

- A. Provide for each cable phenolic or non-ferrous metallic embossed tags at each manhole, describing cable voltage, circuit number, origin and destination, as applicable. Circuit designation shall be as directed by Owner.

PART 3 - EXECUTION

3.1 REEL HANDLING AND STORAGE:

- A. The manufacturer shall ship all reels in an upright position on the flanges. The cable ends shall be sealed to prevent the entrance of moisture, gases or vapors into the cable. After the cutting of any length, the exposed ends of any remaining cable on the reel shall have heat shrinkable end caps applied to prevent the entrance of water or vapor. The manufacturer shall be responsible to indicate to any commercial carrier the requirements for shipping the reels of completed cable. The contractor shall be responsible for the acceptance inspection of the shipped cable reels and shall note any visible damage on arrival in any unacceptable orientation or condition and inform the carrier, distributor and manufacturer of such damage or unacceptable condition. Any movement or lifting of completed reels of cable shall be by the use of a bar inserted through the arbor hole in the cable reel and, as appropriate or necessary, use of a spreader bar to avoid damage to the reel flanges. No completed reel of cable shall be

lifted by any force on or connection directly to the reel drum. Completed reels of cable shall be covered with a suitable material to reduce the impact of weather, rain or sunlight on the cable. Reels under the covering should have adequate ventilation to prevent the formation of condensation.

3.2 CABLE IDENTIFICATION:

- A. Each reel shall have an identification tag by the manufacturer securely attached to each flange and shall contain the following manufacturer's name and location, cable trade name, conductors size and voltage rating, identification of insulation and jacket material, footage and UL label.

3.3 INSTALLATION:

- A. Installation shall conform to NFPA 70 and ANSI C2.
- B. Survey:
 - 1. Survey existing equipment and manholes to verify exact requirements of making new cable terminations and cable connections.
- C. Cutting Cable:
 - 1. Use heat shrink adhesive coated caps on cable ends or tape cable ends immediately after cutting to prevent moisture from entering the cable. Varnish the tape when cable is not expected to be connected for at least 72 hours.
- D. Cable Length:
 - 1. Determine cable lengths based on final ductbank routing and as required to compensate for grade slopes, plus specified slack in manholes and at end of runs. Refer to "Cable Pulling" paragraph for additional requirements.
- E. Bends:
 - 1. Bends in cables shall have an inner radius not less than those specified in NFPA 70 for the type of cable specified, but no less than 12 times the cable diameter.
- F. Horizontal Slack:
 - 1. Leave approximately 10 feet of horizontal slack in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is brought above ground, leave additional slack to make necessary connections. Provide not less than 6 feet of slack at each manhole.
- G. Cable End Seal:
 - 1. Ends of cable shall be taped immediately after cutting to prevent moisture from entering the cable. Where the cable is not expected to be connected for at least 72 hours, the tape shall also be varnished.

H. Cable Pulling:

1. Test duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape or wire shield shall have a bending radius not less than 12 times the overall diameter of the completed cable. Basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip plus an extra 5 feet of cable before splicing and terminating. The cut cable shall be kept at project site for verification by A/E through the cable installation acceptance process.

I. Cable Lubricants:

1. Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

J. Cable Pulling Tensions:

1. Tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer. Monitor and record pulling tension during cable installation to ensure maximum pulling tension is not exceeded. Supply signed and certified report to the A/E indicating the pull tensions used along with manufacturer's information about maximum allowable tension.

3.4 MEDIUM VOLTAGE CABLE TERMINATIONS:

- A. Provide terminating devices and materials to protect medium voltage cable terminations from accidental contact, deterioration of coverings, and moisture. Make terminations by using materials and methods specified herein and as designated by the written instruction of the cable manufacturer and termination kit manufacturer. Termination for high-voltage cables shall be rated, and be capable of withstanding test voltages, in accordance with IEEE Std 48. Terminations of single cables shall include the securing and sealing of the sheath and insulation of the cable conductors, stress relief and grounding of cable shields of shielded cable, and grounding of neutral conductors, metallic sheaths, and armor. Adequately support cables and cable terminations to avoid any excessive strain on the termination and the conductor connection.

3.5 CABLE SPLICES:

- A. 600A, 15KV, non-load break, shielded, submersible, separable cable splice system. Comply with ANSI/IEEE standard 386 and 404.
- B. Manufacturers:
 1. 3M Modular.
 2. Cooper Power Systems.
 3. Elastimold/Fisher Pierce

3.6 CABLE END CAPS:

- A. Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.7 FIELD QUALITY CONTROL:

- A. As an exception to requirements that may be stated elsewhere in the contract, notify the A/E 10 working days prior to each test. Furnish labor, equipment and incidentals required for testing, including electrical power required for the tests. Correct defects in the work provided by the Contractor and repeat tests until the work is in compliance with contract requirements.
- B. Performance of Acceptance Checks and Tests:
 - 1. Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS, and referenced ANSI standards. Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.
- C. Medium Voltage Cables
 - 1. Perform tests after installation of cable terminators and before terminating to equipment.
- D. Visual and Mechanical Inspection
 - 1. Inspect exposed cable sections for physical damage.
 - 2. Verify that cable is supplied and connected in accordance with contract plans and specifications.
 - 3. Inspect for proper shield grounding, cable support, and cable termination.
 - 4. Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.
 - 5. Inspect for proper fireproofing.
 - 6. Visually inspect jacket and insulation condition.
 - 7. Inspect for proper phase identification and arrangement.

3.8 ELECTRICAL TESTS

- A. Perform a shield continuity test and an insulation resistance test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified. Perform High-Potential Test ("Hi-POT") as specified here.
- B. HI-POT Tests
 - 1. After installation, but prior to energizing the system, the contractor shall also high-pot the system in accordance with the Design Engineer's specified testing procedure, as witnessed and "signed-off" by the design engineer. Copies of this test report shall be sent

to the Owner, to the Engineer, and to the State Construction Office (to the attention of the REVIEW SECTION). Refer to the accompanying form (Report of Primary Voltage Cable Testing) for required format.

- C. Perform a DC high-potential test on all cables. Adhere to precautions and limits as specified in the applicable NEMA/ICEA Standard for the specific cable. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. Field acceptance test voltage shall be as specified.
- D. Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.
- E. Record wet- and dry-bulb temperatures or relative humidity and temperature.
- F. Test each section of cable individually.
- G. Individually test each conductor with all other conductors grounded; Ground all shields.
- H. Terminations shall be properly corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.
- I. Ensure that the maximum test voltage does not exceed the limits for terminators specified in IEEE standard 48 or manufacturer's specifications.
- J. Apply the DC high-potential test in at least five equal increments until maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. Record DC leakage current at each step after a constant stabilization time consistent with system charging current.
- K. Raise the conductor to the specified maximum test voltage and hold for fifteen (15) minutes. Record readings of leakage current at 30 seconds and one minute and at one-minute intervals thereafter. Provide a graphic plot of readings with leakage current (X axis) versus voltage (Y axis) at each increment.
- L. Reduce the conductor test potential to zero and measure residual voltage at discrete intervals.
- M. Apply grounds for a time period adequate to drain all insulation stored charge.

END OF SECTION 260513

