



SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

11KV, 1 X 500 SQ.MM DRY CURED XLPE UG CABLE

APPLICABLE TO KSEBL	Rev#0	DOC. NO.: SCM-SPEC/XH-AEE2/11kv, 1 x 500 sqmm Dry cured XLPE UG Cable
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Technical Specification and Evaluation Committee for Transmission Material



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(i) Document Approval & Control Status

	Compiled by	Verified by	Approved by
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Position	Assistant Executive Engineer (Supply Chain Management)	Executive Engineer (Supply Chain Management)	Chief Engineer (Supply Chain Management)
Date	13/08/2021	14/12/2021	15/12/2021
Signature	Sd/-	Sd/-	Sd/-

(ii) Amendments and History

Sec. #	Rev. #	Date	History of Change



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1. PURPOSE:

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **11kv, 1 x 500 sqmm Dry cured XLPE UG Cable** in a professional manner

2. SCOPE:

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL, Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **11kv, 1 x 500 sqmm Dry cured XLPE UG Cable** used in field by KSEBL

3. RESPONSIBILITY:

The Executive Engineer (H), Office of Chief Engineer, Supply Chain Management shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions

4. PROCEDURE FOR REVISION:

Modifications if any, in the technical specification will be incorporated as **Revisions**. Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev. No.0.1, 0.2 etc.**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev. No.1.0, 2.0 etc.**

All the details of regarding the revisions (both minor and major) will be incorporated in **“(ii)-Amendments and history”** above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer (SCM)**. Those who notice any discrepancy or have any suggestion regarding revision, may bring the matter to the attention of Chief Engineer (SCM) in writing or through e-mail id:**cescm@kseb.in**



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TECHNICAL SPECIFICATION FOR 1 CORE 500 MM² DRY CURE TYPE 11 KV UG XLPE CABLE

- 1) **Scope:-** This specification covers requirement of 11kV cross-linked polyethylene (XLPE) insulated and PVC sheathed aluminum cable. 11 kV grade cross-linked polyethylene insulated UG Cable shall be with stranded aluminium conductor. The Cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials. The offered cable shall be complying with Specifications / Guidelines suitable for 11kV earthed neutral system and manufactured through dry cure technology. The bidder shall submit the description of dry curing process, with the clear inclusion of equipments / parameters involved. The manufacturing process shall ensure that the insulation shall be free of voids. **Short circuit rating for the combination of armour and screen may be 7kA for 1 second.** This value shall be guaranteed by the bidders. **The calculation in support of this shall also be provided along with submittals for approval during detailed engineering.**

The cables shall be designed to withstand the thermo mechanical forces and electrical stresses during normal operation and transient conditions to ensure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. The XLPE Cable in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armour which shall be ensured by guarding against corrosion. The materials used for sheaths shall be resistant to oils, acids and alkalis. The sheaths shall be protected against white ants, vermin and termites by suitable, reliable and durable measures. The Cables shall be designed to have a minimum useful life span of forty years.

- 2) **System details:-**

Nominal system voltage (rms V) - 11kV
Highest system voltage (rms) Vm - 12 kV
Number of phases - 3
Frequency - 50 Hz
Variation in frequency - $\pm 3\%$
Type of earthing – solidly earthed



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3) Service Conditions:-

Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

14.Maximum ambient temperature (deg C)	:	50
15.Maximum temperature in shade (deg C)	:	40
16.Minimum temperature in air (deg C) in shade	:	17
17.Relative Humidity (%)	:	10 to 100
18.Maximum annual Rainfall (mm)	:	As per published Meteorological/ Climatological data
19.Maximum Wind Velocity (m/s)	:	39
20.Maximum altitude above mean sea level (Meters):	:	1000
21.Isoceraunic level (days/year)	:	60
22.Maximum soil temperature at cable depth °C	:	30
23.Maximum soil thermal resistivity °C cm/watt	:	150

Moderately hot and humid tropical climate, conducive to rust and fungus growth. Areas having seasonal climate of cold (snowfall prone) are also there.

The cables in service will be subject to daily load cycles, of morning peak, day peak and evening peak with reduced loading during night off-peak hours.

4) Location:-

- 4.1. The Cables may be laid buried directly in ground at a depth of 90 cm-100cm in average and terminate for outdoor connection to a power transformer or for indoor connection to metal enclosed Switchgear panels.
- 4.2. The Cables may also be laid within covered cable trenches, in cable racks or open air ladder trays etc. for certain portions of lengths.

- 5) Applicable Standards:- Unless otherwise specified elsewhere in this specification, the ratings as well as Construction, performance and testing of the HT XLPE power cables shall

conform to the latest revisions including amendments available at the time of placement of order of all the relevant standards as listed, but not limited to the following. If there is any deviation or conflict or ambiguity between the requirements specified in the standards and in this specification, the better one will prevail.

- 1)IS: 7098 (Part II) - Cross linked polyethylene insulation for cables.
- 2)IS: 8130 - Conductor for insulated electrical cables and flexible cords.
- 3)IS: 10810 (series) - Methods of tests for cables.
- 4)IS: 10418 - Drums for electric cables.
- 5)IS: 3975 - Specification for mild steel wires, formed wires and tapes for armouring of cables.
- 6)IS: 5831 - Specification for PVC insulation sheath for electric cables.
- 7)IS: 10462 - Fictitious calculation method for determining of dimensions of protective coverings of cables Part-I elastomeric and thermoplastic insulate cables.
- 8)IEC:60986 - Short-circuit temperature limits of electric cables

Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design.

6) Specification for Cross Linked Polyethylene Insulated PVC Sheathed Cables:-

- 6.1) **Rated Voltage and Temperature:-** The rated voltage of the cables shall be 11kV and the maximum voltage shall be 12kV. Maximum continuous operating temperature (combination of ambient temperature and temperature rise due to load) shall be 90°C under normal operation and 250°C under short circuit conditions.
- 6.2.) **Type of Cables:-** The type of cables covered in this specification shall be single core armoured screened **with improved fire performance category C2.**
- 6.3) **Continuous Current and Short Circuit Rating:-** The indicative values of the continuous current carrying capacities for various cable laying conditions shall be mandatorily stated by the bidder in the GTP attached with this specification along with the Short Circuit Ratings.

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6.4) **Design of Cable:-**

6.4.1) **Conductor:** - The cable conductors shall be of round, stranded and compact aluminum of nominal size as stipulated in Table under clause, standard size of cables, corresponding wire diameter and number of wires in the conductor as given in IS.8130. The conductor shall be clean, uniform in size and shape smooth and free from harmful defects. Not more than two joints shall be allowed in anyone of the single wire forming every complete length of conductor and no joint shall be within 300 mm of any other joint in the same layer. The joint shall be made by brazing, silver soldering or electric or gas welding. No joints shall be made in the conductor after it has been stranded.

6.4.2) **Conductor Screen:-** The conductor screening shall consist of an extruded layer of semi conducting XLPE compound.

6.4.3) **Insulation:-** The insulation shall be of extruded cross-linked polyethylene (XLPE) with an average nominal insulation thickness of 3.6 mm and its properties shall conform to IS:7098 (Part-II).

The insulation shall be so applied that it fits closely on the conductor (or conductor screening or barrier if any)and it shall be possible to remove it without damaging the conductor.

6.4.4) **Insulation Screen:-** The insulation screen shall consist of two parts, namely metallic and non-metallic. The non-metallic part shall be applied directly over the insulation of core and shall consist of a layer of **strippable** extruded semi conducting XLPE compound. The metallic part shall be a layer of copper tape over the core.

6.4.5) **Core-identification & Laying up of Cores:-** The core identification and laying up of cores shall be as per IS:7098 (Part II).

6.4.6) **Inner Sheath:-** The cable should have inner sheath of extruded PVC (type ST2) between the metallic screening and armouring. *It shall be ensured that the shape is as circular as possible.*

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The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to insulation, the thickness of inner sheath shall be as per IS 7098 part-II(latest amendment)

6.4.7) **Armouring:-** The armouring shall be of strip armoured non-magnetic material of **hard drawn aluminium**, applied in line with the specifications laid out in IS:7098 Part II (latest including amendments) and IS:5831((latest including amendments). The armour strips shall be applied as close as possible. A binder tape may be applied on the armour.

6.4.8) **Outer Sheath:** - The outer sheath shall be applied by extrusion over the armouring. The minimum thickness and properties of outer sheath shall conform to the requirements of IS: 7098 (Part II). The overall outer sheath covering shall ensure for service reliability against moisture intrusion and conforming to IS:7098 Part II/ (latest including amendments) and shall be of extruded PVC conforming to the requirements of Type ST 2 of IS 5831 (latest including amendments) or Table 3 of IS:7098 Part II/ (latest including amendments) respectively.

6.5) **Tests:-**The following tests shall be carried out on the cables as per IS: 7098 (Part-II).

6.5.1. **Type Tests:-**

The following shall constitute type tests:

6.5.1.1. Test on conductors:

a) Resistance test.

6.5.1.2. Tests for armouring wires/strips

a) dimensions

b) physical test on formed wire

(i) Tensile strength

(ii) elongation at break

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(iii) wrapping test

(iv) winding test for formed wires

(v) uniformity of zinc coating

(vi) mass of zinc coating

(vii) resistivity

6.5.1.3. Physical test for insulation.

- a) Tensile strength and elongation at break.
- b) Ageing in air oven
- c) Hot set test
- d) Shrinkage test
- e) Water absorption (gravimetric)

6.5.1.4. Test for thickness of insulation (eccentricity) and sheath

6.5.1.5. Test on extruded semiconducting screens

- a) Test for strippability of semi-conducting strippable insulation screen
- b) Volume resistivity.

6.5.1.6. Physical test for outer sheath.

- a) Tensile strength and elongation at break.
- b) Ageing in air oven.
- c) Hot deformation
- d) Shrinkage test.
- e) Loss of mass in air oven.
- f) Heat shock.
- g) Thermal stability

3.1.1.1. Thermal Ageing Test for Complete Cable.

3.1.1.2. Partial discharge test.

3.1.1.3. Bending test.

3.1.1.4. **Dielectric Power factor test.**

a) As a function of voltage.

b) As a function of temperature.

3.1.1.5. Insulation resistance (Volume Resistivity test).

3.1.1.6. Heating cycle test.

3.1.1.7. Impulse withstand test.

3.1.1.8. High voltage test.

3.1.1.9. Flammability test for PVC sheathed cables.

3.1.1.10. The following shall constitute additional type test for the cables. with improved fire performance as per the Category C2.

a) Oxygen index.

b) Flame retardance test on single cables.

c) Flame retardance test on bunched cables.

d) Smoke density test (on sheathing material).

e) Test for halogen acid gas evolution.

f) Temperature index.

6.5.2. **Acceptance test:-**

6.5.2.1. Tensile test

6.5.2.2. Wrapping test

6.5.2.3. Conductor resistance test

6.5.2.4. Test for thickness of insulation (eccentricity) and sheath

6.5.2.5. Hot set test for insulation.

6.5.2.6. Tensile strength and elongation at break test for insulation and outer

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Sheath.

6.5.2.7. Partial discharge test (to carried out on full drum length.

6.5.2.8. High voltage test

6.5.2.9. Insulation resistance (volume resistivity test)

6.5.2.10 The following shall constitute additional acceptance test for the cables with improved fire performance as per the Category C2.

i)Oxygen index.

ii)Flame retardance test on bunched cables.

iii)Test for halogen acid gas evolution.

iv)Temperature index.

6.5.3. **Routine Tests:-**

6.5.3.1. Conductor resistance test.

6.5.3.2. Partial discharge test on full drum length.

6.5.3.3. High voltage test.

10.1) Packing & Marking:-

6.6.1. **Packing:-** The cables shall be supplied in well seasoned sturdy wooden drums (conforming to the latest edition of IS 10418) suitable for vertical / horizontal transport, as the case may be and shall be suitable to withstand rough handling during transport and outer storage. Similarly, the inside surface of drum shall have the protective layer of varnish / paint to protect it from white ants. There shall be no gaps in the wooden lagging around the drum. The wooden drums shall be reinforced with steel bends and strips for better protection reinforcements so as to withstand rough handling during transport by Rail, Road etc. The firm shall be responsible for any damage to the cables during transit due to improper and inadequate packing. Wherever necessary, proper arrangement for lifting, such as lifting

hooks, shall be provided. The packing should withstand extended storage conditions in open yards. The standard length of the cable in each drum shall be 250 metre \pm 2.5%. Any cable found short inside the packing cases will be rejected.

6.6.2) **Marking:-** Cable drum shall carry all the information as per IS:7098 (Part-II) stenciled clearly in the drum. In addition to the standard information as above, the drum should also carry the following information clearly stencilled in it:

- (i) The letters "KSEBL"
- (ii) Purchase Order No. and Date
- (iii) Address of consignee.

6.6.3) **Manufacturer's Identification in the Cable:-** The manufacturers name, trade mark, voltage grade, year of manufacture etc. shall be embossed on the cable as stipulated in IS 7098 (Part II). The embossing shall be done only on the outer sheath. Further, improved fire performance for Category C2 shall be identified by indenting, embossing the appropriate legend on the outer sheath throughout the cable length in addition to the existing marking requirements.

6.7) **Inspection and despatch:-** All the test and inspection shall be made at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. All Tests shall be performed in presence of Purchaser's representative if so desired by the Purchaser. The manufacturer shall give at least Twenty (20) days advance notice for witnessing such tests.

The manufacturer shall afford the inspector representing the purchaser all reasonable facilities without charge, to satisfy him that materials is being furnished in accordance with the inspection.

Certified copies of all routine tests carried out at works for each batch shall be furnished in two (2) copies along with the inspection call (pre-factory report) for approval of the

purchaser. The acceptance test report signed by the manufacturer and inspector shall be furnished for obtained MDCC. The cables shall be despatched from Works only after receipt of Purchaser's written approval of the test reports and MDCC.

Upon delivery of the cable KSEBL will inspect them and / or may perform relevant tests in order to verify compliance with this specification. The Manufacturer / Supplier shall replace/rectify without any extra or additional charge to KSEBL, cables which upon examination, test or use, fail to meet any of the requirements in the specification.

6.8. **Sealing of cable ends on drums:-** The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The core ending shall be sealed effectively with water resistant compound applied over the core and provided with a heat shrinkable or push-on or Tapex or cold shrinkable type cap of sufficient length, with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable **at any point of time.**

6.9. **Documents/Drawings:-** The following shall be submitted by the Bidder along with the tender for tender evaluation. All the required details in complete form shall be submitted through relevant, legible documents in English to avoid delay due to back reference. **Partial submission shall not be restored to by the bidder.**

- a) Guaranteed Technical Particulars completely filled and signed by the bidder.
- b) Copies of certificates of type tests required as per IS: 7098 (Part-II) carried out in **NABL accredited lab/Approved Lab of Government of India/CPRI**. The tests shall be carried out in accordance with appropriate part of IS: 10810. The Type Test Certificates for a cable of the same type and design of the Cable offered and carried out within 5 years before the date of opening of the Tender shall be furnished.



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- c) Manufacturer's Catalogue giving cable construction details, characteristics and Cross sectional drawings of the cable showing detail dimensions.
- d) List of Customers to whom the Cable of similar rating have been supplied.
- e) Quality Assurance Plan / Procedure adopted by the manufacturer for ensuring the quality of the manufacturing process from raw material procurement to supply.
- f) Detailed test program to be followed during factory testing.
- g) Bidder shall submit attested photocopy of valid ISI Licenses with technical bid.
- h) An illustrated literature on the cable, giving full technical information on current ratings, cable constants, short circuit ratings, derating factors for different types of installations, packing details, weights and other relevant information.

Sd/-

Chief Engineer (SCM)

GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE BIDDER

Sl. No	Particulars	Board's Requirement
I)	CABLE PARAMETERS	
a)	Cable Designation	A2XFaY
b)	Applicable standards for manufacturing	IS:7098(P-2) with latest amendments
c)	Conductors Nominal cross sectional area mm ²	500
d)	Material	Aluminium as per IS8130
e)	Number of strands / core (Min.)	53 (min) as per IS 8130
f)	Actual aluminium area mm ²	500 (Nominal)
g)	Tensile strength of aluminium N/mm ²	Min 100
h)	Conductor Resistance Ω/KM at 20 ⁰ C	0.0605
	Cable parameters to be provided by Bidder	
a)	Approximate AC resistance @ ohm/ Km at 90 ⁰⁰ C	
b)	Capacitance in µ F/Km	
c)	Impedance in ohm/Km	
d)	Surge Impedance in ohm	
e)	Approximate conductor weight / km	
f)	Volume resistivity ohm mm ² at 20 ⁰ C.	0.028264
g)	Purity of aluminium used (%)	99.60%
h)	Voltage Grade kV	6.35/11 kV with

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2)	CONDUCTOR SCREEN	
a)	Material	Extruded semiconducting XLPE compound
b)	Thickness (min.)	0.3
3)	METTALIC SHIELD	
a)	Material & Thickness (nominal)	copper tape (applied over extruded layer of insulation screen) & thickness shall be for suitsbly selected to satisfy 7kA for i sec short cuircuit current rating of screen and armour combined
b)	Short circuit current rating	7 kA for 1 sec
4)	INSULATION	
a)	Material	XLPE (dry cured) IS 7098 (Part II) 2011
b)	Thickness (Nom.) mm	3.6
c)	Tensile Strength (Min) N/mm ² .	12.5
d)	Elongation at Break (Min.) %	200
e)	Volume Resistivity (ohm-cm).	1x10 ¹⁴ at 27°C 1x10 ¹² at 90°C
5)	ARMOUR	
a)	Material	Hard drawn Al flat strip
b)	Size of Armour mm (Nominal)	4.0x0.8
c)	Elongation at Break % (min)	6 as per IS 3975
d)	Tensile Strength N/mm ²	100 - 150
e)	Weight of Zinc Coating (min).(gm/m2)	As per IS
f)	Resistivity ohm-M	2.8264x10-8
6)	OUTER SHEATH	
a)	Material	FRLSH PVC type ST2 as per IS 5831/84
b)	Thickness (Min) mm	1.72

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c)	Tensile Strength (Min.) N/mm ²	12.5
d)	Elongation at Break (Min.) %	150
e)	Volume resistivity	Confirm to IS
f)	Colour	Black
7)	INNER SHEATH	
a)	Material	PVC extruded type ST2 with IS 5831/84
b)	Thickness mm (min)	0.5
c)	Colour	Black
8)	INSULATION SCREEN	
a)	Material	Strippable extruded semi conducting compound strippable type
b)	Thickness mm (min)	0.3
c)	Colour	Black
9)	Continuous current rating of cable- In ground (at 30⁰C), in Air (at 40⁰C),in Duct (at 40⁰C) A	495 680 365
10)	SHORT CIRCUIT CURRENT RATING	
a)	Short Circuit current rating for 1 sec for conductor. $I=0.094xA/\sqrt{t}$ (1 sec)	47 kA
b)	Short Circuit Current Rating for 1 second for armour & screen combined (kA)	7 kA
11)	DIMENSIONS OF THE CABLE	
a)	Overall dimension of Cable (Approx)mm	44±3
b)	Standard Length of Each piece(mtrs)	250
c)	Tolerance if Any on Standard Length	±2.50%
d)	Dimensions of the drum (overall diaxwidth) mm	As per IS 10418
e)	Weight of Cable in one drum(kg)	>700

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f)	Weight of cable drum	>250
g)	Gross Weight of drum including weight of cable Kg.	>950
h)	Standard according to which cable will be manufactured & Tested	IS 7098 part II 2011
12)	CONSTRUCTIONAL DETAILS OF DRUM	
a)	Type of wood used	As per IS 10418
b)	Number and thickness of piles forming the flange	
c)	Number & diameter of barrel bolts	
d)	Thickness of barrel battons mm	
e)	Spindle hole diameter mm	
f)	Thickness of external laggings mm	
g)	Details of protective wrappings	
h)	Weight of empty drum with protective wrapping and external laggings kg (Approximate)	
i)	Standard to which the cable drum conforms	
13)	OTHER PARTICULARS IF ANY	
a)	Overall quantity tolerance	±1%
b)	Sequential length marking	Shall be printed on every meter of length on outer sheath by hot foil indenting/printing
c)	Packing material	Non-returnable wooden drum
d)	Embossing Details	Manufacturer's name and trade name, voltage grade ie. 6.35/11 kV, Year of manufacture & improved fire performance for category C2 ie FRLSH shall be embossed on outer sheath at an interval not exceeding one meter



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e)	FRLS properties of outer sheath	
1	Min Oxygen index as per ASTM - 2863	29.00%
2	Min. Temperature index as per ASTM D- 2863	250°C
3	Max. acid gas generation as per IEC 745 (P-1)	20% (Max)
4	Max. smoke density Generation ASTM 2843	60% (max)
5	Flammability test	As per IEC 332 Part I

Sd/-

Chief Engineer (SCM)