TECHNICAL SPECIFICATION FOR 1.1kV XLPE INSULATED PVC SHEATHED POWER CABLES

1. Scope

This specification covers the design, manufacture, shop testing, supply and delivery in proper packed condition of 1.1kV voltage grade Aluminum Conductor, XLPE insulated, PVC sheathed, Armoured, screened Power Cables generally conforming to the latest standards of IS / IEC / BS or equivalent.

2. Service Conditions:

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

a) Maximum ambient temperature of air: 50˚C
b) Maximum temperature of air in shade: 4˚C
c) Maximum daily average ambient temperature: 40˚C
d) Maximum yearly average ambient temperature: 30˚C
e) Relative Humidity: up to 95%
f) Average number of thunder storm days per annum: 15
g) Maximum annual Rainfall: 150cm
h) Maximum Altitude above mean sea level: 1000Meter
i) Maximum Wind Pressure: 150 Kg/cm2 (As per IS 802 latest code)
j) Maximum soil temperature at cable depth: 30˚C
k) Maximum soil thermal resistively: 150˚C cm/watt

3. Code & Standards:

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: Codes, standards, etc.) referred to herein, the former shall prevail.

Nothing in this specification shall be construed to relieve the contractor of his responsibility. Where no standards are available, the supply items shall be good quality, workmanship and backed by test results.

The power cable shall conform to the latest applicable standards and codes of practice as mentioned in this specification.
Other National Standard are acceptable if they are established to be equivalent to or superior to the listed standards subject to approval by the purchaser and the contractor shall provide English version of standards and codes applicable.

The 1.1kV XLPE power cable shall confirm to the currently applicable standards and codes of practice and reports as mention below table:

S. No.	Title	IS Standard	IEC / BS Standard
1	Conductors for insulated electric cables and flexible cords.	IS: 8130 – 1984	IEC 60228-1978
2	PVC insulation and sheath of electric cables.	IS: 5831 – 1984	IEC 60502
3	Mild steel wires, Formed wires and Tapes for armouring of cables.	IS: 3975 – 1988	
4	Fictitious calculation method for determination of dimensions of protective coverings of cables.	IS :10462 (Part I) – 1983	IEC 60502:1978
5	1.1 KV Grade XLPE insulated cables.	IS : 7098 (Part-I)	
6	Method of test for cables	IS : 10810	
7	Code of practice for installation & maintenance of power cables up to & including 11 KV rating.	IS : 1255	
8	Drums for electric cables.	IS : 10418	
9	Electro Technical Vocabulary for Electric Cables	IS:1885, Part-32	

4. General Technical Requirements: -

(I) Armoured cables: -

1100 Volts Grade L.T. cable with stranded H2/H4 grade aluminum conductor, XLPE insulated, colour coded, laid up, with fillers and/or binder tape where necessary provided with extruded PVC inner sheath, single galvanized round steel wire / strip armoured and provided with PVC outer sheath. All LT cable shall be conforming to IS : 5831& IS : 8130 (amended up to date) and bearing ISI mark .

(II) Insulation, Inner sheath and Outer sheath: -

Insulation, inner sheath and outer sheath shall be applied by separate extrusion. Inner sheath shall be applied by extrusion only. Bedding of PVC tape for inner sheath is not acceptable. The color of the outer sheath shall be different according to the different size of cables and color of outer sheath shall be approved before manufacturing. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

The core insulation shall be with cross linked polyethylene insulating compound applied by extrusion & should be manufactured with Dry/Gas curing process. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating condition. It shall conform to the properties given in Table-1 of IS: 7098(Part-2).

The conductor screen, XLPE insulation and insulation screen shall be extruded in one operation by “Triple Extrusion Dry. Cured” process to ensure perfect bonding between the layers. The core identifications shall be colored strips or by printed numerals.

The outer sheath of the cables shall be of PVC compound conforming to the armouring and shall be of PVC compound conforming to the requirements of Type ST2 compound of IS:5831 with suitable additives shall be provided (To prevent attack by rodent & termite). The thickness of outer sheath shall be as per amendment No. 1 to Table 5 of IS: 7098- part-2.
The dimension of the insulation, inner sheath and armour materials shall be governed by values given in latest IS: 7098(pt.2)1958.

(III) Sequential marking of length on cable: -
Non erasable Sequential Marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

(IV) Continuous A C current capacity: -
Continuous A.C. current capacity shall be as per Table given below.

LT Aluminium Armored Cable sizes in sq.mm.	Continuous A.C. current capacity in Amps.	
	In ground(Amps)	In air(Amps)
1C × 400 sq.mm	520	600
1C × 300 sq.mm	435	505
3.5C × 400 sq.mm	460	545
3.5C × 300 sq.mm	390	465
3.5C × 240 sq.mm	335	402
3.5C × 185 sq.mm	285	339
3.5C × 150 sq.mm	260	305
3.5C × 120 sq.mm	225	258
4C × 95 sq.mm	205	230
4C × 70 sq.mm	175	195
4C × 50 sq.mm	145	160
4C × 35 sq.mm	120	130
4C × 25 sq.mm	95	99
4C × 16 sq.mm	80	85
4C × 10 sq.mm	78	70
4C × 6 sq.mm	58	62
2C × 4 sq.mm	40	43
2C × 10 sq.mm	70	75
2C × 6 sq.mm	55	60

(V) Common Conductor Resistance and Short circuit current carrying capacity: -

Nominal Area of Conductor (Sq.MM)	Maximum DC resistance at 20 deg C (Ohms / kM)	Short Circuit Current for Conductor (KA / Sec)
400 Sqmm Aluminium	0.0754	52.0
300 mm2 Aluminium	0.100	39.0
240 mm2 Aluminium	0.125	31.0
185 mm2 Aluminium	0.164	24.0
150 mm2 Aluminium	0.206	20.0
120 mm2 Aluminium	0.253	16.0
95 mm2 Aluminium	0.320	13.0
70 mm2 Aluminium	0.443	9.5
50 mm2 Aluminium	0.641	6.8
35 mm2 Aluminium	0.868	4.7
25 mm2 Aluminium	1.20	3.4
16 mm2 Aluminium	1.91	2.2
10 mm2 Aluminium	3.08	1.4
6 mm2 Aluminium	5.13	0.85
4 mm2 Aluminium	7.41	0.56

(VI) Dimensional Details of Cable: -

LT Aluminium Armored Cable sizes in sq.mm.	Nominal Thickness of Insulation (mm)	Minimum thickness of Inner sheath (mm)	Minimum thickness of Outer Sheath (mm)
1C × 400 sq.mm	1.8	1.8	2.0
1C × 300 sq.mm	1.8	1.8	2.0
3.5C × 400 sq.mm	1.8	1.8	2.0
3.5C × 300 sq.mm	1.8	1.8	2.0
3.5C × 240 sq.mm	1.8	1.8	2.0
3.5C × 185 sq.mm	1.8	1.6	1.8
3.5C × 150 sq.mm	1.8	1.6	1.8
3.5C × 120 sq.mm	1.8	1.6	1.8
4C × 95 sq.mm	1.6	1.4	1.8
4C × 70 sq.mm	1.4	1.4	1.8
4C × 50 sq.mm	1.2	1.4	1.8
4C × 35 sq.mm	1.2	1.2	1.8
4C × 25 sq.mm	1.2	1.2	1.8
4C × 16 sq.mm	1.0	1.0	1.8
4C × 10 sq.mm	1.0	1.0	1.8
4C × 6 sq.mm	0.8	1.0	1.8
2C × 4 sq.mm	0.8	1.0	1.8
2C × 10 sq.mm	1.0	1.0	1.8
2C × 6 sq.mm	0.8	1.0	1.8

(VII) Storage and handling of cables: -

a. All cables shall be inspected upon receipt at site and checked for any damage during transit. Cable drums shall be stored on a well-drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.
b. During storage periodical rolling of drums once in 3 months done. Rolling shall be done in the direction of the arrow marked on the drum.
c. It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.
d. Protection from rain and sun shall be ensured. Sufficient ventilation between cable drums, should be ensured during storage.
e. The drums shall always be rested on the flanges and not on the flat sides.
f. Damaged battens of drums etc. should be replaced, if necessary.
g. When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.
h. For transportation over long distances, the drum should be mounted on cable drum wheels strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
i. When unloading cable drums from vehicles, a crane shall preferably be used. Otherwise the drum shall be rolled down carefully on a suitable ramp or rails, where necessary.
j. While transferring cable from one drum to another, the barrel of the new drum shall have a diameter not less than that of the original drum.
k. The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of XLPE cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.
l. Cable with kinks and straightened kinks or with similar apparent defects like defective armouring etc. shall be rejected.
m. Cables from the stores shall be supplied by the contractor as per the site requirement in pieces cut in the stores, and further both ends are to be sealed as per Para ‘c’ above.

(VIII) Drums

Cables shall be supplied in the drums made from eco-friendly material in the specified length. The Drums shall be strong, weatherproof and non-returnable. The ends of the cable shall be sealed by means of non-hygroscopic sealing material. Applicable Length of Cable/ drum should be as per IS.

The cable shall be supplied in standard drum length of 500 mtrs. +/- 5% tolerance for all the sizes of cable except 10 mm2 & 16mm2 size cable. The drum length for 10 mm2 and 16mm2 cable shall be 1000 mtrs. +/- 5%.

Over all tolerance in total quantity of ordered cables shall be +/- 2%.

General

- All cables shall be suitable for installation in air, conduits, ducts, and open concrete trenches or for direct burial in either wet or dry locations for normal operating conditions.
- All cables shall be flexible and easy to bend, pull, handle and install

(IX) Installation (Laying in trench):-General:

The cable installation including necessary termination shall be carried out in accordance with the specifications given herein and IS 1255.

Trenching:

The detail technical specification of Trench shall be a part of civil works.

(i) Width of Trench: - 300/450/600mm

(ii) Depth of Trench: - 1200mm.

Laying of Cable in Trench

i. At the time of issue of cable for laying, the cores shall be tested for continuity and insulation resistance.

ii. The inter-axial spacing between the cables shall be maintained as per IS to maximize the cable capacity.

iii. The cable drum shall be properly mounted on jacks or on a cable wheel, at a suitable location, making sure that the spindle, jack etc. shall be strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

iv. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be pulled of in one stretch. However, where this is not possible the remainder of the cable may be removed by 'Flaking' i.e. by making one long loop in the reverse direction.

v. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 m apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

vi. When the cable has been properly straightened, the cores shall be tested for continuity and insulation resistance. In case of PVC XLPE cables, suitable moisture seal tape shall be used for this purpose.

Laying in HDPE pipes by HDD/closed ducts:

i. In location such as road crossing, crossing other utilities etc. cables shall be laid in pipes.

ii. HDPE Pipes shall be used for such purposes. Pipes as required shall be laid along with the civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the Road Crossing Drawing for Electrical Services.

iii. The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage

cables.

iv. Manholes of adequate size as specified or decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design.

v. Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

5. TEST &INSPECTION: -

Cables shall be subjected to routine & acceptance tests in accordance with the IS 1554 (Part – I, in addition to physical, ageing and electrical tests at the Manufacturer's plant in accordance with applicable standards and will be approved by 3rd party agency.

5.1 Type Test: -

The successful bidder shall submit the following type test reports conducted on similar equipment's for approval of owner.

a) Annealing test (for copper)
b) Tensile Test (for aluminum)
c) Conductor resistance test
d) Test for Armour wires
e) Test for thickness of insulation check
f) Physical test for insulation
g) Physical test for PVC sheath
   i. Fire resistance.
   ii. Cold-impact
   iii. Bleeding and blooming
h) Partial discharge test
i) Bending Test
j) Dielectric power factor tests
k) Heating cycle test
l) Impulse withstand test
m) High voltage test (water immersion test)

All the following routine / acceptance tests specified in relevant standards shall be witnessed by the owner / consultant.

5.2 Acceptance Test:-

a) Conductor resistance test
b) Test for thickness of insulation and sheath
c) Partial discharge test (for screened cables only)
d) High voltage test (water immersion test)
e) Annealing test (for copper)
f) Tensile test (for aluminum)
g) Wrapping test (for aluminum)
h) Insulation resistance test

5.3 Routine Test: -

a) Conductor resistance Test
b) Partial discharge test (for screened cable only)
c) High voltage test.

5.4 Test Certificate: -

Three (3) copies of routine / acceptance test certificates shall be produced with the endorsement of the inspecting authority to the purchaser before effecting dispatch.

5.5 PACKING AND MAKING

Cables shall be dispatched in non-returnable wooden drums of suitable barrel diameter. Securely battened, with the take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from

defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

On the flange of the drum, necessary information confirming to IS such as project title, manufacturer's name, type, size, voltage grade of cable, length of cable in meters drum no, cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to Show the direction of the drum.

MARKING/EMBOSSING

The following words shall be duly embossed on the sheath of every meter length of cables. The embossing should be clear and visible.

a) Name of Purchaser (i.e. MGVCL/DGVCL/UGVCL/PGVCL)
b) Robust 3.0
c) AT No.:
d) Electric
e) Voltage Grade
f) No. of cores
g) Size of the cable
h) Sequential length marking at every meter distance throughout the cable length with adequate font size (Not less than 5mm) embossed on the cable in bold letters.
i) Year of Manufacture
j) Trade Mark of Supplier
k) IS Number

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S No	Description	To be submitted by Bidder						
	NAME OF MANUFACTURER							
1	Size of the cable	1C × 400 sq.mm	3.5C × 400 sq.mm	3.5C × 300 sq.mm	3.5C × 240 sq.mm	3.5C × 185 sq.mm	3.5C × 150 sq.mm	3.5C × 120 sq.mm
2	Rated Voltage	1.1 kV						
3	Standard Referred							
4	Conductor	Aluminium as per Class-2 of IS: 8130						
5	Nominal Cross Section Area							
6	No of wires/DIA							
7	Shape of Conductor							
8	**Insulation**							
	Material	XLPE						
	Nominal Thickness							
	App. Dielectric strength							
	Suitability with regard to temperature, moisture, acid, oil and alkaline surrounding	YES						
9	**Inner Sheath**							
	Material	PVC Type ST-2 as per IS: 5831; Options: FR Type/FRLS Type						
	Minimum thickness of sheath (mm)							
10	**Armouring**							
	Material & Type	Single Layer of Galvanized Steel Round Wire / Flat Strip						
	Nom.dia/dimen of armour wires/Strips in mm							

11	**Outer sheath**							
	Material	PVC Type ST-2 as per IS: 5831; Options: FR Type/FRLS Type						
	Minimum thickness of sheath (mm)							
12	**Approx. overall dia of**							
	Cable (in mm)							
13	**Method of core identification**		By colour coding (Red, Yellow, Blue & Black)					
14	**Electrical Properties: -**							
	Maximum d.c. resistance of conductor at 20º C (Ohm/Km)							
	Maxmimum permissible conductor temperature(˚C) under full load	90˚C for XLPE insulation						
	Rated voltage	1.1 kV						
	Maximum operating voltage	1.1 kV						
	Permissible voltage variation	±10%						
	Rated frequency	50HZ						
	Permitted frequency variation	±5%						

	Approx. Conductor A.C.Resistance at 90 ˚C							
	Reactance of Cable at 50 Hz (Approx.)							
	Normal Current Rating							
	Short Circuit Current Rating for 1 Second Duration in K amps							

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S No	Description	To be submitted by Bidder						
	NAME OF MANUFACTURER							
1	Size of the cable	4C × 95 sq.mm	4C × 70 sq.mm	4C × 50 sq.mm	4C × 35 sq.mm	4C × 25 sq.mm	4C × 16 sq.mm	4C × 10 sq.mm
2	Rated Voltage	1.1 kV						
3	Standard Referred							
4	Conductor	Aluminium as per Class-2 of IS: 8130						
5	Nominal Cross Section Area							
6	No of wires/DIA							
7	Shape of Conductor							
8	**Insulation**							
	Material	XLPE						
	Nominal Thickness							
	App. Dielectric strength							
	Suitability with regard to temperature, moisture, acid, oil and alkaline surrounding	YES						

9	**Inner Sheath**							
	Material	PVC Type ST-2 as per IS: 5831; Options: FR Type/FRLS Type						
	Minimum thickness of sheath (mm)							
10	**Armouring**							
	Material & Type	Single Layer of Galvanized Steel Round Wire / Flat Strip						
	Nom.dia/dimen of armour wires/Strips in mm							
11	**Outer sheath**							
	Material	PVC Type ST-2 as per IS: 5831; Options: FR Type/FRLS Type						
	Minimum thickness of sheath (mm)							
12	**Approx. overall dia of**							
	Cable (in mm)							
13	**Method of core identification**		By colour coding (Red, Yellow, Blue & Black)					
14	**Electrical Properties: -**							
	Maximum d.c. resistance of conductor at 20º C (Ohm/Km)							
	Maxmimum permissible conductor temperature(˚C) under full load	90˚C for XLPE insulation						
	Rated voltage	1.1 kV						

	Maximum operating voltage	1.1 kV						
	Permissible voltage variation	±10%						
	Rated frequency	50HZ						
	Permitted frequency variation	±5%						
	Approx. Conductor A.C.Resistance at 90 ˚C							
	Reactance of Cable at 50 Hz (Approx.)							
	Normal Current Rating							
	Short Circuit Current Rating for 1 Second Duration in K amps							

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S No	Description	To be submitted by Bidder						
	NAME OF MANUFACTURER							
1	Size of the cable	4C × 6 sq.mm	2C × 4 sq.mm	-	-	-	-	-
2	Rated Voltage	1.1 kV						
3	Standard Referred							
4	Conductor	Aluminium as per Class-2 of IS: 8130						
5	Nominal Cross Section Area							
6	No of wires/DIA							
7	Shape of Conductor							
8	**Insulation**							

	Material	XLPE						
	Nominal Thickness							
	App. Dielectric strength							
	Suitability with regard to temperature, moisture, acid, oil and alkaline surrounding	YES						
9	**Inner Sheath**							
	Material	PVC Type ST-2 as per IS: 5831; Options: FR Type/FRLS Type						
	Minimum thickness of sheath (mm)							
10	**Armouring**							
	Material & Type	Single Layer of Galvanized Steel Round Wire / Flat Strip						
	Nom.dia/dimen of armour wires/Strips in mm							
11	**Outer sheath**							
	Material	PVC Type ST-2 as per IS: 5831; Options: FR Type/FRLS Type						
	Minimum thickness of sheath (mm)							
12	**Approx. overall dia of**							
	Cable (in mm)							
13	**Method of core identification**		By colour coding (Red, Yellow, Blue & Black)					
14	**Electrical Properties: -**							

	Maximum d.c. resistance of conductor at 20º C (Ohm/Km)							
	Maxmimum permissible conductor temperature(˚C) under full load	90˚C for XLPE insulation						
	Rated voltage	1.1 kV						
	Maximum operating voltage	1.1 kV						
	Permissible voltage variation	±10%						
	Rated frequency	50HZ						
	Permitted frequency variation	±5%						
	Approx. Conductor A.C. Resistance at 90 ˚C							
	Reactance of Cable at 50 Hz (Approx.)							
	Normal Current Rating							
	Short Circuit Current Rating for 1 Second Duration in K amps							