



TECHNICAL SPECIFICATION FOR 11/22/33 kV NOMINAL VOLTAGE HT TR - XLPE POWER CABLES
[SPECIFICATION NO. DIST: MSC-I/SPEC/HT CABLE/TR - XLPE/7/2010(221210)]

**MAHARASHTRA STATE ELECTRICITY DISTRIBUTION
CO. LTD. MUMBAI**

TECHNICAL SPECIFICATION

FOR

11/22/33KV

H.T. T R XLPE POWER CABLES

FOR

DISTRIBUTION NETWORK IN MAHARASHTRA

(SPEC NO. DIST: MSC-I/SPEC/HT CABLE/TR - XLPE/7/2010/R0/221210)

(Based on old Spec No. MM/I/HTXLPE/2006for HT XLPE Cables)

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1. **SCOPE:**

The specification covers design, manufacture, shop testing, packing and delivery of 11, 22 & 33 kV, multi core, cross linked polyethylene insulated power cables by road/rail to the designated Store Centers in the State of Maharashtra. These cables shall be suitable for the 3 phase AC-50 Hz system with the nominal voltage of 11/22/33 kV which may reach maximum of 12/24/36 kV respectively. These cables shall primarily be designed for effectively earthed neutral system. The cable shall be manufactured strictly conforming to IS:7098 (Part 2) - 1985 amended up to date and shall bear ISI mark.

2. **SERVICE CONDITIONS:**

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

2.1.1	Maximum ambient temperature in open air (°C):	50
2.1.2	Maximum ambient temperature in shade (°C)	45
2.1.3	Minimum temperature in shade(°C):	3.5
2.1.4	Relative humidity (%)	10 to 100
2.1.5	Maximum annual rainfall (mm)	1450
2.1.6	Maximum wind pressure (Kg/ Sqmtr.)	150
2.1.7	Maximum altitude above mean sea level (Mtrs)	1000
2.1.8	Isoceraunic level (days/year)	50
2.1.9	Seismic level (Horizontal acceleration)	0.3 g.
2.1.10	General nature of climate :	Moderately hot and humid tropical climate, conducive to rust and fungus growth.

3. **STANDARDS:**

3.1 Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the HT TR XLPE power cables shall conform to the latest revisions available at the time of placement of order of all the relevant standards as listed bellow, but not limited to the said list. All cables made with TR-XLPE insulation shall be tested and/or certified to meet the performance parameters as per Annexure- I attached.

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Sr. No.	Standard No.	Title
1.	IS:8130 – 1984	Conductors for insulated electric cables and flexible cords.
2.	IS:7098 (Part 2)/1985	Cross linked Polyethylene (XLPE) Insulated PVC sheathed cable for working voltages from 3.3 kV up to and including 33kV
3.	IS:5831 – 1984	PVC insulation and sheath of electric cables.
4.	IS:3975 – 1988	Mild steel wires, Formed wires and Tapes for armouring of cables.
5.	IS:0462 (Part I)/1983	Fictitious calculation method for determination of dimensions of protective coverings of cables
6.	<u>IEC 60502-2</u>	<u>Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)</u>
7.	<u>ANSI/ICEA S-94 649:2004</u>	<u>Standard for concentric neutral cables rated 5 through 46KV</u>

4. GENERAL TECHNICAL REQUIREMENTS:

- 4.1 6.35/11 kV, 12.7/22 kV, 19/33 kV earthed, multi core power cables shall normally be with stranded compacted H2/H4 grade aluminum conductor as per IS: 8130 – 1984 with latest amendments, provided with conductor screening (of extruded semi-conducting cross link material) and shall be insulated with water tree retardant (TR) XLPE of natural colour. The insulation screening shall be provided consisting of extruded semi-conducting cross link material in combination with a metallic layer of copper tapes. Three such screened cores shall be laid up together with fillers and/or binder tapes where necessary and provided with extruded inner sheathing of heat resistant PVC conforming to type ST-2 of IS: 5831 - 1984.

Maximum continuous operating temperature shall be 90°C under normal operation and 250°C under short circuit condition

4.2 CABLE DESIGN & CONSTRUCTION:

4.2.1 Conductor :

Electrolytic grade aluminum conductor shall be of H2/H4 grade as per clause 3.1 of IS 8130/1984 and shall have flexibility class-2 in accordance with clause 5.3 of IS 8130-1984. The shape of conductor shall be compacted, stranded, and circular.

4.2.2 Conductor screen/Shield:

The conductor screen shall be an extruded layer of black, semi-conducting compound. The allowable operating temperatures of the conductor shield shall

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be equal to or greater than those of the insulation. The conductor screen shall be extruded in the same operation as the insulation. The semi-conducting screens should be effectively cross linked to achieve 90°C cable rating. The interface between the extruded conductor screen and insulation shall be free of any voids. The volume resistivity of the screen material shall not exceed 1000 Ωm at 90°C.

4.2.3 Insulation :

The insulating material shall be Cross Linked Polyethylene (XLPE) cured by dry curing process and applied by extrusion process as per IS-7098 and its latest amendments. The insulation shall be an extrusion of dry cured thermosetting cross linked poly ethylene water tree retardant material rated for 90°C continuous operation.

The insulating material shall have excellent electrical properties with regard to resistivity, dielectric constant and loss factor and shall have high tensile strength and resistance to abrasion. This shall not deteriorate at elevated temperatures or when immersed in water. The insulation shall be preferably fire resistant and resistant to chemicals like acids, alkalis, oils and ozone.

The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90°C rising momentarily to 250°C under short circuit conditions. It shall be free from any foreign material or porosity visible to the unaided eye. The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damaging the conductor.

The extruded water tree retardant (TR) XLPE insulation shall be of very high degree of purity. The manufacturer should provide the certification that the TR-XLPE compound used has proven track record. The tree retardant cross linked polyethylene insulation should be such as to retard the development and growth of water trees in the compound. The insulation compound shall be clean with low levels of contamination. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

The average thickness of insulation shall not be less than the nominal value as specified in IS: 7098 (Part II) with latest amendments. No tolerance on the negative side shall be acceptable.

4.2.4 Insulation Screen/ Shield:

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.

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The insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of the 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 the 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 tape applied in helical form

4.2.5 Core Identification:

Individual core of multi-core cables shall be colour coded and/or numbered for proper identification in accordance with clause 13.1 of IS: 7098 (Part – II).

4.2.6 Laying up of cores:

In three core cables, the cores shall be laid together with a suitable right hand lay. The interstices shall be filled with non-hygroscopic material. Further, the compounds used with fillers shall be such as to have no deleterious effect on other components of the cable and to be stable at cable temperatures.

4.2.7 Inner Sheath:

The laid up cores shall be provided with inner sheath applied by extrusion process. It shall be ensured that the shape is as circular as possible. It shall be applied to fit closely on to the laid up cores and shall be possible to remove easily without causing any damage to the underlying insulated cores and screens.

The thickness of the inner sheath shall be as per IS: 7098 (Part - II). No tolerance on the negative side shall be acceptable.

4.2.8 Armoring:

The armoring shall be of galvanized round steel wires for multi core cables. The armoring shall be applied as closely as practical. The galvanized steel wires shall comply with the requirements of IS: 3975-1988 with latest amendments. In case of Single core cable armoring shall be of Non-magnetic material conforming to IS: 3975 – 1988 (amended upto date)

The dimensions of the galvanized steel wire shall be as per IS: 7098 (Part-II). No tolerance on the negative side shall be acceptable.

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4.2.9 Outer Jacket:

The outer jacket shall consist of extruded tough outer sheath of PVC compound insulation over the armouring. Inner conductor shielding, TR XLPE insulation and outer shielding shall be extruded in one operation by special process to ensure that the insulation is free from contaminations and voids and perfect bonding of inner & outer shielding with insulation is achieved. The PVC compound for the outer sheath shall conform to type ST-2 of IS: 5831 - 1984 (amended up to date). The colour of the outer sheath shall be black. The cable must meet all the requirements of the IS: 7098 (Part 2) - 1985 amended up to date and shall bear ISI mark.

4.3 DISCHARGE FREE CONSTRUCTION:

4.3.1 The inner conductor shield, TR-XLPE insulation, and outer insulation shield shall be extruded with a true triple extruder head using a dry cure process. The conductor screen, Insulation and Insulation screen shall all be extruded in single point at one time process to ensure homogeneity and reduction of voids, in the insulation and the screening system of the cable. The bidders are requested to elaborate the manufacturing technique adopted by their manufacturers to achieve this motive.

The Company will order the verification of true triple extrusion dry cure process at manufacturer's works as a pre qualification if it is technically accepting the bid. During verification if it is found that the firm is not manufacturing the cable with true triple extrusion dry cure process the offer shall be rejected.

4.4 CONTINUOUS A.C. CURRENT CAPACITY:

Continuous a.c. current capacity shall be as per Table given below.

Conductor sizes in sq. mm.	Continuous A.C. current capacity in Amps. at maximum conductor temp. of 90°C		
	When laid direct in the ground 30°C		When laid in air_40°C
	11 kV	22/33 kV	11/22/33 kV
70 sq.mm	160	155	165
95 sq mm	190	175	200
120 sq mm	215	195	230
150 sq mm	240	225	265
185 sq mm	270	255	310
240 sq mm	315	290	345
300 sq mm	355	325	396
400 sq mm	405	385	460
500 sq mm	450	450	590

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4.5 SHORT CIRCUIT CURRENT:

Short circuit current of 11, 22 & 33kV XLPE cable shall be as per Table given below.

Duration of Short Circuit in sec	Area of Al. Conductor	Short circuit current in kA
T	A	$I=0.094 \times A/\text{sq.rt (t)}$
1	70 sq.mm	6.58
1	95 sq.mm	8.93
1	120 sq.mm	11.28
1	150 sq.mm	14.10
1	185 sq.mm.	17.39
1	240 sq.mm.	22.56
1	300 sq.mm.	28.20
1	400 sq.mm.	37.60
1	500 sq.mm	47.00
1	630 sq.mm	59.20

5. TESTS AND TESTING FACILITIES :

5.1 TYPE TESTS:

All the type tests in accordance with IS: 7098 (Part 2) - 1985, amended up to date, shall be performed on cable samples drawn by purchaser.

Type tests are required to be carried out from the first lot of supply on a sample of all sizes of cables ordered for each voltage grade. In case facilities of any of the type tests are not available at the works of the supplier, then such type test shall be carried out by the supplier at the independent laboratory at the cost of supplier. Sample for the type test will be drawn by the purchaser's representative and the type test will be witnessed by him. In case of other Government recognized laboratories / Test House valid approved Government certificate shall be enclosed along with test.

5.2 ROUTINE TESTS:

All the Routine tests as per IS: 7098 (Part 2) - 1985 amended up to date shall be carried out on each and every delivery length of cable. The result should be given in test report. Partial discharge test must be carried out in a fully screened test cell. It is, therefore, absolutely essential that the manufacturer should have the appropriate type of facility to conduct this test which is routine test.

The details of facility available in the manufacturer's works in this connection should be given in the bid.

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5.3 ACCEPTANCE TESTS:

All Acceptance tests as per IS:7098 (Part 2) - 1985 as modified up to date including the optional test as per clause no 18.4 and Flammability Test shall be carried out on sample taken from the delivery lot.

5.4 SHORT CIRCUIT TEST:

The contractor shall also undertake to arrange for the short circuit test as a type test on any one size of each voltage grade i.e on one size of 11 kV, one size of 22 kV and one size of 33 kV earthed grade shielded TR-XLPE cables ordered at a recognized testing center such as Central Power Research Institute at Bangalore/ Bhopal at the cost of supplier. If facilities for carrying out short circuit tests are available at the works of the supplier, and provided the certification procedure is approved by the Purchaser, testing at the supplier's works will be acceptable. Short Circuit test shall be witnessed by the purchaser's representative.

5.4.1 The short circuit test shall be preceded and followed by the following tests so as to ensure that the characteristics of the cable remain within the permissible limits even after it is subjected to the required short circuit rating.

- a) Partial Discharge Test.
- b) Conductor Resistance Test.
- c) High Voltage Test.

5.4.2 The manufactured cable will be acceptable only after such a sample test is successfully carried out at CPRI or at suppliers works and approved by the Purchaser.

5.4.3 The contractor can however claim exemption from carrying out Short Circuit test provided the S.C.Test was carried out by the supplier on same voltage grade for M.S.E.D.C.L. (previous M.S.E.B.) in the past within five years and the test certificates thereof submitted to our C. E. (Dist.).Chief Engineer (Dist.) may at his option grant waiver from carrying out Short circuit test if the test certificates are acceptable.

5.5 TESTING FACILITIES :

The supplier / tenderer shall clearly state as to what testing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out type, routine and acceptance tests mentioned in specified IS. The facilities shall be provided by the bidder to purchaser's representative for witnessing the tests in the manufacturer's works. If any test cannot be carried out at manufacturer's works reason should be clearly stated in the tender.

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When requested, a certified test report shall be supplied for production runs of cable. The report is to include all actual production test values required by the referenced specifications. The manufacturer should provide the traceability information from cable till the materials used in the manufacturing.

6 PACKING AND MARKING:

6.1 IDENTIFICATION MARKS ON CABLE:

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter through out the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

- a) Manufactures name and/or Trade name.
- b) Voltage grade TR-XLPE Cable.
- c) Year of manufacture.
- d) M.S.E.D.C.L.
- e) Successive Length.
- f) Size of cable
- g) ISI mark

6.2 The cable shall be supplied in continuous standard length of 250 running meters with plus minus 5% tolerance wound on non returnable wooden drum of good quality and non-standard lengths not less than 100 meters upto 5% of the ordered quantity shall be accepted. Alternately cable can be supplied wound on non-returnable steel drum without any extra cost to the purchaser. Packing and marking shall be as per clause No. 21 of IS:7098 (Part 2) - 1985 amended up to date.

6.3 Supplier should provide statistical data regarding cables of all sizes viz.-

- 1) Weight of one meter of finished product of cable of various sizes and ratings.
- 2) Weight of one meter of bare conductor used for cables of various sizes and ratings.

7 QUALITY ASSURANCE PLAN:

A detailed list of bought out items which got into the manufacture of cables should be furnished indicating the name of the firms from whom these items are procured. The bidder shall enclose the quality assurance plan invariably along with offer followed by him in respect of the bought out items, items manufactured by him & raw materials in process as well as final inspection, packing & marking. The Company may at its option order the verification of these plans at manufacturer's works as a pre qualification for technically accepting the bid.

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During verification if it is found that the firm is not meeting with the quality assurance plan submitted by the firm, the offer shall be liable for rejection.

8. GUARENTEE:

Supplier shall stand guarantee towards design, materials, workmanship & quality of process/manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract.

In the event any defect is found by the Company (MSEDCL) up to a period of 12 months from the date of commissioning or 18 months from the date of last supplies made under the contract, whichever is earlier, supplier shall be liable to undertake to replace/rectify such defects at his own costs. within mutually agreed timeframe, and to the entire satisfaction of the Company, failing which the Company will be at liberty to get it replaced/rectified at supplier's risks and costs and recover all such expenses plus the Company's own charges(@ 20% of expenses incurred), from the supplier.

Supplier shall further be responsible for 'free replacement' for another period of FOUR years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Company.

9 SCHEDULES:

9.1 The tenderer shall fill in the following schedule which form part of the offer.

Schedule `C' - Tenderer's Experience.

9.2 The tenderer shall submit the list of orders for similar type of equipments, executed or under execution during the last three years, with full details in the schedule of Tenderer's experience (Schedule `C') to enable the purchaser to evaluate the tender.

ANNEXURE - I

All cables made with TR-XLPE Insulation should be tested and/or certified to meet the following performance parameters as per ANSI /ICEA S-94-649

Property	Units	Requirements Values
Min. Avg. Electrical Breakdown Strength (Qualification test)	Kv/mm	≥ 25
Impulse Strength	Kv/mm	≥ 83
Water Tree Length	mm	0.25
Max. Bowtie Tree Density	(Number per 16.4 cu. cm)	Maximum 15 (0.12-0.25 mm range)

Manufacturing processes to produce high-quality cables with the following characteristics:

- Cure consistency with hot set/creep less than 100%
- No voids larger than 75 microns per 16.4 cubic cm
- No ambers larger than 250 microns per 16.4 cubic cm
- No contaminants larger than 125 microns and less than 5 between 50-125 microns per cubic 16.4 cubic cm tested.
- Partial discharge less than 5 pico coulombs at 52 kV
- Neutral indent on cable is less than 375 microns
- Cable insulation concentricity greater than 90% tested
- No protrusions greater than 75 microns at the conductor shield and 125 microns at the insulation shield

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SCHEDULE-C

SCHEDULE OF TENDERER'S EXPERIENCE

Tenderer shall furnish here a list of similar orders executed/under execution by him to whom a reference may be made by Purchaser in case he considers such a reference necessary.

Sr. No.	Name of client & Description of order	Value of order	Period of supply and commissioning	Names & Addresses to whom reference may be made

Name of the firm _____

Signature of the tenderer _____

Designation _____

Date _____