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115kV Concentric Neutral Wire Shield Underground Cable and Accessories			
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Version History

Version	Date	Revision Comments
00	3/30/2022	First issue
01	5/09/2022	Revised per SME comments.
02	7/05/2022	Added cross bonding link boxes (Section 20).
03	8/09/2022	Original specification was divided into two separate cable specs by shield type. Also added Section 21.

1.0 INTRODUCTION

1.1. This specification covers LUMA Energy's (LUMA) minimum requirements for the design and manufacture of 115kV Concentric Neutral Wire Shield Underground Cable and Accessories (joints, terminations, and link boxes). The following standards and guides are made part of this specification, and the cable, joint, termination and link box design and manufacturing shall comply with these standards, except where specifically noted:

- AEIC CS7-93, Specifications for Crosslinked Polyethylene Insulated Shielded Power Cables Rated 69 through 138kV
- AEIC CS9-2015, Specification for Extruded Insulation Power Cables and their Accessories Rated Above 46kV Through 345kV AC
- ICEA T-25-425, Guide for Establishing Stability of Volume Resistivity for Semiconducting Polymeric Components of Power Cables, 2015 Edition
- ICEA S-108-720, Extruded Insulation Power Cables Rated above 46kV through 500kV, 2018 Edition
- ICEA P-45-482, Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cable, 2017 Edition
- IEEE 48-2020, Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
- ASTM B3-13(2018), Standard Specification for Soft or Annealed Copper Wire
- ASTM B8-11(2017), Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft

1.2. If there are any conflicting requirements between the referenced standards and guides, or between this specification and the referenced standards and guides, the requirements of this specification shall prevail.

1.3. The product or material described in this specification requires qualification before supply and delivery can be made to LUMA.

1.4. The following environmental and physical data shall be used in the design of the cable, joints, terminations, and link boxes:

- Average Air Temperature: 88°F (31°C)
- Maximum Air Temperature: 100°F (38°C)
- Seismic Zone Level: 3
- Humidity: 90%
- Minimum cable laying depth 4 feet (48 inches) below ground level
- Duct bank configuration Vertical, single cable per conduit

1.5. Final cable, joint, termination and link box design shall be approved by LUMA before the start of manufacturing.

2.0 CABLE DESCRIPTION

2.1. The specified cable shall be a segmental copper conductor, extruded semi-conducting thermosetting conductor shield, super-clean unfilled cross-linked polyethylene insulation, extruded semiconducting thermosetting insulation shield, metallic sheath with longitudinal water blocking, insulating jacketed power cable for use on a three-phase, 60 Hz, single circuit per phase, underground power transmission system. The cable system will be single point grounded or cross bonded when installed and will have link boxes and removable links that shall permit testing of the cable jacket when necessary.

3.0 OPERATING TEMPERATURES

3.1. Cable shall be suitable for operation continuously in both wet and dry locations at a conductor temperature of 90°C. Under short circuit conditions, conductor temperature shall not exceed 250°C.

4.0 CONDUCTOR

4.1. Cable conductor shall be 2750 kcmil (1394 mm^2), Class B stranding, segmented annealed copper in accordance with AEIC CS7-93, ASTM B3-13, and ASTM B8-11.

4.2. The cable manufacturer shall provide a system to prevent the protrusion of the conductor shield screen compound between the conductor wires.

5.0 CONDUCTOR SHIELD

5.1. The conductor shield shall consist of a black, extruded, semi-conducting, thermosetting compound, with a volume resistivity in accordance with AEIC CS7-93, applied over the conductor. This material shall be compatible with the conductor metal, free stripping from the stranded conductor, and shall be uniformly and firmly bounded to the overlying insulation. Application of the conductor screen shall be part of a true triple head extrusion process. The thermal characteristics of the compound shall be equal to or better than those of the insulation. The thickness of the extruded conductor shield shall be in accordance with AEIC CS7-93.

6.0 INSULATION

6.1. The insulation shall be high quality cross-linked polyethylene, unfilled and of a super-clean grade. The insulation shall meet the requirements of AEIC CS7-93.

6.2. The insulation and shielding layers shall be extruded in a true triple head extrusion with an extrusion mesh filter of less than 5 mils. The process shall use completely dry curing and preferably dry cooling in a single pass through the extrusion line. If wet cooling is used, a certified test shall be provided to prove that the cable has less than 100 ppm of water.

6.3. The minimum average thickness of the insulation shall be 0.700 inches (700 mils). The minimum thickness at any point shall not be less than 90% of this value.

7.0 INSULATION SHIELD

7.1. The insulation shield shall consist of an extruded, semi-conducting thermosetting compound applied over the insulation. The thermosetting material shall be compatible with the insulation and the overlying metallic sheath. The thermal characteristics of the compound shall be equal to or better than those of the insulation.

7.2. The thickness of the extruded insulation shield shall be 0.035 inches (35 mils) minimum point insulation shield thickness, with a volume resistivity no greater than 500 ohm-cm at 90°C, in accordance with AEIC CS7-93.

8.0 WATER SWELLABLE TAPE

8.1. A suitable water swellable tape shall be applied over the insulation shield to prevent longitudinal water penetration if the cable is damaged. In the case of a metallic sheath that includes copper concentric neutral wires, a semi-conductive bedding tape shall be applied over the insulation shield.

9.0 METALLIC SHEATH (RADIAL MOISTURE BARRIER)

9.1. The metallic sheath shall provide a watertight seal against moisture or water ingress of any kind, including salt water or brine. A longitudinally overlapped, laminated copper foil/polymer film moisture barrier is acceptable, provided that the following conditions are met:

- The minimum thickness of the copper foil is 5 mils.
- The longitudinal overlap of the copper foil is sealed with an adhesive that is water impervious for temperatures ranging from 0°C to the emergency operating temperature of the cable, minus 15°C.
- The overlap of the copper foil at the longitudinal seam is at least 600 mils.
- The copper foil is intimately bonded to the polyethylene jacket.

9.2. Copper concentric wires are provided between the copper foil and the cable core that are designed to carry 55kA symmetrical fault current magnitude for 30 cycles at 60 Hz.

10.0 INSULATING JACKET

10.1. Anticorrosion oversheath (jacket) shall be composed of black linear insulating low or medium density polyethylene and shall be extruded over the metallic sheath. The minimum average jacket thickness over the sheath shall be 0.150 inches (150 mils).

11.0 SEMICONDUCTING JACKET COATING

11.1. The insulation jacket shall have one of the following coatings applied to facilitate jacket integrity testing, as part of the factory acceptance and pre-commissioning testing:

- Semiconductive extrusion with a volume resistivity of no greater than 1000 ohm-cm at 25°C that is intimately bonded to the underlying polyethylene jacket, or
- Graphite coating

12.0 EXTRUSION PROCESS

12.1. The extrusion process for the semi-conductive shields and the insulation shall be applied simultaneously using a true triple extrusion head.

13.0 CABLE JACKET MARKINGS

13.1. The cable jacket shall be durably and permanently marked, at intervals not exceeding three feet in length, with the following minimum information:

- Manufacturer Name
- Type of Insulation: XLPE
- Conductor Size: 2750 KCMIL
- Conductor Material: COPPER
- Rated Voltage: 115 000 VOLTS
- Year of Manufacture
- Cable Owner’s Name
- Insulation Thickness
- Country of Manufacture
- Footage Markers. Marks shall begin from the inside to the outside of the drum.

13.2. If the cable markings consist of raised lettering in the jacket material, in no case shall the jacket thickness be reduced below the specified minimum average thickness.

13.3. If an extruded semi-conductive jacket is applied for insulating jacket testing, the above marking shall be made in the semi-conductive jacket. If a graphite coating is used for testing, the above marking shall be applied in the insulating jacket.

14.0 CABLE QUANTITY PER REEL

14.1. Two thousand five hundred linear feet of cable per reel, shipped in steel reels. Cables shall have end caps installed on both ends of the cable for protection against water ingress during storage. Cable shall be completely degassed in the factory prior to installing the final end caps for shipment.

15.0 OPERATING CONDITIONS

15.1. The cables shall be designed to operate continuously during the required design life under the following electrical constraints:

- Rated Nominal System Voltage, Line-to-Line 115 kV
- Maximum Continuous System Voltage 123 kV
- Lightning Impulse Withstand Voltage 550 kV

16.0 TESTING REQUIREMENTS

16.1. Qualification tests shall be performed per ICEA S-108-720 and shall include the following:

- Cable bending procedure
- Thermal cycling procedure
- Hot impulse test
- AC voltage withstand test
- Partial discharge test
- Measurement of dissipation factor
- Dissection and analysis of test specimens
- Jacket environmental cracking test
- Sunlight resistance
- Insulation resistance test
- Accelerated water absorption tests

16.2. Electrical tests on completed cable shall be performed per ICEA S-108-720 and shall include the following:

- AC withstand test
- Partial discharge test

16.3. Production tests shall be performed per ICEA S-108-720 and shall include the following:

- DC Resistance
- Diameter measurement

16.4. Production tests on conductor and insulation shields shall be performed per ICEA S-108-720 and shall include the following:

- Elongation after aging
- Volume resistivity
- Thickness measurement
- Voids and contaminant test
- Wafer boil test

16.5. Production tests on insulation shall be performed per ICEA S-108-720 and shall include the following:

- Aged and unaged, tensile and elongation tests
- Hot creep test
- Voids and contaminant test
- Diameter measurements
- Shrink-back test
- Thickness and eccentricity test

16.6. Production tests on metallic sheath shall be performed per ICEA S-108-720 and shall include the following:

- Dimensional measurements

16.7. Production tests on jacket shall be performed per ICEA S-108-720 and shall include the following:

- Aged and unaged, tensile and elongation tests
- Thickness measurement

16.8. Production tests on cable terminations shall be performed and shall include the following:

- Production tests per AEIC CS9 and IEEE 48
- Partial discharge measurements per AEIC CS9
- Dimensional checks per AEIC CS9
- Visual inspections per AEIC CS9

17.0 TEST REPORTS

17.1. A detailed Test Report documenting the results of all tests shall be submitted. The Test Report shall include but not be limited to the following:

- Description of all test arrangements and test procedures
- Description of all important test equipment and documentation showing calibration of equipment
- All test data and results

18.0 CABLE JOINTS (SPLICES)

18.1. Cable Joints shall meet the following minimum requirements:

- Shall be of pre-molded construction, with sheath interrupts for cross bonding.
- Shall be supplied with metallic casings that provide a hermetic seal.
- Vendor shall provide joints that have been tested with the cable and shall be compatible with the cable design and application.
- The design of the joints shall meet the same electrical operating requirements as the cable.
- Vendor shall submit descriptions with drawings of the proposed design of the joint.

19.0 CABLE TERMINATIONS

19.1. Cable Terminations shall meet the following minimum requirements:

- The cable supplier shall provide terminations, suitable for terminating cable in air. Cable terminations and components shall comply with IEEE Std 48. The design of the termination shall maintain the same electrical operating requirements as the cable.
- The cable termination shall be of the outdoor type. The external skirted insulation shall be made of polymer (silicon rubber or other hydrophobic composite material). Porcelain insulation will not be accepted.
- If the cable terminations are to be used for connecting cable to SF6 insulated switchgear, the terminations shall be supplied with voltage limiters placed between the SF6 enclosure and the cable metallic sheath designed to limit transient over-voltages during switching of the attached SF6 switchgear.
- Vendor shall provide terminations that have been tested with the cable to be supplied and shall be compatible with the cable design and application.
- The cable termination stress relief shall consist of slip-on, pre-molded stress cones.
- The cable termination design shall be of the type that shall permit fault location equipment to be connected with relative ease.

- Aerial connector lugs shall be provided for each termination. Connectors shall have NEMA four-hole spacing and shall have the same continuous current-carrying capacity as the termination. Bolt hardware shall be stainless steel.
- Each termination shall be packaged as a self-sufficient kit. It shall contain packing lists, instructions, detailed drawings and illustrations, and all permanent and consumable materials required for installation by LUMA personnel.
- Manufacturer's specifications and technical data on the proposed cable termination design, with drawings, shall be submitted to LUMA for evaluation with the proposal.

20.0 CROSS-BONDING LINK BOXES WITH SHEATH VOLTAGE LIMITERS

20.1. Cross-bonding link boxes shall meet the following minimum requirements:

- The link boxes shall be hermetically sealed, fully submersible (IP68), and shall make it possible to test the integrity of the cable jacket by removing bolted links. The bolted links shall be manufactured from copper or other suitable non-corroding material.
- The link boxes shall be provided with sheath voltage limiters that are suitable for cross bonding the cable sheaths, to ensure that the cable jacket is not damaged under transient overvoltage and system fault conditions.
- The sheath voltage limiter U_C rating shall be provided by LUMA Energy at the time of purchase and shall be selected so the standing sheath voltage never exceeds 150V at any point of the line segment.
- The insulators shall be capable of withstanding a DC voltage of 20 kV for 1 minute.
- The housing of the link boxes shall be ASTM Type 316L stainless steel or other durable corrosion-resistant material suitable for long-term installation in an underground manhole.

21.0 LUMA WAREHOUSE CODE NUMBERS

Description	LUMA Warehouse Code Number
115kV Concentric Neutral Wire Shield Underground Cable	006-83261
115kV Concentric Neutral Wire Shield Cable Joint	038-83262
115kV Concentric Neutral Wire Shield Cable Termination	038-83263

22.0 MANUFACTURER TECHNICAL DATA

22.1. The following information for cable and accessories covered in this Specification shall be supplied with the bid. Failure to provide any of the information specified herein shall be sufficient cause for rejection of tender.

Cable manufacturer	_____
Rated voltage class	_____
Maximum continuous voltage	_____
Load factor	_____
Cable conductor material	Copper
Number of conductors per cable	Single
Conductor Size, kcmil	_____
Stranding per ASTM	_____
Maximum continuous current	_____
Emergency operating current/duration	_____ A @ _____ hours
Maximum allowable short circuit current/duration	_____ kA @ _____ sec
Longitudinal water tightness	Yes
Type of conductor shielding	_____
Conductor shielding thickness	_____
Type of insulation	_____
Insulation thickness	_____
Type of insulation shielding	_____
Insulation shielding thickness	_____
Metallic shielding material and type	_____
Metallic shielding thickness	_____

Jacket type and material	_____
Jacket thickness	_____
Overall diameter	_____
Resistance at 60 Hz	_____
Maximum operating temperature, °C	_____
Minimum bending radius for laying (x cable O.D.)	_____
Minimum bending radius for installation (x cable O.D.)	_____
Weight of cable, lbs	_____
Maximum pulling tension applied to conductor, lbs	_____
Maximum pulling tension applied over jacket, lbs	_____
Method of insulation curing	_____
Insulating material	_____
Jacket material	_____
Cable termination type	Outdoor, Dry Type
Cable termination housing material	_____
Cable termination insulator creepage, inches	_____
Cable length per reel, ft	_____
Reel diameter, ft	_____
Technical literature and drawings	_____

- End of Specification –

4752.249 115kV Concentric Neutral Wire Shield Underground Cable and Accessories

Final Audit Report 2022-08-18

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