

2. XLPE Power Cables (11kV & 33 kV)

SECTION I

STANDARD TECHNICAL REQUIREMENT

1.0 SCOPE:

This section covers the standard technical requirements of design, manufacturing, testing, packing and dispatching of 11 kV and 33 kV XLPE HT Power Cable.

2.0 APPLICABLE STANDARDS

The materials shall conform to the latest editions of the following Indian/International Standards :

IS 7098 Part 2 : 1985 XLPE insulated PVC sheathed cables For working voltages from 3.3 kV up to and including 33 kV

IS 5831 : 1984 PVC Insulation and Sheath of electric Cables

IS 8130:1984 Conductors for insulated electric cables and flexible cords. IS 613:1984 Copper rods and bars for electrical purposes.

IS 3975:1988 Mild steel wires, formed and tapes for armouring of cable. IS 10810:1984 Method of tests for cables.

IEEE-383:1974 Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.

ASTM-D2843,1993 Standard test method for density of smoke from burning or decomposition of plastics.

ASTM-D2863, 1991 Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).

NEMA-WC5,1992 Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.

IEC:754 Test on gases evolved during combustion of electric cables -

(Part-1):1994 Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.

IEC:332 Test on electric cables under fire conditions

(Part I):1993 Test on a single vertical insulated wire or cable. IS 3961 Recommended current rating for cables -

(Part II):1967 PVC insulated and PVC sheathed heavy duty cables.

IS 10418:1982 Drums for electric cables.

3.0 GENERAL REQUIREMENTS

All cables shall be suitable for high ambient, high humid tropical Indian Climatic conditions. Cables shall be designed to withstand the mechanical, electrical and thermal stresses under the unforeseen steady state and transient conditions and shall be suitable for proposed method of installation.

Conductor shall be of uniform, of good quality, free from defects Aluminium copper.

Insulation shall be Cross Linked Polyethylene (XLPE) .

For 33 kV and 11 kV cables, conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 33 kV cable shall be "Dry curing/ gas curing " only, whereas for 11 kV and 3.3 kV cables it shall be "Dry curing/ gas curing / Steam curing".

Extruded Semi-conducting screening and metallic screening of copper tape shall be generally as per IS 7098 (Part-II) with latest amendments. The semi conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

The insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of insulation. The semi-conducting screens should be effectively cross linked to achieve 90 ° C cable rating. The contact surface between insulation and insulation screen shall be smooth and free from protrusion and irregularities.

The interface between insulation and insulation screen shall be free of any voids. Insulation screen shall be strippable type.

The metallic screen shall consist of a layer of copper cable applied in helical form.

Inner sheath - All armoured and multi-core un-armoured cables shall have distinct extruded inner PVC sheath of black colour.

Armouring - Material for armour for Single Core Cable shall be Aluminum wire. For Multicore cable it shall be GS wire / flat. Armouring shall be as per relevant IS and it shall have minimum 90% coverage.

Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath – It shall be of black colour PVC (type ST2 as per IS 5831) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 (one) Meter distance. Word "FRLS" shall also be embossed on it at every 5 (Five) meter distance.

FRLS Properties - All cable shall be Flame Retardant, Low Smoke (FRLS) type. Outer sheath shall have the following properties –

Acid Gas Generation – Max 20% (as per IEC 754-1)

Smoke density rating: 60% (As per ASTM D 2843)

Flammability test - As per Swedish chimney test F3 as per SEN 4241475

As per IEC 332 part-3 (Category B)

Minimum bending radius shall be 10 D

Repaired cables shall not be acceptable.

4.0 CURRENT RATING OF CABLES

- 1) Normal current rating shall not be less than that covered by IS 3961. Vendor shall submit data in respect of all cables in the prescribed format.
- 2) Tables given de-rating factors for various conditions of cable installation including the following, for all types of cables shall be furnished.
 - Variation in ambient air temperature. - Variation in ground temperature.

- Depth of laying.
 - Cables laid in the ground - Cables laid in trench
 - Cables laid in ducts - Soil resistivity.
 - Grouping of cables.
- 3) The value of short circuit withstand current ratings of all cables shall be indicated for a short circuit for 1 second duration and should also specify the maximum temperature during short circuit.
 - 4) The following factors shall also be accounted for, while specifying the maximum short circuit withstand of the cables.
 - 5) Deformation of the insulation, due to thermo-mechanical forces produced by the short circuit conditions, can reduce the effective thickness of insulation.
 - 6) Conductor and core screens can be adversely affected with loss of screening effect. Likewise the thermal properties of the outer sheath material can be the limitation.
 - 7) It is essential that the accessories which are used in the cable system with mechanical and/or soldered connections are suitable for the temperature adopted for the cables.
 - 8) Formula for calculating short circuit current for different duration or curve showing short time current v/s time for different sizes of cables shall be furnished by vendor.

5.0 CABLE DRUMS

- 5.1 Cables shall be supplied in non-returnable wooden or steel drums of heavy construction and drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.
- 5.2 All Power Cables shall be supplied in drum length of 1000 m. Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. The cable length per drum is allowed a tolerance of $\pm 5\%$. The tolerance allowed on total quantity of each size is as given below.
 - 3.1 150 meters for cable length upto 10 kms.
 - 3.2 100 meters for cable length more than 10 kms. and up to 20 kms.
 - 3.3 150 meters for cable length more than 20 kms.

Where the ordered quantity is not multiple of 1000 m and the incremental quantity is very small, the same may be included in one of the drums. Otherwise, an additional length for the incremental quantity will be supplied.
- 5.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 5.4 A clear space of at least 40mm shall be left between the cables and the logging.
- 5.5 Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 5.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

6.0 TESTS

- 6.1 Type Tests

The following shall constitute type tests:

- i) Tests on conductor
 - a. Annealing test (for copper)
 - b. Tensile tests (for aluminium)
 - c. Wrapping tests (for aluminium)
 - d. Resistance test
- ii) Tests for armouring wires/strips
- iii) Test for thickness of insulation and sheath
- iv) Physical tests for insulation
 - a. Tensile strength and elongation at break
 - b. Ageing in air oven
 - c. Hot test
 - d. Shrinkage test
 - e. Water absorption (gravimetric)
- v) Physical tests for out sheath
 - a. Tensile strength and elongation at break
 - b. Ageing in air oven
 - c. Hot test
 - d. Shrinkage test
- vi) Bleeding and blooming tests (for outer sheath)
- vii) Partial discharge test
- viii) Bending test
- ix) Dielectric power factor test
 - a. As a function of voltage
 - b. As a function of temperature
- x) Insulation resistance (volume receptivity) tests
- xi) Heating cycle test
- xii) Impulse withstand test
- xiii) High voltage test
- xiv) Flammability test

6.2 Acceptance tests

The following shall constitute acceptance tests:

- a. Annealing test (for copper)
- b. Tensile test (for aluminium)
- c. Wrapping tests (for aluminium)

- d. Conductor resistance test,
- e. Test for thickness of insulation
- f. Hot set test for insulation,
- g. Tensile strength and elongation at break test for insulation and sheath
- h. Partial discharge test (for screened cables only)
- i. High voltage test and
- j. Insulation resistance (volume resistivity) test

6.3 Routine test

The following shall constitute routine tests:

- i) Conductor resistance test
- ii) Partial discharge test (for screened cables only) and
- iii) High voltage tests.

6.4 Optional tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests.

SECTION II

SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.

1.0 **SCOPE**

This section of the specification covers project information, site condition, desired Technical parameters and quantity of XLPE Cable.

1.1 Project Information

- a. Customer :
- b. Engineer/Consultant :
- c. Project Location :
- d. Transport facilities
 - i) Nearest Railway station : /Gauge
 - ii) Distance from site :
- e. Access Roads :

1.2 **SITE CONDITIONS**

- (i)** Ambient air temp. (max.) °C :
- (ii)** Ambient air temp. (min.) °C :
- (iii)** Design ambient temp. °C :

- 1.2.1 Relative humidity for design : purposes
- 1.2.2 Height above mean sea level in : meters
- 1.2.3 Earth quake data

- i) Seismic zone : IS:1893-84

ii) Seismic acceleration : As per IS 2.2.4

1.2.4 Wind data

Site Wind Pressure Kg/m² : As per IS 2.3

1.3 System Particulars

a.	Line Voltage (kV)	11/33
b.	Highest System Voltage (kV)	12/36
c.	Number of Circuits	1
d.	Frequency	HZ50
e.	Neutral	effectively earthed
f.	Short circuit level (KA)	22.77 KA, 31.8KA / 22.5KA,45KA

1.4 **SPECIFIC TECHNICAL REQUIREMENTS**

Technical Parameters of the cable shall be as follows:

S. No.	PARTICULAR	Unit	DATA	DATA
1	Rated Voltage	kV	6.35/11	19.0/33
2	Type of Insulation	-	XLPE	XLPE
3	Single core/ Multi core	-	Single/Three core	Single/Three core
4	Armoured / Unarmoured	-	Armoured	Armoured
5	Material of Conductor	-	Aluminium/Copper	Aluminium/Copper
6	System	-	11 kV Earthed	33 kV Earthed
7	Highest System Voltage	kV	12	36
8	Conductor size	sq. mm	120, 150, 185, 240, 300	150, 185, 240, 300, 400
9	Material		Stranded Aluminium/copper	Stranded Aluminium/copper
10	Shape of Conductor		Circular	Circular
11	Short Circuit Current	kA	13.12 , 18.35 for 3 secs.	13.12, 26.24 for 3 secs
12	Power Frequency Withstand Voltage	KV rms	28	70
13	Lightning Impulse Withstand Voltage	kVp	75	170
14	Continuous Withstand Temperature	Deg C	90	90
15	Short Circuit withstand Temperature	Deg C	250	250
16	Oxygen Index		Min 29 (as per ASTM D 2863)	Min 29 (as per ASTM D 2863)
17	Acid Gas Generation		Max 20% (as per IEC 754-1)	Max 20% (as per IEC 754-1)
18.	Smoke Density Generation		60% (As per ASTM D 2843)	60% (As per ASTM D 2843)
19.	Flammability Test		As per Swedish Chimney test	As per Swedish Chimney test

SECTION-III
GUARANTEED TECHNICAL PARTICULARS

Sl. No.	Item Particulars	Unit
1	Manufacturers Name & Address	
2	Country of manufacturer	
3	Type of cable	
4	Applicable standards for manufacturing	
5	Applicable standards for testing	
6	Rated voltage	kV
7	Maximum service voltage	kV
8	Maximum continuous current carrying capacity per cable when lain in air at an ambient air temperature of 50 deg. (single core cables solid bonded)	A
9	Maximum continuous current carrying capacity per cable when lain in ground at a depth of 1.0 m (ground temp. 40 deg. C and soil thermal resistivity of 150 deg.c/watt/cm max. Conductor temp. 90 deg. C) (single core cables solid bonded)	A
10	Maximum continuous current carrying capacity per cable when drawing into duct./pipes (single core cables solid bonded)	A
11	Maximum continuous current carrying capacity per cable when lain in covered RCC trenches at an ambient temperature of 50 Deg. C laying conditions to be specified (Single core cables solid bonded)	A
12	Short circuit withstand capacities for 1 second of (With a conductor temperature of 90 Deg. C at the commencement	
i)	Conductor	KA
ii)	Screen	KA
iii)	Armour	KA
13	Conductor	
i)	Material & Grade	
ii)	Nominal cross – sectional area	sq.mm
iii)	No. of strands	
iv)	Diameter of each strand (Nominal)	mm
v)	Max. DC resistance of conductor at 20 Deg. C	ohm/km
vi)	Max. AC resistance of conductor at 90 Deg. C	ohm/km
14	Reactance of cable at normal frequency (Approx)	ohm/km
15	Electrostatic capacitance at normal frequency	microfarads per km
16	Charging current	
17	Loss tangent at normal frequency at U ₀	
18	Conductor screen	
i)	Material	
ii)	Nominal thickness	mm
19	XLPE Insulation	
i)	Composition	
ii)	Type of curing	

iii)	Thickness of insulation (nominal)	mm
iv)	Tolerance on thickness	mm
v)	Dielectric constant at normal frequency	
vi)	Specific insulation resistance at 20 deg. C	ohm/km
vii)	Min. Volume resistivity at 20 deg. C	
viii)	Min. volume resistivity at 90 deg. C	
ix)	Min. Tensile strength	kg/sq.cm
x)	Min. Elongation percentage at rupture	%
xi)	Identification of cores	
20	1.2/50 microsecond impulse wave withstand voltage	kVp
21	5 min. power frequency withstand voltage	kV
22	Max. Dielectric stress at the conductor	kV/cm
23	Max. Dielectric stress at the conductor screen	kV/cm
24	Insulation screen	
i)	Material	
ii)	Extruded/wrapped	
iii)	Nominal thickness	mm
iv)	Colour	
25	Metallic screen	
i)	Material / composition	
ii)	Nominal radial thickness / dia	
26	Nominal diameter over metallic screen	mm
27	Nominal radial clearance allowed under metal sheath	mm
28	Type and material of filler	
29	Armour	
i)	Material and type	
ii)	Dia	