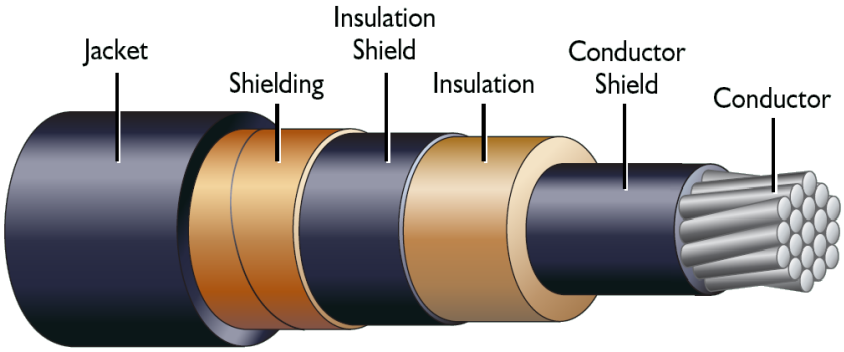
15 kV EPR Insulated, Jacketed, URD Cable



1000 kcm Aluminum Conductor with Tape Shield

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1 GENERAL

1.1 This specification covers detail for furnishing medium voltage, jacketed, shielded underground distribution power cables. The cables shall consist of one ethylene propylene rubber (EPR) insulated aluminum conductor, with a helically applied copper tape shield over the insulation shielding, and an overall jacket of black, linear low density polyethylene. The cables shall be 15 kV rated - suitable for use on 12470GrdY/7200 Volt primary underground distribution systems.

1.2 The cables shall be suitable for use in single, two, and three phase, primary underground distribution systems installed in underground ducts, above grade conduit, or direct burial in both wet or dry locations.

1.3 The cable shall be designed and constructed so that it will operate at normal operating temperatures of at least 90ºC maximum, emergency operating temperatures of at least 130°C, and short circuit operating temperatures of at least 250°C. The cable shall be suitable for a minimum installation temperature of -40ºC.

2 STANDARDS

2.1 All material and equipment furnished under these specifications shall conform to the latest NEMA, ICEA, AEIC, ANSI, and ASTM Standards.

2.2 Where the term "AEIC specification" is used, it shall mean AEIC Cable Specification No. CS6-87 for ethylene propylene rubber insulated cable

2.3 Where the term "ICEA specification" is used, it shall mean ICEA – NEMA Standards Publication No. S-97-682 and S-93-639 for ethylene propylene rubber insulated cable.

3 APPROVED CABLE MANUFACTURERS

3.1 The District has approved and verified that the following manufacturers meet this Standard 5110.0103.

3.1.1 OKONITE

3.1.2 KERITE

4 REEL SPECIFICATIONS

4.1 The cable shall be packaged in lengths specified by the District with a tolerance of -0%/+5%.

4.2 The cable is to be packaged in approximately 2000-foot lengths on non-returnable reels with a maximum flange diameter of 82 inches for 1000kcm Cable. Each reel shall be marked with gross, tare and net weights, and cable footage.

4.3 Each end of the cable shall be firmly and properly secured to the reel. Care shall be taken to prevent looseness of reeled cable. The cable end attached through the interior of the reel shall be fastened in such a manner that it remains attached as the cable is dispensed from the reel and does not interfere with other reels or waste cable.

4.4 Reels shall be covered to provide protection of the outer layers against damage from normal handling and shipping. The covering shall be a Class 2 protection in accordance with NEMA 26-1990.

4.5 Watertight seals shall be applied to all cable ends to prevent entry of moisture during transit and outside storage.

4.6 Reels shall be shipped upright on their flanges from the manufacturing plant to the District. Delivery to the District shall be on flatbed trucks. The District will offload the reel(s) from the flatbed.

4.7 Steel bushings shall be used to line the reel arbor holes if the gross weight exceeds 2500 pounds.

4.8 All cable larger than 4/0 must be supplied on metal reels, designed to be stored long term outdoors. Conductor on reels must be covered with protective cover to keep cable safe from moisture and UV damage. Reels shall be free of foreign objects (nails, etc.) sharp edges and burs that could damage the conductor during transit or while dispensing. Reel size shall be a minimum of 1 ½" larger than wound conductor.

5 PRODUCTION INFORMATION/ACCEPTANCE TESTS

5.1 At a minimum, Contractor shall provide production information as outlined on Exhibit A which information shall be submitted with each order delivery.

5.2 The District or its authorized agent may conduct performance tests on delivered cable. All test procedures, examinations and test results shall conform to AEIC CS8 and ICEA S-97-682 unless specifically noted. Test results that indicate a failure to satisfy the requirements of any section of this Specification may be a cause for rejection of that reel of cable.

5.3 Rejected cable shall be returned to the Contractor at Contractor's expense and the District shall make no payment for the cable.

6 PRICING ADJUSTMENTS

6.1 Metals price adjustment - Bids submitted may provide for metal de-escalation as well as escalation. Price increases/decreases will be allowed on per-item basis due to base metals price adjustments between time of order and time of shipment per the process listed below.

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Obtain the average price issued the third Monday of the month prior to the District's purchase order.
<table>
<tr><th>Metal</th><th>Price Source</th></tr>
<tr><td>Aluminum Ingot</td><td>US METALS WEEK</td></tr>
<tr><td>Copper</td><td>COMEX</td></tr>
</table></td></tr>
<tr><td></td><td>Subtract the metals price from the base price of the metals quoted.</td></tr>
<tr><td>2</td><td>Multiply the difference by the percentage of aluminum or copper in the cable price.</td></tr>
<tr><td>3</td><td>Add or subtract the result from the base price of the cable quoted.</td></tr>
</table>

7 DISTRICT APPROVED EQUAL

7.1 The District will consider approved equals. The term "approved equal" shall mean that the quality and characteristics of equipment or materials are equal to or better than specified in this Standard.

7.2 Determination of Equality - The District will judge the suitability, reliability, and serviceability of a proposed substitute. To be considered by the District, the request for

substitution shall be accompanied with complete physical and technical data, manufacturing information, manufacturer's catalog data, photographs, samples, test results, as well as the address of the nearest authorized service representative. The District shall be the sole arbiter in the determination of equality.

7.3 It is imperative that the District utilize cable that can be exchanged with other nearby utilities. Therefore, a qualified manufacturer shall have a customer base of at least 5 Pacific Northwest utilities. Bidder shall submit with the bid a current list of Pacific Northwest Utilities (minimum 5) that use the exact type of cable. Information included with these listings shall include total circuit feet of cable installed, number of years of service using this cable, and number of insulation failures recorded to date. Listings shall include contact persons and telephone numbers.

7.4 Bidder who bids a manufacturer not already approved by the District shall submit information with the bid to demonstrate compliance with this Specification as outlined below.

7.4.1 MANUFACTURING METHOD

7.4.1.1 Bidder shall provide with the bid a description of materials to be used in the manufacturing of the conductor shielding, insulation, insulation shielding, and cable jacket.

7.4.1.2 The conductor shield, insulation, and insulation shield shall be extruded on the central conductor with a single-pass triple extrusion or a two plus one process to prevent inter-surface contamination. The extrusion operation shall be performed by separate heads, thereby permitting the measurement and accurate control of the wall thickness of each individual layer as the cable is being manufactured.

7.4.1.3 All alterations to the critical process parameters of the extrusion line shall be noted in the production log.

7.4.1.4 The curing process shall employ a steam process.

7.4.1.5 A moisture free or water cooling process is acceptable.

7.4.2 CABLE CONSTRUCTION

7.4.2.1 Central Conductor-Conductors shall comply with the requirements of ICEA Standards. The central conductor shall be uncoated 1350 aluminum alloy. The aluminum rod from which the conductor is extruded shall be cleaned of contaminants and free of defects and corrosion. Stranded conductor shall be Class B concentric-lay, compressed 3% maximum, in accordance with ASTM B231 and ASTM B609.

7.4.2.2 Conductor Shielding-The conductor shield shall be a black, semi-conducting or stress grading material, extruded directly over the conductor. The strand shield material shall be compatible with the conductor and thoroughly bonded to the overlying insulation.

7.4.2.2.1 The shield material shall be clean stripping from the conductor. Its minimum thickness shall be in accordance with Table 3-1, ICEA S-97-682.

7.4.2.2.2 The contact surface between the conductor shielding and the insulation shall be cylindrical and free from protrusions and irregularities that extend more than 5 mils

into the insulation and 7 mils into the conductor shielding. The conductor shield layer shall be free of any voids larger than 3 mils at the insulation interface.

7.4.2.2.3 The shielding material shall meet the physical requirements of Part 3, ICEA S-97-682. The conductor shielding shall not exceed the maximum volume resistivity values as outlined in ICEA S-97-682.

7.4.3 INSULATION

7.4.3.1 Bidder shall submit with the bid a description of the manufacturer and manufacturing process used to produce the insulation pellets and a statement as to how long this source of insulating compound has been used. Quality control procedures utilized in manufacturing shall also be included with this information.

7.4.3.2 The insulation shall be ethylene propylene rubber (EPR), a flexible thermosetting dielectric based on an ethylene propylene elastomer.

7.4.3.3 The minimum average thickness of the insulation at any cross section along the cable length shall be either 175 or 220 mils depending upon District stock number. The minimum thickness at any point shall not be less than 90 percent of the specified minimum average thickness.

7.4.3.4 The insulation shall be extruded directly over and firmly bonded to the conductor shielding.

7.4.4 INSULATION SHIELDING

7.4.4.1 Bidder shall provide with the bid a description of the manufacturing process which shall include position of extruders, curing process, cooling process, pellet inspection, and pellet handling procedure.

7.4.4.2 The insulation shielding shall be a black, extruded, semi-conducting thermosetting or stress control layer of polymeric material extruded directly over the surface of the insulation. The material shall be completely compatible with the insulation and it shall meet the physical requirements of ICEA S-97-682.

7.4.4.3 The insulation shield shall be readily distinguishable from the insulation and shall be legibly identified as semi-conducting or stress control layer by surface printing. Indent printing shall not be allowed.

7.4.4.4 The minimum and maximum thickness of the insulation shielding shall be in accordance with ICEA S-97-682, 5-1.

7.4.4.5 Protrusions and irregularities shall not exceed 5 mils into the insulation and shall not exceed 7 mils into the insulation shielding. The insulation-shielding layer shall be free of any voids larger than 5 mils at the insulation interface.

7.4.4.6 The insulation shielding shall strip freely and cleanly from the underlying insulation using standard stripping tools. Any conductive material left after stripping shall be easily removable by wiping the insulation. If the shielding is semi-conducting, then the strip ability shall conform to the requirements of ICEA S-97-682.

7.4.5 METALLIC SHIELDING

7.4.5.1 A 5-mil copper tape shield with a minimum overlap of 20% shall be helically applied over the insulation shield in accordance with ICEA S-97-682.

7.4.6 OVERALL OUTER JACKET

7.4.6.1 A black, linear low-density polyethylene (thermoplastic) jacket, extruded-to-fill type, shall be placed directly over the helically wound tape shield.

7.4.6.2 The nominal thickness of the jacket shall be 80 mils and shall not be less than 80 percent of this value at any place on the cable. The jacket shall be free stripping and suitable for exposure to sunlight and extreme temperatures. The overall outer jacket shall meet the requirements of ICEA S-97-682.

7.4.6.3 The outer jacket shall be manufactured such that the overlaps of the metallic tape shield remain equally spaced and in contact with the underlying extruded insulation shielding, leaving no voids after application.

7.4.7 IDENTIFICATION

7.4.7.1 The center strand of stranded conductor cable shall be indent printed with the manufacturer's name and year of manufacture at regular intervals with no more than 12 inches between repetitions as per ICEA S-97-682.

7.4.7.2 The outer surface of the jacket of each cable shall be clearly and permanently marked throughout its length in accordance with ICEA S-97-682, Part 8. Stamped markings denoting the conductor size, conductor metal, voltage class, insulation type and thickness, date of manufacture, and name of manufacturer, shall be included on the surface of the jacket. A lightning bolt symbol in accordance with NESC (Rule 350) shall be included in the identification marking.

7.4.7.3 Sequential footage numbers shall be clearly and permanently marked throughout the cable at 2-foot intervals. The depth of the indentation shall be a minimum of 1 mil and a maximum of 15% of the jacket thickness.

7.4.7.4 The outer surface of the jacket of each cable shall be marked with three extruded, continuous, longitudinal, highly visible opaque red stripes spaced 120° apart. The dimensions of the stripes shall be 0.2 to 0.4 inches wide.

7.4.8 TESTING BY THE MANUFACTURER

7.4.8.1 Conditions applying to tests shall be in accordance with ICEA S-97-682.

7.4.8.2 Bidder shall submit with the bid documentation of successfully passing an accelerated cable life test (ACLT) such as the EPRI/CPI protocol, or other District approved independent testing protocol, for at least 1000 days with no cable failures.

7.4.8.3 Qualification Tests

7.4.8.3.1 A certified copy of the results of Core Material Qualification Tests shall be provided with the bid. Cable with a # 1/0 conductor size is the preferred size for the qualification tests.

7.4.8.3.2 Alternate qualifications tests must be approved by the District.

7.4.8.4 Production Sampling Tests

7.4.8.4.1 The manufacturer shall provide with the bid Production Sampling Tests results in accordance with ICEA S-97-682, Table 9-5 and shall include testing of the following:

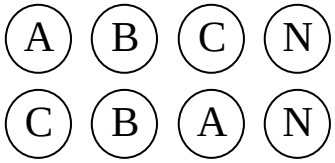
a) conductor
b) non-metallic conductor shield
c) insulation
d) non-metallic insulation shield
e) jacket
f) electrical tests
g) moisture tests

7.4.8.4.2 Alternate production tests shall be approved by the District.

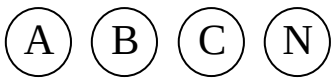
8 CABLE DAMAGE DATA

8.1 Cable damage curves shall be provided for the following cases. In all cases the cable shield will be grounded at each end of any run.

8.1.1 Six 1000 kcmil aluminum primary cable and two 350 kcmil aluminum neutral cable, one in each of eight separate 3" nonmetallic underground conduit runs. The conduit runs shall be configured four ducts across and two ducts high. An ambient earth temperature of 20°C will be used in the calculation along with a duct spacing of 5.25" centerline to centerline on the horizontal axis and a 5.01" duct spacing centerline to centerline on the vertical axis. The phasing is shown below.

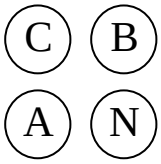


8.1.2 Three 1000 kcmil aluminum primary cable and one 350 kcmil aluminum neutral cable, one in each of four separate 3" nonmetallic underground conduit runs. The conduit runs shall be configured four ducts across and one duct high. An ambient earth temperature of 20°C will be used in the calculation along with a duct spacing of 5.25" from centerline to centerline. The phasing is shown below.



8.1.3 Three 1000 kcmil aluminum primary cable and one 350 kcmil aluminum neutral

cable, one in each of four separate 3" nonmetallic risers. The riser is attached to a pole located in free air. The risers shall be in rectangular configuration with one riser located at each point of the rectangle. A spacing of 2" shall be utilized between the outside of each riser. No wind shall be used in this calculation and the ambient temperature shall be 30°C. The phasing is shown below.



8.2 The data shall be plotted as time versus current on log-log graph paper where time shall be in seconds and current in amperes. The time values shall be shown on the vertical axis and the current values shown on the horizontal axis. The first data point shall be for a time of 300 seconds and the last data point for a current of 12,000 amperes

9 WARRANTY

9.1 The manufacturer shall warrant that the cable furnished under this specification will be free from defects in material, design, and workmanship for a minimum of 40 (forty) years after purchase. In the event of a cable failure within the 40 year period, the manufacturer will be responsible for promptly providing replacement cable for the failed section of cable, unless it can be demonstrated to the District's satisfaction that the failure was not due to a manufacturing defect or design inadequacy.

10 Exhibit A MANUFACTURER: _____ CABLE SIZE: _____

1. Location of manufacturing plant _____
2. No. & size (AWG) of drain wires _____
3. Central conductor stranding _____
4. Aluminum Base Price: _____ $/lb.
5. Copper Base Price: _____ $/lb.
6. Metal Content in Cable:

Aluminum: _____lbs/1000ft	Copper:_____ lbs/1000ft
Lead: _____ lbs/1000ft	Steel: _____lbs/1000ft

7. Outside Diameter: Over Insulation _____ Complete Cable_____ Inches.
8. Weight of complete cable _____ Lbs. /1000 Ft.
9. Type & Thickness of Insulation _____ _____ Inches.
10. Insulation Compound _____
11. Polyethylene content of insulation _____ % by weight
12. Minimum thickness and maximum thickness Min: _____ Max: _____
13. Minimum average thickness for the conductor shielding, insulation and insulation shielding _____
14. Minimum thickness and maximum thickness for the jacket _____
15. Minimum diameter and maximum diameter for the insulation, insulation shielding and jacket _____
16. Reel size _____
17. Flange & Drum diameters/overall width _____
18. Length of cable on reel _____ Feet
19. Recommended pulling tensions _____ Lbs
20. Minimum Bending Radius _____ Inches
21. Series Resistance of Cable Per Phase @ 75°C _____ Ω/1000 Ft.
22. Series Reactance of Cable Per Phase @ 75°C 60Hz _____ Ω/1000 Ft.

    Spacing between Cable, 5.25”
23. Cable Ampacity (For Three Different Cases Described in Section 8 of this spec).
    Conductor Temperature, 105°C, 100% Load Factor, Ambient Earth Temperature 20°C, Soil Thermal Resistivity RHO-90

Case 8.1.1 _____ Amps Case 8.1.2 _____ Amps
Case 8.1.3 _____ Amps

24. **Cable Ampacity Adjustment Factors**
    1. Ambient Earth Temperature of 14°C, Adjustment Factor = _____
    2. Ambient Earth Temperature of 8°C, Adjustment Factor = _____
    3. Ambient Earth Temperature of 0°C, Adjustment Factor = _____

25. **Deviations from Specifications (indicate "none" if no deviations):**

_____
_____
_____
_____
_____
_____
_____
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