الشركة السعودية للكهرباء
Saudi Electricity Company
نعمل بإتقان من أجلكم

11-SDMS-04

REV. 0 (19-07-2018)

SPECIFICATION FOR ALUMINUM UNARMORED XLPE/LLDPE INSULATED POWER CABLES FOR RATED VOLTAGES FROM 15KV UP TO 36KV

Saudi Electricity Company

1. SCOPE

This specification defines the minimum technical requirements for design, engineering, manufacturing, testing, inspection and performance of aluminum unarmored XLPE/LLDPE insulated, 3-core power cables rated 15kV up to 36kV (*Um*) suitable for direct burial or installation in ducts or in air within cable guard on poles intended to be used in the medium-voltage system of Saudi Electricity Company (SEC).

Cables included in this specification are itemized in Table-1.

Table 1: 3-Core Aluminum Unarmored XLPE/LLDPE rated 15kV and 36kV Power Cables

S. No.	Cable Size, ($mm^{2)}$	Description
1	3 x 500/35	3-Core, Aluminum, Unarmored, XLPE/LLDPE, 15kV
2	3 x 400/35	3-Core, Aluminum, Unarmored, XLPE/LLDPE, 36kV

2. CROSS REFERENCES TO OTHER SEC STANDARDS

This specification shall always be read in conjunction with SEC General Specification No. 01-SDMS-01 (latest revision) titled "General Requirements for all Equipment/Materials," which shall be considered as an integral part of this specification. It shall also be read in conjunction with SEC purchase order and/or contract schedules, and scope of work/technical specifications for projects, as applicable.

3. APPLICABLE CODES AND STANDARDS

The latest revision of the following codes and standards shall be applicable for the equipment/materials covered in this specification. In case of any deviation, the vendor/manufacturer may propose equipment/materials conforming to alternate codes or standards. However, the provisions of SEC standards shall supersede the provisions of these alternate standards in case of any difference.

Table 2: List of applicable standards

Standard #	Title
IEC 60228	Conductors of Insulated Cables
IEC 60502-2	Power Cables with Extruded Insulation and Their Accessories for Rated Voltages from 1kV (*Um*=1.2kV) up to 30kV (*Um*=36kV) – Part 2: Cables for Rated Voltages of 6kV (*Um*=7.2kV) and 30kV (*Um*=36kV)

Standard #	Title
IEC 60811	Common Test Methods for Insulating and Sheating Materials of Electric Cables
IEC 60229	Electric Cables – Tests on Extruded Oversheaths with a Special Protective Function
AEIC CS8	Specification for Extruded Dielectric, Shielded Power Cables Rated 5kV Through 46kV

4. MATERIAL, DESIGN AND CONSTRUCTION REQUIREMENTS

4.1. GENERAL

4.1.1 The power cable shall meet or exceed the requirements of this specification in all respects and it shall be manufactured and tested in conformance with relevant international standards.

4.1.2 Manufacturer's drawing shall show the outline of the cables together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

4.2. DESIGN CRITERIA

4.2.1 Unless otherwise specified, the cable shall be manufactured and tested in conformance with IEC 60502-2.

4.2.2 Cables shall be designed for ambient temperature conditions specified in 01-SDMS-01.

4.2.3 Cable design shall facilitate cold-shrink and pre-molded joints and terminations.

4.2.4 The conductor semi-conducting screen, core insulation, and insulation semi-conducting screen shall be extruded by using a method of triple extrusion process.

4.2.5 The construction of the cables shall be essentially as shown in Figure 1. The size, ratings, shape, dimensions and materials shall be as indicated in the technical data schedule.

4.3. MATERIALS

4.3.1. CONDUCTOR

The conductor shall be aluminum, Class-2 per IEC 60228, and shall be round, compacted and stranded.

4.3.2. CONDUCTOR SEMI-CONDUCTING SCREEN

Conductors of the cable shall be screened by an extruded non-metallic black semi-conducting compound compatible with the insulation of the conductor, and shall have an allowable operating temperature equal or higher than the insulation.

The outer surface of the conductor semi-conducting screen shall be firmly bonded to the insulation and easily removable from the conductor.

The allowable minimum thickness of the conductor semi-conducting screen is shown in the table below.

Table 2: Allowable minimum thickness of conductor semi-conducting screen

S. No.	Cable Size, ($mm^{2)}$	Voltage Level, (*Um*)	Minimum Thickness, (mm)
1	3 x 500/35	15kV	0.51
2	3 x 400/35	36kV	0.51

4.3.3. CORE INSULATION

The insulation shall be extruded solid dielectric cross-linked polyethylene (XLPE) complying with the applicable requirements of IEC 60502-2. The cross-linking process shall not expose the material to water or steam.

The nominal insulation thickness shall be as per values specified in Table 6 of IEC 60502-2 relative to the voltage rating and cross-section of the cable.

The minimum thickness of the insulation at any point shall not fall below the nominal value by more than 0.1mm + 10% of the nominal value.

4.3.4. INSULATION SEMI-CONDUCTING SCREEN

The core insulation of the cable shall be screened by an extruded non-metallic strippable black semi-conducting compound applied directly over the insulation and is complying with the requirements of AEIC CS8. It shall be easily strippable without damaging the insulation. Any trace of left-over semi-conducting compound over the insulation that cannot be readily removed after stripping is not acceptable. An insulation screen that requires heat for removal is not acceptable.

The insulation semi-conducting screen shall comply with the stripping test requirements of AEIC CS8.

The allowable minimum thickness of the core insulation semi-conducting screen is shown in the table below.

Table 3: Allowable minimum thickness of core insulation semi-conducting screen

S. No.	Cable Size, ($mm^{2)}$	Voltage Level, (*Um*)	Minimum Thickness, (mm)
1	3 x 500/35	15kV	1.02
2	3 x 400/35	36kV	1.02

4.3.5. METALLIC SCREENING

All cores with semi-conducting insulation screen shall have supplementary copper wire screen helically applied in intimate contact with the non-metallic semi-conducting screening.

A copper tape with minimum size of 0.1mm x 15mm shall be bounded counter-helix over the copper wire screens.

The overall size of the metallic screening is $35mm^2$.

4.3.6. ASSEMBLY OF CORES AND FILLERS

The assembly of the 3-cores of the cable shall conform to the applicable clauses of IEC 60502-2.

The metallic screens of the cores shall be in contact with each other.

The material of the binding tape and fillers shall be suitable for the operating temperature of the cable and compatible with the insulating material.

Filler material shall be non-hygroscopic.

4.3.7. OUTER SHEATH

The outer sheath shall be black for 36kV cables and black with 2 red stripes on the opposite ends of the cable diameter for 15kV cables, LLDPE, Type-ST_7 with nominal thickness conforming to the applicable clauses of IEC 60502-2.

The minimum thickness at any point shall not fall below 80% of the nominal value.

4.4. CORE IDENTIFICATION

4.4.1 The 3-cores of the cable shall be provided with identifying tapes colored red, yellow and blue.

4.4.2 Core insulation shall not be colored.

5. FABRICATION

All cables shall be free of material and manufacturing defects that would prevent it from meeting the requirements of this specification.

The conductor semi-conducting screen, core insulation, and insulation semi-conducting screen shall be extruded using a method of triple extrusion process.

6. MARKING

The outer sheaths of the cables specified herewith shall be marked by embossing at intervals not exceeding 1 meter of the following minimum information:

a. Manufacturer Name or Trademark in English and/or Arabic
b. Voltage Designation in English
c. Type of Insulation/Type of Over Sheath in English (XLPE/LLDPE)
d. Conductor Size and Material in English and Arabic
e. Year of Manufacture in English and Arabic
f. Cumulative length at every 1 meter with the reel length marked on the outer end of the cable.

All cables shall be marked with "PROPERTY OF SAUDI ELECTRICITY COMPANY" in English and Arabic.

All markings/numbering shall be indelible. Marking using a matrix print is not acceptable.

7. TESTING AND INSPECTION

The aluminum unarmored XLPE/LLDPE medium-voltage power cable shall be tested in conformance with IEC 60502-2. Supplier/manufacturer shall provide all test results for review and approval of SEC.

SEC reserves all the rights to attend and witness the tests.

7.1. ROUTINE TESTS

Routine tests in conformance with the applicable clauses of IEC 60502-2 shall be carried out on all finished cables at the manufacturing plant's test facility.

For every batch of delivery, electronic copies of the routine test reports together with the packing lists and sample test reports, shall be submitted to SEC for review and approval prior to issuance of the releases.

Unless otherwise specified, the following routine tests shall be carried out on all finished cables:

7.1.1 Electrical Resistance of Conductors – shall be performed per applicable clauses of IEC 60502-2, and the measured values of resistance shall conform with IEC 60228.

7.1.2 Partial Discharge Test – shall be carried out in accordance with IEC 60885-3. The magnitude of the detectable discharge at $\sqrt{3}\,Uo$ shall not exceed 10pC.

7.1.3 Voltage Test – the power frequency test voltage shall be 3.5 x Uo. Values for single-phase test voltage are given below:

Rated Voltage:	15(17.5) kV	30(36) kV
Test Voltage:	30.5kV	63kV

Phase-to-phase values of test voltage shall be $\sqrt{3}$ x the values of single-phase test voltage mentioned above.

7.2. TYPE TESTS

Type test shall be performed in complete conformance with the applicable standards. It shall be performed at SEC approved laboratories. Full report including the certification shall be submitted to SEC.

SEC reserves the right to attend and witness the tests.

SEC reserves the right to request the supplier/manufacturer to repeat the type test every five (5) years, or as needed should the supplied cables have frequent faults and failures.

7.3. SAMPLE TESTS

Sample tests is generally performed on each type of cable to verify supplier/manufacturer's compliance with this specification, and actual confirmation of the values proposed in the submitted technical data schedules.

Samples shall be randomly selected by SEC from the available packing list or by actual on-site selection.

Unless otherwise specified, the following tests and inspections shall be performed:

7.3.1. Conductor Examination – examination shall conform to IEC 60228.

7.3.2. Dimensional Check – the minimum measured values shall conform to the applicable clauses of IEC 60502-2.

7.3.3. Hot-Set Test for XLPE Insulation – values shall conform to applicable clauses of IEC 60502-2.

7.3.4. Strippability Test – shall conform to applicable requirements of AEIC CS8.

8. PACKING AND SHIPPING

Packing and shipping requirement shall generally be as per latest revision of SEC General Requirements for Equipment/Materials, 01-SDMS-01 or as per purchase order requirements.

Packing and shipping of the aluminum unarmored XLPE/LLDPE medium-voltage power cables shall conform to the following requirements:

- The cable ends shall be watertight sealed with SEC approved heat-shrinkable end cap lined with waterproof adhesive type sealing compound. Cable ends shall be properly secured to the reel.

- The cable shall be delivered without splices, on standard sized non-returnable steel reel of sturdy construction, properly packed and lagged externally to prevent possible damage on the cable during transport. Wood lagging or better material shall also be secured with high-tensile low-elongation steel straps to provide physical protection for the cables during transit and customary storage and handling operations.
- The minimum radius of the drum of the shipping reel shall not be less than the bending radius of the cable.
- Unless otherwise specified, cables shall be supplied in reel lengths of 500 meters each with allowable tolerance of ±5%.
- Each cable reels/drums shall be marked in legible and indelible letters on aluminum or stainless steel plate 30cm x 20cm x 1.5mm plate, showing the following information:
    a. Cable Voltage Rating, Conductor Material, and Size
    b. Type of Cable
    c. Length and Weight of the Cable on Reel
    d. Gross Weight
    e. Dimensions of Reel
    f. Manufacturer's Name and Country of Origin
    g. Purchase Order Number
    h. Tender Number
    i. Serial Number of Reel
    j. Year of Manufacture
    k. SEC Item Code in Bold Numerals
    l. SEC Address (Warehouse)
    m. Roll Direction
    n. 11-SDMS-04 (latest revision)
    o. Additional information required per SEC shipping instructions, if applicable.

- All markings shall appear on both sides of the reel.

9. GUARANTEE

The supplier/manufacturer shall guarantee the products against all defects arising out of faulty design or manufacturing defects or defective materials for a period of five (5) years from the date of delivery.

10. SUBMITTALS

The following submittals shall be provided as hard copies, and in electronic formats stored in USB Flash Drive. Unless otherwise specified, e-copies of the files should be in PDF format.

10.1. SUBMITTALS REQUIRED WITH TENDER/INQUIRY

10.1.1. Summary in table form with the following information: list of items offered, manufacturer, origin, catalogue number, and quantity

10.1.2. Clause-by-clause compliance with the latest revision of SEC specification 11-SDMS-04

10.1.3. Manufacturer's Catalogue

10.1.4. Certificate stating that the raw material has been sampled, tested and inspected in accordance with relevant standard specifications

10.1.5. Product type test reports and certificates carried out from SEC approved laboratories

10.1.6. Filled-up technical data schedule on each of the items offered, e-copy in Excel (*.xlsx) format

10.1.7. Manufacturer CAD drawings, e-copy in AutoCAD 2010 (*.dwg) format, for each of the items offered showing the dimensions and cross-sectional views of each cables and its associated shipping reel/drum.

10.1.8. USB Flash Drive containing e-copy of all the documents mentioned above

10.2. SUBMITTALS REQUIRED FOLLOWING AWARD OF CONTRACT

10.2.1. Manufacturing and Routine Test Schedules

10.2.2. Quality Assurance Tests

10.2.3. Factory Test Reports

10.2.4. Special tests, if applicable

10.2.5. USB Flash Drive containing e-copies of all the documents mentioned above.

11. TECHNICAL DATA SCHEDULE

Table 4: Technical Data Schedule for Aluminum Unarmored XLPE/LLDPE MV Power Cable

SEC Inquiry No: Item No:

No	Description	SEC Specified Values (*)	Vendor Proposed Values (**)
1	**Material, Design, and Construction**	-	
1.1	Reference Manufacturing Standard	IEC 60502 -2	
1.2	Maximum Permissible Continuous Conductor Temperature	90°C	
1.3	Maximum Short-Circuit Temperature, (°C)	250°C	
1.4	Maximum Permissible Continuous Temperature of Inner Covering, (°C) – if applicable	*	
1.5	Maximum Permissible Continuous Temperature of Outer Sheath, (°C)	*	
1.6	Rated Voltage (Control/Power Cable)	15kV or 36kV	
1.7	Number of Cores	3	
1.8	Conductor Material	Aluminum	
1.9	Shape of Conductor	Round	
1.10	Conductor Cross-Section, (mm^2)	*	
1.11	Approximate Diameter of Conductor, (mm)	*	
1.12	Number of Strands of Conductor	As per IEC	
1.13	Minimum Thickness of Conductor Semi-Conducting Screen, (mm)	As per IEC	
1.14	Insulation Material	XLPE	
1.15	Nominal Thickness of Insulation, (mm)	As per IEC	
1.16	Diameter Over Insulation	*	
1.17	Minimum/Maximum Thickness of Strippable Semi-Conducting Insulation Screen, (mm)	*	
1.18	Number and Nominal Diameter of Copper Wire Screen, (mm)		

1.19	Minimum Thickness and Width of Copper Tape	0.1mm x 15mm	
1.20	Core Identification (red, yellow, blue)	Yes	
1.21	Filler Material	Yes	
1.22	Diameter Under Binding Tape, (mm)	*	
1.23	Binding Tape Material	*	
1.24	Nominal Thickness of Binding Tape, (mm)	*	
1.25	Outer Sheath Material	LLDPE Type-ST_7	
1.26	Diameter Under Outer Sheath (mm)	*	
1.27	Thickness of Outer Sheath (mm)	As per IEC	
1.28	Color of Outer Sheath	15 kV – Black w/ 2 Red Stripes 36 kV – Black	
1.29	Marking Embossed as Specified	Yes	
1.30	Overall Diameter of the Cable (mm) *	*	
1.31	Net Weight of Conductor (kg/km) *	*	
1.32	Conductor DC Resistance at 20°C (Ω/km) *	*	
1.33	Conductor AC Resistance at 90ºC (Ω/km) *	*	
1.34	Inductance (mH/km) *	*	
1.35	Capacitance (uF/km) *	*	
1.36	Inductive Reactance (Ω/km) *	*	
1.37	Capacitive Reactance (Ω/km) *	*	
1.38	Conductor Impedance at 90º C (Ω/km)	(R + jX)	
1.39	Positive Sequence Impedance (Ω/km)	(R1 + jXL1)	
1.40	Zero Sequence Impedance (Ω/km)	(R0 + jXL0)	
1.41	Positive Sequence Charging Admittance (µS/km)	(jB1)	
1.42	Zero Sequence Charging Admittance (µS/km)	(jB0)	
1.43	Zero Sequence Impedance, Assuming All Currents in Screens: R(Ω/km) X (Ω/km)	*	

1.44	Charging Current (A/km) *	*	
1.45	Earth Fault Capacitive Current (A/km) *	*	
1.46	Short-Circuit Rating of Cable Based on Maximum Conductor Operating Temperature for 1 second - Conductor (kA) - Screen (kA)	*	
1.47	Conductor Temperature Before Short-Circuit (ºC) *	*	
1.48	Conductor Temperature at the End of Short-Circuit (ºC) *	*	
1.49	Screen Temperature Before Short-Circuit (ºC) *	*	
1.50	Screen Temperature at the End of Short-Circuit (ºC) *	*	
1.51	System Short-Circuit for 1 Second (kA)	21 for 15 kV 25 for 36 kV	
1.52	Permissible Load in Amps Under Maximum Service Conditions Given in this Specification (A)	*	
1.53	Maximum Pulling Tension (kN)	*	
1.54	Maximum Side Wall Pressure (kN/m)	*	
1.55	Maximum Bending Radius (m)	*	
1.56	Meets Strippability Requirement of AEIC CS8	Yes	
1.57	Maximum Partial Discharge at 1.5 x Rated Voltage, 10pC	Yes	
1.58	Meets Spark Test Requirement for Jacket	Yes	
1.59	Meets All Test Requirements of IEC 60502-2	Yes	
1.60	Permissible Load in Amps Under Maximum Service Conditions Given in this Specification (A)	*	
2	**Packing and Shipping**	-	
2.1	Drum Type	Non-Returnable	
2.2	Length of Cable, (m)	500 meters	
2.3	Dimensions, (m)	*	
2.4	Gross Weight, (kg)	*	

2.5	Net Weight, (kg)	*	
2.6	Marking as per the Specification	Yes	
3	**Others**	-	
3.1	Product is Type Tested	Yes	
3.2	SEC Approved Laboratory	*	
3.3	Date Tested	*	
3.4	Manufacturer	*	
3.5	Country of Origin	*	
3.6	Submittals Required with Tender/Inquiry Included or Not?	*	

(*) – Values to be provided/proposed by the Vendor

(**) – Please provide explanation for deviations, if any

Aluminum Unarmored XLPE/LLDPE Medium-Voltage Power Cable

SEC Inquiry No: Item No:

- Additional Technical Information or Features Specified by SEC

- Additional Supplementary Data or Features Proposed by Bidder/Vendor/Supplier.

- Other Particulars to be filled-up by the Bidder/Vendor/Supplier.

- List of Deviations and Clauses to which exception is taken by the Bidder/Vendor/Supplier. (Use separate sheet, if necessary).

Description	Manufacturer of Material/Equipment	Vendor/Supplier
Name of Company		
Location and Office Address		
Name and Signature of Authorized Representative with Date		
Official Seal / Stamp		

12. DRAWING

Figure 1: General construction of 400mm² aluminum unarmored XLPE/LLDPE rated 36kV

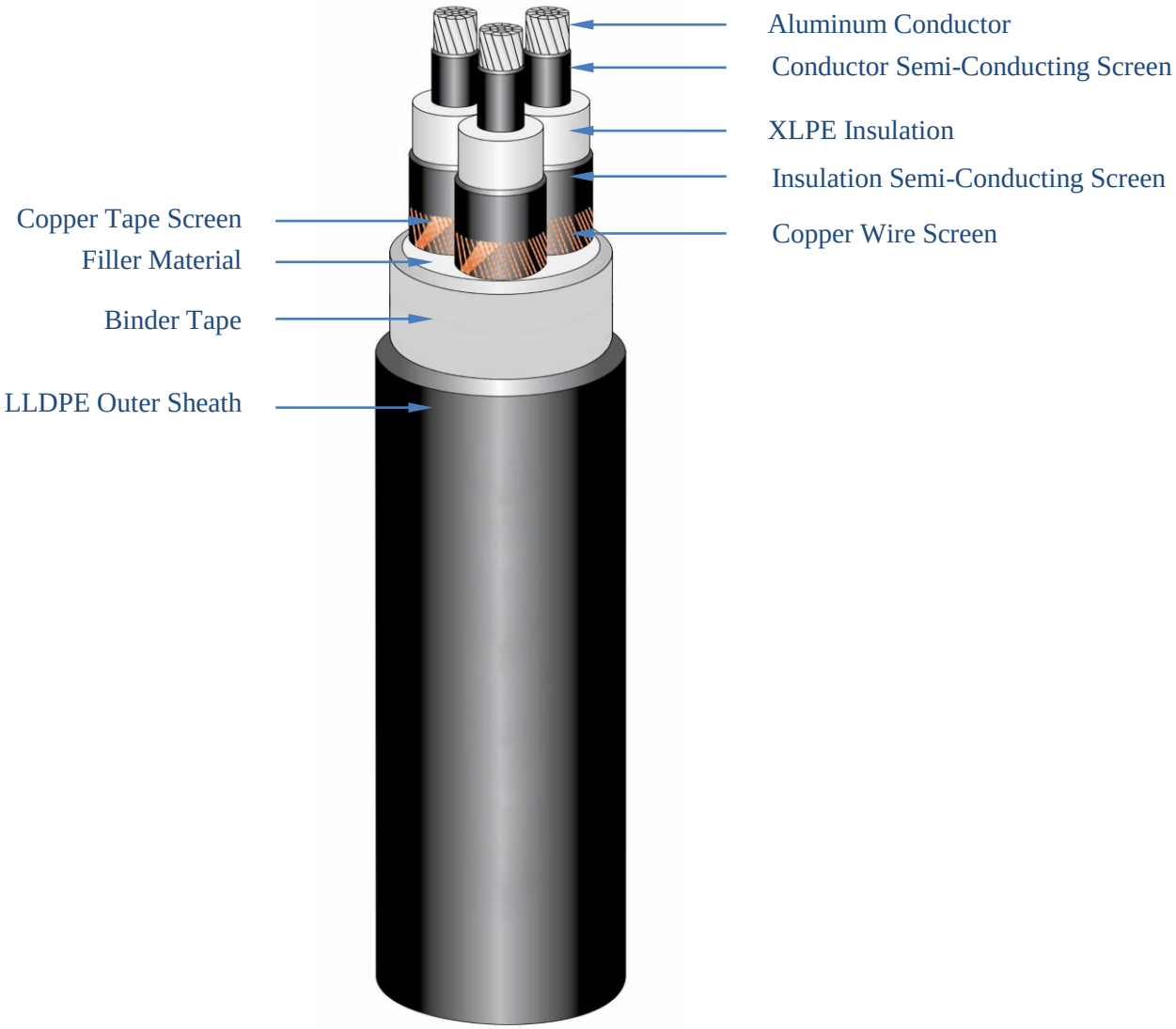

Figure 2: General construction of 500mm² aluminum unarmored XLPE/LLDPE rated 15kV