CHAPTER 9: TECHNICAL SPECIFICATIONS OF XLPE INSULATED COPPER CONTROL AND POWER CABLE

This technical specification intends to cover the following:

Technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in non-returnable steel drums), various sizes of copper conductor, XLPE insulated, voltage upto and including 1100 Volts, extruded PVC inner sheathed, extruded FRLS PVC outer sheathed, GI round wire armoured cables, suitable for solidly grounded system. The cables shall confirm to IS 7098-Part 1 with latest amendments. For cable list refer Table-1 (Sl. no. 1.1 to 1.19).

Note:

Tenders will only be considered from the cable manufacturers and any one supplier to whom manufacturer can authorize. The bidder shall have adequate experience of at least 5 years in manufacturing of LT/MV & HT cables and field proven experience of min 5 years.

Copper samples from the finished cable drums shall be tested at any 3rd party NABL accredited lab to ensure its purity.

The following document shall be attached with technical part of the bid:

Duly filled & Signed copy of Annexure-I, II, III & IV

Deviation sheet, if any

Table 1

Sl. No	Power Cable
1	3C X 2.5 Sq.mm, Copper Power Cable Type: 2XWY
2	4C X 2.5 Sq.mm, Copper Power Cable Type: 2XWY
3	3C X 4 Sq.mm, Copper Power Cable Type: 2XWY
4	4C X 4 Sq.mm, Copper Power Cable Type: 2XWY
5	3C X 6 Sq.mm, Copper Power Cable Type: 2XWY
6	4C X 16 Sq.mm, Copper Power Cable Type: 2XWY
7	3C X 10 Sq.mm, Copper Power Cable Type: 2XWY
8	4C X 10 Sq.mm, Copper Power Cable Type: 2XWY
9	3C X 16 Sq.mm, Copper Power Cable Type: 2XWY
10	2C X 16 sqmm
11	2CX50 sqmm
12	3.5 C X 35 sqmm
13	3.5 CX70 sqmm
14	3.5 C X 95 sqmm
15	3.5 C X 150 sqmm
16	3.5 C X 300 sqmm
17	1 C X 1000 sqmm
18	2C X 6 sqmm
Control Cable(Copper)	
1	2 C, 1.5mmsq
2	4C, 2.5 sq mm
3	5C, 2.5 sq mm
4	7C, 1.5 sq mm

Sl. No	Power Cable
5	7C, 2.5 sq mm
6	10 C, 2.5 sq mm
7	12 C, 2.5 sq mm
8	12 C,1.5 sq mm
9	14 C, 2.5 sqmm
10	17 C,1.5 sqmm
11	19 C,1.5 sqmm
12	19C,2.5 sqmm

Technical Specifications for 1.1 kV grade, Copper conductor, Power and Control cable

This section covers the technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in non-returnable steel drums), 1.1KV grade, Multi-stranded Copper conductor, XLPE insulated, extruded PVC inner sheathed, GI round-wire armoured, extruded FRLS PVC ST2 outer sheathed. Power Cables and Control Cables for effectively grounded system, conforming to the latest revisions of IS: 7098 (Part –I), 1988 & as per the technical specifications attached herewith.

STANDARDS

The design, manufacture and testing of the cable shall comply with the latest editions/amendments of the following Indian Standards, unless otherwise specified. Equipments complying with equivalent standards shall also be acceptable.

a.	**IS-7098, 1998 (Part-I)**	**:**	**Cross linked polyethylene**	**insulated**			
			PVC sheathed cables for working				
			voltages upto 1100V.				
b.	IS-3961	:	Recommended	current ratings	for		
			Cables				
c.	IS 8130-1984	:	Specification	for	conductors	for	
			insulated electric cables and flexible				
			cords.				
d.	IS-3975, 1999	:	Low Carbon galvanized steel wires,				
			formed wires & tapes for armouring				
			of cables				
e.	IS-4759	:	Specifications	for	Hot	dipped	
			galvanized coating on round steel				
			Wires				
f.	IS-5831	:	PVC insulation and sheath of electric				
			cables.				
g.	IS-10418	:	Drums for electric cables.				
h.	IS-10810	:	Method of test for cables.				

SERVICE CONDITION

Service Condition shall be as per General Technical Requirements (GTR).

DESIGN AND CONSTRUCTION PERTICULARS

9.3.1. General

The cables supplied under this specification shall be adequate insulated to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of the cables. The sheathing material shall be high quality PVC based compound. The construction of cable shall be as per IS: 7098 (Part I) – 1988.

Cable shall be designed and manufactured to prevent damage during transportation, installation & operation under all climatic & operating condition.

9.3.2. Technical parameters		
Quantity	: Refer Table-1	
Packaging	:	Steel drum packaging, each
		having single length cable ≥
		500 metres. (for size less than1000sqmm.).
Cable Type	:	A2XWY/ 2XWY (refer Table-
		1 for details)
No. of Cores	:	Shall be decided during detailed engineering (Cable sizing calculation)
Voltage Level	:	1.1Kv
System Grounding	:	Solidly Grounded

Nominal System voltage : 415V ±10%

Nominal System Frequency : 50 Hz

Maximum conductor temperature at rated current : 90 deg C

Maximum conductor temperature at Short-circuit : 250 deg C

Conductor Conductor Material : H4-Grade Aluminium of purity > 99.6% Electrolytic grade Copper, Purity > 99.97%

Conductor type : Stranded with number of strands as per IS 8130 (Part-I) 1984

Insulating material : Cross-Linked-Polyethylene (XLPE) Compound.

Core Identification Strips : Red, Yellow, Blue & Black (for neutral)

Material of Inner Sheath : FRLS, PVC ST-2 Compound

Conductor

COPPER

The conductors shall be made from high conductivity copper rods complying with IS: 613-1964. The conductor material used shall be electrolytic grade with high purity. Two sample conductor randomly selected from finished lot of cables, shall be tested for its purity at any 3rd party NABL accredited lab. The conductors shall conform to appropriate dimensions, resistance and number of wire in the conductor (number of strands) as given in IS 8130 (Part I): 1984.

Insulation

The insulating material for power and control cables shall be extruded cross linked polyethylene (XLPE) compound as per IS-7098(Part-I)-1988. The minimum thickness of insulation shall not be less than the values specified in Table-2 of IS-7098 (Part-I)-1988. No negative tolerance shall be applicable for the thickness. The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions. The cores shall be identified as per the following colour scheme:

3-Core - Red, Yellow & Blue

3 ½ or 4-Core - Red, Yellow, Blue & Black

Inner Sheath

The inner sheath shall be extruded FRLS PVC, Type ST2, compatible with thermal rating of insulation conforming to IS-6380-1984. The sheath shall have adequate thickness, mechanical strength and elasticity, as specified in IS 5831. The material shall be soft thermoplastic type, applied by extrusion method. The thickness of the inner sheath shall be as per IS: 7098 (Part I) and the color of the inner sheath shall be Grey. The inner sheath shall be so formed that it fits closely on the laid up cores and could be easily removed without damaging insulation. One or more layer of proofed plastic tape shall be provided over the laid up core before extrusion.

9.7 Outer Sheath

Extruded outer sheath shall be provided over the armouring. The material used for sheathing shall be FRLS PVC sheath, Type ST-2 base compound conforming to IS 1554/ IS 5831 for power and control cable. The outer sheath shall be so formed that it fits closely on the laid up armour and could be easily removed without damaging the intermediate sheath and insulation. The colour of the outer sheath shall be black. The thickness of outer sheath shall be in accordance with the IS 1554 (Part-I)-1988. Suitable additives shall be added to prevent attack by rodents and termites. All serving must be given anti-termite treatment.

Cables shall have suitable fillers laid up with the conductor to provide a substantially circular cross section before the sheath is applied. Fillers shall be suitable for the temperature of the cable and compatible with the insulating material. The material shall be of the best quality and workmanship. The fillers and sheath material shall be non-hygroscopic. All materials shall be new, unused and of the finest quality.

9.8 TESTS

All the tests specified below shall be carried out in accordance with the Indian Standards by the manufacturer in the presence of Purchaser’s representative. If the cable fails to pass the test specified, the Purchaser shall have the option to reject it. Shipping release shall be obtained from the Purchaser's representative. The Purchaser, however reserves the right to waive off the inspection.

The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards, in addition any test called for by the Purchaser or his representative to ensure that the equipment being supplied fulfils the requirement of the specification.

For test not covered by any code or specifically mentioned in this specification, the test procedures are to be agreed with the Purchaser.

9.9 Pre Dispatch Inspection

The manufacturer shall be given at least 15 days advance notice prior to the commencement of testing, so that Purchaser’s representative can plan to witness the tests.

All the tests indicated in the test clause of this specification shall be carried out in the presence of Purchaser’s representative by the manufacturer and shall provide all the facilities and equipment for testing.

Six copies of the Test Certificate shall be furnished to the Purchaser for approval prior to dispatch of cables from factory.

Visual check to conform the details given in this specification is to be done. In addition to the above, the general workmanship of the cable drums and cables laid in drums shall be checked.

Manufacturer shall have proper test set up for testing all the routine tests & type tests on finished cables as per IEC.

List of type tests mentioned in the tender specifications shall be conducted on four drum irrespective of type test certificates given or not.

9.10 Type Test

Type tests on four randomly selected cable drums will have to be conducted in the presence of the department’s representative. The test samples will be taken from finished cables. This test shall be in accordance to IS: 7098, Part-1,1988.

a. Test on Conductor

Annealing test for copper conductors

Tensile test for aluminium conductor

Wrapping test for aluminium conductor

Conductor Resistance Test

Test on Insulation

Physical dimension measurement

Tensile strength and elongation at break

Hot set test

Shrinkage test

Ageing in air oven

Water absorption test

Test on round Armour

Physical dimension measurement

Tensile strength

Elongation at break

Torsion test for round wires

Winding test for firmed wire

Mass of zinc coating.

Uniformity of zinc coating

Resistivity measurement, Resistance test for armour

Test on Sheath

Physical dimension measurement

Tensile strength & Elongation at break test

Ageing in air oven

Loss of mass in air oven

Shrinkage test

Hot deformation test

Heat shock test

Thermal stability test

Insulation Resistance Test

High Voltage Test at room temperature

Volume resistivity at room temperature & at 90o C. (IS-10810-Part 43)

Flammability test

Test requirement of FRLS inner and outer sheath

The inner and outer sheath of cables shall meet the following test requirements related to flame retardant, low smoke emission, low acid and toxic gas emission. The BIDDERs shall have proper test apparatus to conduct all the relevant tests as per the applicable standards:

Flame retardant test on single cable.

Oxygen Index Test

The critical oxygen index value shall be minimum 29 when tested at 27+2ºC as per ASTMD-2863

Temperature index test

Temperature index value shall be minimum 250ºC at oxygen index of 21 when tested as per NES 715.

Flammability test

Smoke Density Test

The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.

Acid Gas Generation test (halogen acid gas evolution)

The hydrochloric acid generation when tested as per IEC 754-1 shall be less than 20% by weight.

Test for specific optical density of smoke

Anti termite and rodent property test

The sequence of electric tests shall be as per the relevant Indian/International standards. The Bidder shall submit the sequence of tests for the approval of the purchaser before conducting the tests. A copy of the adopted standard shall also be supplied.

9.11 Routine Test (On each drum)

The following routine tests shall be carried out by the Manufacturer on each and every length of the cable in the presence of Purchaser's representative at manufacturer's works.

a. Resistance test for conductors

b. Insulation resistance test

c. High voltage test

9.12 Conductor purity test

Two samples of aluminium and copper shall be taken from any of the finished set of cables at random and the sample shall be tested for its purity at a NABL accredited lab.

Qualifying Criteria:

The test results should be within limits as per IS 7098. All the routine tests as per IS 7098 / IEC shall be conducted and passed as per the limits given in the standards. All the bought out certificates will be verified and the test results shall be as per respective standards.

Identification

The following details shall be marked sequentially for each meter run length of the cable by non-erasable embossing on the outer sheath:

Reference to Indian Standard

Name of the manufacturer/ Trade Name

Name of the project:

Configuration of the cable: viz. Voltage grade, no. of Core, Sq. mm, A2XWY/2XWY/YWY / YY as applicable

Year of manufacturing

Sequential marking of running meter length

The running length of the cable shall be identified at regular intervals of one meter (Increasing order from inner end to outer end of the cable)

PACKAGING

Each drum shall consist of single length cable ≥ 500 metres (for sizes less than 1000sqmm.).

The cable shall be wound on non-returnable steel drums of suitable size, packed and marked.

Packing shall be sturdy to protect the cable from any injury during transportation, handling and storage. The cut ends of the cable shall be sealed by means of non-hygroscopic sealing material preferably Heat shrinkable end caps.

One end of the cable shall be brought out of the drum and suitably clamped to the drum flange with proper mechanical protection. Location of the other end may be marked on the drum.

The cable shall be placed on drums in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. No undue stress shall appear on cables when laid on drums.

The cable drum shall carry the following information stencilled on a metallic label, securely attached to each end of the drum:

Reference to the Indian standard

Manufacturer's name, brand or trade mark

Type of cable and voltage grade

No. of cores

Nominal cross-sectional area of conductor

Cable code

Length of cable on drum

No. of lengths on reel, drum or coil (if more than one)

Gross weight

Country of manufacture

Year of manufacture

Direction of rotation of drum (an arrow)

ISI certification mark

PREFERRED MAKE

POLYCAB/KEI/KEC or reputed brand possessing system certification of ISO 9001:2008, ISO14001:2004, OHSAS18001:2007 & EN 16001-2009 and product certifications IS: 7098 (Part-I), CE, UL etc. Quotations without these certification details will not be considered for technical evaluation.

Preferred make of bought out material:			
a.	Aluminium for Conductor	:	Hindalco/Balco/Nalco or any other approved make at the time of detailed engineering.
b.	Copper for Conductor	:	Hindustan Copper/Hindalco or any other approved make at the time of detailed engineering
c.	XLPE compound of Insulator	:	Dow/Borealis at the time of detailed engineering

GUARANTEE

All the cables shall be guaranteed against faulty material, defective design & poor workmanship for a period of 18 months from the date of commissioning. The materials becoming defective during the guarantee period shall be replaced free of cost and the defects arising out of the works shall be rectified free of charge without delay.

ANNEXURE-I

Technical Data Format for 1.1KV, XLPE Insulated, Copper Cable

The tenderer shall furnish all technical details as called for in the following format for all sizes of cables failing which the tender shall be considered as incomplete. The details shall be furnished separately for all the cables.

Sl. No.	**Particulars**	**Details**
A	Cores	
1	No. of cores	
2	Nom Area of conductor in sq mm.	
3	Voltage Grade	
B	Conductor	
1	Standard Applicable	
2	Material Copper Grade	
3	Purity	
4	Nominal Cross Sectional Area	
5	Form of conductor/circular shaped	
6	No. of strands	
7	Nominal dia of each strand	
8	Temperature co-efficient of resistance at 20 degree celsius	
C	Insulation	
1	Standard Applicable	
2	Material (Mention Type)	
3	XLPE is cured by steam process or Gas process?	
4	Minimum Average Thickness	
5	Tolerance on the smallest of the measured values of thickness of Insulation	
6	Minimum volume resistivity at 27 deg cel	

Sl. No.	Particulars	Details
7	Minimum volume resistivity at 70 deg cel	
8	Colour Scheme for identification of cores	
9	Average Dielectric Strength	
D	Inner Sheath	
1	Standard Applicable	
2	Material for inner sheath	
3	Minimum thickness of inner sheath	
4	Whether extruded	
E	Armour	
1	Standard Applicable	
2	Shape	
3	Size	
4	Material for Armour	
F	Outer Sheath/Overall Covering	
1	Standard Applicable	
2	Material (type)	
3	Whether extruded	
4	Minimum average thickness	
5	Whether anti-termite treatment has been given in the outer sheath	
6	Whether flame retardant low smoke compound added in the outer sheath	
G	Electrical Properties	
1	Maximum DC Resistance of conductor at 20 deg Celsius in ohms/km	
2	Maximum DC Resistance of amour at 20 deg Celsius in ohms/km	
3	Maximum Permissible conductor temperature	
	Under continuous full load	
	Under transient conditions	
4	Loss Tangent at normal frequency	
5	Reactance at maximum operating temperature 50 Hz (ohm/km)	
6	Capacitance at maximum operating temperature 50 Hz (ohm/km)	
7	Total Impedance at maximum operating temperature 50 Hz (ohm/km)	
8	Recommended continuous current rating	
	In Ground at 30 deg C Ground Temperature (A)	
	In Trench/Ducts at 40 deg C (A)	
	In Air at 40 deg C ambient Temperature (A)	
9	Short Ckt Current Rating for 1 sec duration (in KA)	
	Conductor	
	Armour	
10	Minimum volume Resistivity of insulation	
	At 27 °C in Ohm cm	
	At Max operating temperature in Ohm-cm	
11	Approximate AC resistance at max. Operating temperature	
	Phase	
	Neutral	
H	Mechanical Data	

Sl. No.	Particulars	Details
1	Overall Dia of the cable	
2	Dia of the cable under the sheath	
3	Diameter under armour	
4	Diameter over the stranded cores	
5	Wight of cable per km.	
6	Drum length	
7	Tolerance on drum length	
8	Total weight of the drum	
9	Dimension of the drum	
10	Recommended minimum installation radius/ bending radius	
11	Maximum safe pulling force	
12	Whether identification as per clause of the specification is being provided	
13	Whether packing has been done as per clause of the specification	