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TECHNICAL SPECIFICATIONS FOR 33 KV XLPE INSULATED UNDERGROUND CABLES

1. SCOPE:

1.1 The scope of this specification covers the design, manufacture, stage inspection at works, inspection and testing the finished ISI marked 33KV 3x400 Sq.mm stranded, compact circular aluminum conductor, conductor screened with extruded semiconducting compound water tree retardant (TR), XLPE insulated , insulation screened with extruded semi conducting compound dry cured(Nitrogen gas cooled) from triple extrusion through common triple cross head (single point triple extrusion) in combination with copper tape cores laid up, Filler inner sheathed, galvanized round steel wire armored and overall PVC sheathed Black colour cable conforming to IS:7098 /II/85 with latest amendments and as per specification detailed.

2. RATED VOLTAGE:

a. The rated voltage of the cable shall be 33000 Volts AC with the highest system voltage of **36000** Volts between phases of the effectively earthed three-phase transmission system.

3. APPLICABLE STANDARDS:

a. Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:
a. IS 7098 (Part 2)-Cross-linked Polyethylene insulation for Cables.
b. IS 8130-Conductors for insulated electrical cables and flexible cords.
c. IS 10810(series)-Methods of tests for cables.
d. IS 10418-Drums for electric cables.
e. IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables.
f. IS 5831-Specification for PVC insulation sheath for electric cables.
g. IS 10462-Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables.

The cables manufactured to any other International Standards like BSS, IEC or equivalent standards not less stringent than Indian Standards are also acceptable. In such cases the Bidders shall enclose a copy of the equivalent international standard, in English language, along with the bid.

4. CONSTRUCTION:

4.1 Conductor**:** - The cable conductor shall be made from stranded aluminum to form compact shaped conductor having resistance within the limits specified in IS:8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay. Stranded Class 2 – Annealed as per the IS:8130 / IEC 60228/ BS 6360 standards.

- The continuous rated current in ground shall be 410 A and 485 A in air.
- The Approx. conductor diameter shall ne 24.0 mm
- The Approx. DC resistance of conductor at 20 degrees centigrade shall be 0.0778 ohms.
- The Approx. AC resistance of conductor at 90 degrees centigrade shall be 0.101ohms.
- The Approx. Capacitance of the cable shall be 0.24 microfarads/KM.

4.2 Conductor Shield : The conductor having a non-magnetic semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. This conductor screen shall be extruded in the same operation as the insulation, the semi-conducting polymer shall be cross linked and shall be as per the IS:7098 Part 2, IEC:60502 Part – 2, BS:6622, BS:7835.

4.3 Insulation: - The insulation shall be water tree retardant (TR) cross linked polyethylene insulation applied by extrusion and shall conform to the following requirements:

Sl.No.	**Properties**	**Requirements**
1.	Tensile Strength	12.5N/mm², Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: a) Treatment: Temperature: Duration: b) Tensile Strength variation: c) Elongation variation:	 135±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set: a) Treatment: Temperature: Time under load Mechanical stress b) Elongation under load c) Permanent elongation (set) after cooling	 200±3°C 15 min 20N/cm² 175 percent, Max 15 percent, Max
5.	Shrinkage: a) Treatment: Temperature Duration b) Shrinkage	 130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): a) Treatment: Temperature:	 85±2°C

	Duration b) Water absorbed	14 days 1 mg/cm², Max
7.	Volume Resistivity a) at 27°C b) at 70°C	 $1x10^{14}$ ohm-cm, Min $1x10^{13}$ ohm-cm, Min
8	Thermal Resistivity	350 degrees C cm/W
9	Power factor at maximum conductor temperature	0.008
10	Dielectric strength	22 kV/mm

4.3.1 The XLPE insulation should be suitable for specified 33 KV system voltage.

4.3.2 The curing process of XLPE insulation should be dry cured with nitrogen cooled.

4.3.3 The manufacturing process shall ensure that insulations shall be free from voids.

4.3.4 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.3.5 The extrusion method should give very smooth interface between semi-conducting screen and insulation.

4.3.6 The insulation of the cable shall be high stranded quality, specified in IS:7098 (Part-II/1985). Withstand continuous conductor temperature of 90 deg C, which means higher continuous rated current carrying

4.3.7 Capacity: The cables can operate even at conductor temperature of 130 deg C during a short time emergency can withstand conductor temperature up to 250 deg C during a Short Circuit condition

4.3.8 The average thickness of the insulation shall not be less than 8.8-mm. 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.

4.3.9 The eccentricity of the insulation thickness shall be less than 10% and ovality shall be less than 5%.

4.4 Insulation Shield: To confine electrical field to the insulation, non-magnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion through single head process and shall be as IS:7098 Part 2, IEC:60502 Part – 2, BS:6622, BS:7835.

4.5 Sheath : The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all defects. The PVC sheath shall be extruded as per IS:7098 Part-II/1985. IEC:60502 Part – 2,BS:6622, LSOH to BS:7835.

4.6 **ARMOUR :** Armoring shall be applied over the inner sheath with single galvanized steel strip complying with the requirements of IS:3975/1979. The dimensions of the galvanized wire shall be as specified in table 4 of the IS:7098/Part-II/1985. The armour wire shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire shall be atleast 300mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS:7098 Part 2, IS: 3975, IEC:60502 Part – 2, BS:6622, BS:7835

4.7 **OUTER SHEATH :** Extruded PVC ST2, outer sheath as per IS:5831/1984, IS:7098

Part 2, IEC:60502 Part – 2, BS:6622, LSOH to BS:7835. shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the PVC sheathing material used.

4.8 The screening shall consist of nonmetallic semi-conducting compound, shielded cores

laid up with solid Non-hygroscopic fillers, inner sheath of extruded PVC, Galvanized round wire Armour and PVC overall sheath**.**

4.9 The cables should be suitable for use in solidly earthed system.

4.10 The 33 kV underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The bidder shall furnish the quality plan, giving in detail the quality control procedure / management system.

4.11 The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

4.12 The successful Bidder shall give sufficient advance notice to the purchaser of not less than one month to arrange for inspection and quality assurance program during manufacture, at the works.

5 SYSTEM DETAILS:

General Technical particulars

Nominal system voltage (rms) (U)	33KV
Highest system voltage (rms) (U_m)	36.3KV
Phase to Earth voltage (rms) (U_o)	19.05 KV
Number of Phase	3
Frequency	50Hz
Variation in Frequency	± 3%
Type of Earthing	Solidly Earthed
Basic impulse insulation level (1.2/50 μS wave)	170 kV
Total relay & circuit breaker Operating time	15 – 20 cycles

6 CLIMATIC CONDITIONS:

(a)	Maximum ambient air temperature (in shade)	45^0 C
(b)	Maximum ambient air temperature (under sun)	50^0 C
(c)	Maximum daily average ambient air temperature	35^0 C
(d)	Maximum yearly average ambient air temperature	30^0 C
(e)	Maximum humidity	100%
(f)	Altitude above M.S.L.	Up to 1000M
(g)	Average No. of thunder storm days per annum	50
(h)	Average No. of dust storm days per annum	Occasional
(i)	Average No. of rainy days / annum	90
(j)	Average Annual Rain fall	925mm
(k)	Normal tropical monsoon period	4 months
(l)	Maximum wind pressure	150 kg/Sq.M

7 DESIGN CRITERIA:

7.1 The cables that are covered in these specifications are intended for use outdoor , under the climatic conditions and installation conditions described in the technical specification.

7.2 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only, in the offer made by the bidder, giving technical reasons, and justifying the need to incorporate these features.

7.3 For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.

7.4 The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.

7.5 The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

7.6 The cables shall have the mechanical strength required, during handling and laying.

7.7 The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.

7.8 The cables shall be designed to have a minimum useful life span of Thirty-five years.

7.9 The detailed design drawings shall be submitted along with the bid documents.

8 MANUFACTURE PROCESS:

8.1. Cross-linking of the insulation materials water tree retardant (TR) (pre compounded polyethylene) shall be conforming to IS: 7098 (Part – II) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection.

8.2 The conductor screen shall be of extruded semi conducting compound. The insulation screen shall consist of the nonmetallic part, extruded semi conducting compound with non-magnetic metallic part. The XLPE insulation and the shields for conductor and insulation shall be extruded in one operation.

8.3 The cable must have Dry Cure-Dry (Nitrogen) Cooled Insulated Cores.

8.4 The cable must have Insulated Cores produced from triple Extrusion through Common Triple Cross Head (single point triple extrusion).

8.5 The bidder shall specify the length of curing and cooling chamber.

8.6 The partial discharge shall be less than 2 PC and the bidder shall submit the type test certificate with the value of less than 2 PC.

9 MATERIALS:

9.1 The conductor shall be of stranded construction. The material for conductor shall consist of the plain aluminum of H2 or H4 grade as per clause – 3 of IS 8130/ 1984.

9.2 The minimum number of wires shall be 53 for circular compacted 400 sq. mm aluminum conductor as per table – 2 of IS 8130/ 1984.

10 SCREENING:

10.1 The conductor screening shall be provided over the conductor by applying by extrusion of semi-conducting compound. The semi-conducting compound shall withstand the operating temperature of the cable and shall be compatible with the insulating material.

10.2 The insulation screen shall be applied over the insulation. The insulation screening shall consist of two parts; namely metallic and non-metallic. The non-metallic part shall be applied directly over the insulation of each core and shall consist of a semi conducting tape and extruded semi conducting compound with a semi conducting coating. The metallic part of the insulation screen shall consist of either tape, or braid, or concentric serving of wires or a sheath; shall be non-magnetic and shall be applied over the non-metallic part.

11 CORE IDENTIFICATION:

11.1 The core identification for 3 core cables shall be provided, by suitable means, like, by application of colored stripes, or by numerals or by printing on the cores as per clause 13 of IS: 7098 - Part 2

11.2 For identification of different coloring of XLPE Insulation, or by using colored strips, red, yellow and blue colors respectively shall be used to identify the phase conductors.

12. LAYING UP OF CORES:

12.1 The cores shall be laid together with a suitable right hand lay. The interstices at the center shall be filled with a non- hygroscopic material.

13. INNER SHEATH (COMMON COVERING):

13.1 The laid up cores shall be provided with inner sheath applied either by extrusion or by wrapping. It shall be ensured that the shape is as circular as possible. 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 the insulation.

13.2 The thickness of the inner sheath (common covering) shall be given as follows**:**

CALCULATED DIAMETER IN MM OVER LAID UP CORES [REF IS 10462 (PART 1)]		**THICKNESS OF INNER SHEATH (Min) mm**
Over	Up to and including	
_	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	_	0.7

13.3 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as a part of inner sheath.

14. ARMOURING:

14.1 Armoring shall be applied over the inner sheath with single galvanized steel strip complying with the requirements of IS:3975/1979. The dimensions of the galvanized wire shall be as specified in table 4 of the IS:7098/Part-II/1985. The armour wire shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire shall be atleast 300mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS:7098 Part 2, IS: 3975, IEC:60502 Part – 2, BS:6622, BS:7835

14.2 Bidders shall furnish the calculation / data sheet for the short circuit carrying capability of the Armour.

15. OUTER SHEATH:

15.1 The outer sheath shall be applied by extrusion. It shall be applied over the armouring shall consist of poly-vinyl chloride (PVC) compound, conforming to the requirements of type ST-2 of IS 5831. Suitable additives shall be added to give anti termite protection.

15.2 The minimum thickness of the PVC outer sheath shall not fall below the following value by more than 0.2 mm + 0.2 ts

Calculated diameter under the outer sheath [IS 10462 Part 1] – mm		**Nominal thickness of the outer sheath (ts) - mm**
Over	**Up to and including**	
_	15	1.8
15	25	2.0
25	35	2.2
35	40	2.4
40	45	2.6
45	50	2.8
50	55	3.0
55	60	3.2
60	65	3.4
65	70	3.6
70	75	3.8
75	_	4.0

16. IDENTIFICATION:

16.1 The outer sheath shall have the following information embossed or indented on it; the manufacturer’s name or trade mark, the voltage grade, the year of manufacture and the

letters “A_PDCL”. The identification shall repeat every 300/350 mm along the length of the cable. Outer sheath of cable shall be black in permanent colour.

17. **INSPECTION AND QUALITY CONTROL:**

17.1 The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement. During the manufacturing process, at all stages, inspections shall be made to check the physical and dimensional parameters, for verification to compliance to the standards. The bidder shall arrange, for inspection by the purchaser, during manufacture with one month advance notice for verifying the various stage inspections as specified in the quality assurance plan enclosed to verify the quality control process of the Bidder.

18. TYPE TESTS:

Type test certificates from Accredited NABL Testing Laboratories for 33 kV XLPE UG cable, shall be submitted along with Bid. The Type Tests should have been conducted not later than 5 years as on the date of BID opening.

18.1 Stage wise Inspection

The Bidder shall offer the stage wise inspection as detailed in the in the quality assurance plan

18.2 Notwithstanding, that type test have been conducted earlier, the supplier shall conduct all type tests as per IS: 7098 part-II, 1985, with up to date amendments or equivalent international standard, and supplies made only after approval of test reports from the purchaser. The purchaser reserves the right to wave the repetition of the type test.

18.2 All acceptance tests shall be conducted in the presence of the purchaser/ representative.

18.3 The supplier shall give 15 days advance notice for inspections, and witnessing of tests by the purchaser or his representative.

18.4 The following type tests shall be conducted on the cable.

Sl. No.	Test	Requirement	Test method Ref. Part no of IS: 10810
a)	Tests on conductor i) Tensile test ii) Wrapping test	IS:8130 IS:8130 IS:8130	1 2 3

	iii) Resistance test		
b)	Tests for armoured wires and strips	Clause 15.2 & IS:3975	5
c)	Test for thickness of insulation and sheath	Clause 4.3, 14.2 & 16.2	6
d)	Physical tests for insulation: i) Tensile strength and elongation at break ii) Aging in air oven iii) Hot test iv) Shrinkage test v) Water absorption (gravimetric)	Clause 4.2	7 11 30 12 33
e)	Physical tests for outer sheath i) Tensile strength and elongation at break ii) Aging in air oven iii) Shrinkage test iv) Hot deformation	IS: 5831	7 11 12 15
f)	Bleeding and blooming test (outer sheath)	IS: 5831	19
g)	Partial discharge test		Less than 2 PC
h)	Bending test		50
j)	Dielectric power factor test i) As a function of voltage ii) As a function of temperature		48
k)	Insulation resistance (volume resistivity) test	Clause 4.2	43
m)	Heating cycle test	Clause 22.5	49
n)	Impulse withstand test	Clause 22.6	47
p)	High voltage test	Clause 22.7	45
q)	Flammability test	Clause 22.8	53

The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories:

I. Partial discharge test.
II. Bending test followed by partial discharge test.
III. Dielectric power factor as a function of voltage.
IV. Dielectric power factor as a function of temperature.
V. Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests.
VI. Impulse withstand test
VII. High voltage test.

19. ACCEPTANCE TEST:

19.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix ‘A’.

19.2 The following shall constitute the acceptance test.

a) Tensile test for aluminum.
b) Wrapping test for aluminum.
c) Conductor resistance test.
d) Test for thickness of insulation.
e) Test for thickness of inner and outer sheath.
f) Hot-set test for insulation.
g) Tensile strength and elongation at break test for insulation and outer sheath.
h) Partial discharge test (on full drum length).(shall be less than 2PC)
i) High voltage test.
j) Insulation resistance (volume resistivity) test.

20. ROUTINE TEST:

20.1 The following shall constitute routine tests:

a) Conductor resistance test.
b) Partial discharge test on full drum length.
c) High voltage test.

21. DETAILS OF TESTS:

21.1 Unless otherwise mentioned in this specification, the tests shall be carried out in accordance with appropriate part of IS: 10810.

21.2 The partial discharge magnitude at test voltage equal to $1.5U_o$ shall not exceed 2 pC.

21.3 Bending test: The diameter of the test cylinder shall be 200±5% D; where D is the overall diameter of the completed cable. After completing the bending operations, the test sample shall be subjected to partial discharge measurement and shall comply with the requirements given in 22.2.

21.4 Dielectric power factor test:

21.4.1 Tan δ as a function of voltage: The measured value of Tan δ at U_o shall not exceed 0.004 and the increment of Tan δ between 0.5 U_o and 2 U_o shall not be more than 0.002.

21.4.2 Tan δ as a function of Temperature: The measured value of Tan δ at U_o shall not exceed 0.004 at the ambient temperature and 0.008 at 90°C.

21.5 Heating cycle test: The sample, which has been subjected to previous tests, shall be laid out on the floor of the test room and subjected to heating cycles. After the third cycle, the

sample shall be subjected to dielectric power factor as a function of voltage, and partial discharge test.

21.6 Impulse voltage withstand test: The impulse voltage level shall be 170 kV. No breakdown of insulation shall occur during the test.

21.7 High Voltage Test:

21.7.1 Type test and Acceptance tests: The cable shall withstand without breakdown an ac voltage equal to 3 U_o when applied to the sample between conductor and screen/armour. The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

21.7.2 Routine test: The cable shall withstand without any failure, 48 kV rms between conductors and screen/armour, when applied for a period of five minutes for each test connection.

21.8 Flammability test: Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (un charred) portion from the lower edge of the top clamp shall be at least 50-mm.

AP-PDCL reserves the right to select a random sample of 33 kV UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by AP-PDCL at Bidders cost. If the testing results are found to be not satisfactory AP-PDCL reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of AP-PDCL in this regard is final.

22. PACKING:

22.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable steel drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The cable drums shall conform to IS 10418-1982 or equivalent standard. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks. The end of the cable shall be sealed with good quality heat shrink sealing caps. The sufficiently required additional sealing caps shall be supplied for use of testing during laying and jointing at site and to seal spare lengths of cable. The packing should be able to withstand the rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

i) Name & Address of the manufacturer, Trade name/Trade mark/Brand
ii) Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.
iii) Length of cables (Meters)

iv) Direction of rolling
v) Net weight (in Kg)
vi) Gross weight (in Kg)
vii) Owners purchase order reference.

23. **SEALING OF CABLE ENDS ON DRUMS**:

23.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings 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. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

23.2 The three cores should have an overall heat shrinkable or push-on or Tapex or cold shrinkable type cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable. The ends of single core cables shall also be sealed on the same lines to prevent entry of moisture.

24. **CABLE LENGTHS**:

24.1 The cables shall be supplied in continuous lengths of 300 m or more with 5% tolerance and cable shall on the steel drums only.

25. **QUANTITY TOLERANCE:**

A +3% tolerance shall be allowed on the ordered quantity including 300m cable as spare.

26. **MARKING:**

The packed cable drum shall carry the following information, clearly painted or stenciled.

a) The letters AP-PDCL
b) Reference to Standard and ISI mark.
c) Manufacturer's Name or trade mark.
d) Type of cable & voltage grade.
e) Number of cores.
f) Nominal cross- sectional area of conductor.
g) Cable code.
h) Length of cable on the drum.
i) Direction of rotation.
j) Gross weight.
k) Country of Manufacture.

l) Year of Manufacture.
m) Purchase order and date.
n) Address of consignee.

27. GUARANTEED TECHNICAL PARTICULARS:

The bidder, shall furnish the guaranteed technical particulars of the cable offered in the GTP format provided

28 **DRAWING & LITERATURE:**

The following shall be furnished along with the tender

a) Cross sectional drawings of the cables, giving dimensional details.
b) An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation, packing date, weights and other relevant information**.**

29.GUARANTEE:

The cable manufactured shall be guaranteed for the period of 18 months from the date of receipt at stores.

30.The tenderer shall furnish a copy of valid BIS licence for ISI marking together with their offer, without which the offer shall be treated as non-responsive.

A1 : GUARANTEED TECHNICAL PARTICULARS FOR 33 KV UG Cable

	Bidder's Name		
	Class of Power Cable		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable / cable code		
4	Applicable standard		
5	Voltage		
	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for :		
	a. Earthed system		
	b. Unearthed system		
7	Conductor		
	a) Nominal cross section (sq.mm)		
	b) Material		
	c) Shape		
	d) Diameter of conductor (mm)		
	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
8	Conductor screen		
	a) Material and type		
	b) Thickness (mm)		
	c) Maximum volume resistivity at 90 deg C before and after ageing (ohm-cm)		
9	Maximum value of Electric stress at		
	a) Conductor screen KV/mm		
	b) At the insulation KV/mm		
10	Insulation XLPE		
	a) Curing process (furnish details separately)		
	b) Material/Composition		

	c) Dia over insulation		
	d) Radial thickness		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
11	Insulation screen (Non metallic)		
	a) Material		
	b) Nominal thickness (mm)		
	c) Maximum volume resistivity at 90 deg. C. (ohm-cm)		
12	Tape swellable (Longitudinal water / Moisture / Protection)		
	a) Material		
	b) Thickness (mm)		
	c) Tolerance		
13	sheath		
	a) Type / composition		
	b) Material		
	c) Nominal thickness		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
14	Bedding Tape over Inner sheath		
	i) Material		
	ii) Dimension (Wxt) (mm) x (mm)		
	Nom. (mm)		
	Min. (mm)		
15	Concentric screen / Armour of wires		
	a) Material		
	b) Dia of wire		
	Nom. (mm)		
	Min. (mm)		
16	Binder open Helix, contact copper Tape over screen / Armour wires		
	a) Material		
	b) Dimension (Wxt)		
	Nom. (mm)		
	Min. (mm)		
17	Non-woven water swellable Tape over Binder Tape		

	a) Material		
	b) Dimension		
18	Overall sheath		
	i) Material & Type		
	ii) Thickness		
	Nom. (mm)		
	Min. (mm)		
19	Conductive coating outer sheath		
	a) Material		
	b) Thickness		
20	Anti-termite treatment to outer sheath		
	a) Material		
21	External overall dia of cable		
22	Short circuit rating of conductor 90 deg. C operating temperature for 1 Sec.		
23	Minimum cable bending radius (in terms of cable diameter)		
24	Permissible maximum tension		
25	Continuous current rating under specified insulation conditions at conductor temperature of 65 deg. C and 90 deg. C.		
	Ground Temperature 30 deg. C		
	Thermal resistivity of soil 150 deg. C CM/W		
	Depth of laying 200 mm		
	Ambient Air temperature 40 deg. C		
	No. of circuits 1 OR 2		
	Spacing between two circuits (600 mm)		
	Formation		
26	Maximum permissible conductor temperature for continuous operation under specified installation conditions (deg. C)		
27	Conductor temperature at rated current (deg. C)		
28	Basic impulse level at conductor temperature of 90 deg. C (KV)		
29	Impulse wave shape		
30	Power frequency with stand voltage (KV)		
31	Tan Delta at 50 Hz (at U.KV and 90 (-5/+10) deg. C		

32	Sheath voltage at max. load		
33	Withstand voltage of sheath on spark test		
34	Permissible short circuit current ratings of conductor		
	i) 0.1 Sec KA		
	ii) o.2 Sec KA		
	iii) 0.5 Sec KA		
	iv) 1.0 Sec KA		
35	Conductor resistance DC & AC		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 105 deg. C (d.c)/A.C. ohm/KM over load temp) a.c. (ohm)		
36	Equivalent star resistance at 50 Hz of 3 phase current		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 10% continuous overload temperature (ohm/KM)		
37	Star reactance at 50 hz (ohm/KM)		
38	Approximate impedance at 50 hz per KM		
	a) at 20 deg. C ohm/KM		
	b) at 90 deg. C ohm/KM		
	c) at 10% continuous overload temperature (ohm/KM)		
39	Self electrostatic capacitance per phase (Micro farad/KM)		
40	Maximum power factor at charging KVA of cables when laid direct in ground at normal voltage & frequency		
	a) at ambient Temperature		
	b) at Maximum conductor Temperature		
41	a) Positive and negative sequence impedance (ohm/KM)		
	b) Zero sequence impedance (ohm/KM)		
42	Zero sequence data		
	a) Series resistance (ohm/KM)		
	b) Series reactance (ohm/KM)		

	c) Shunt capacitive reactance (ohm/KM)		
43	**a) Sheath resistance at 20 deg. C ohm/KM**		
	b) Screen resistance at 20 deg. C ohm/KM		
	c) Combined resistance at 20 deg. C ohm/KM		
44	Surge impedance of cable (ohm/KM)		
45	IR value at ambient temperature per KM		
46	Maximum magnitude of partial discharge at 1.5 U.o		
	At Ambient Temperature (Po)		
	At High Temperature (Po)		
47	Losses per Km.		
	NOTE : (i) Cable Conductor size 400 sq. mm		
	a) Total 3 phase dielectric loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	b) Total 3 phase resistive loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	c) Total 3 phase sheath / screen loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive load KW/KM on each circuit		
	d) Other losses due to reinforcement		
	i. One circuit alive KW/KM		
	ii. Both circuits alive KW/KM on each circuit		
	e) Total losses		
	i. One circuit alive KW/KM		
	ii. Both circuits alive KW/KM		
48	Charging current at rated voltage per Km (Amps)		
49	Short circuit capacity of conductor for one second at 90 deg. C prior to short circuit and 250 deg. C during short circuit (KA)		
50	Circulating current under the BEB condition in		
	i. sheath Amps		
	ii. Copper tape screen Amps		
	iii. In both Amps		
	when current in conductor is the rated current		
51	Circulating current in sheath armouring /Cu screen (when the conductor is carrying 25 KA S.C. current. In KA		

52	Combined short circuit capacity of Metallic sheath and screen for 1 Sec. at metallic sheath/screen temperature of 75 deg. C (conductor temperature 90 deg. C before S.C and 250 deg. C during S.C		
53	Screening factor of cable for calculating interferance on control and communication cables :		
54	Approximate value of attenuation of carrier current signals operating over a frequency range		
	i. 50 KC/s - dB/KM		
	ii. 100 KC/s - dB/KM		
	iii. 150 KC/s - dB/KM		
	iv. 200 KC/s - dB/KM		
55	Shipping weight and size of cale drum		
	a) Size of Drum		
	i. Dia of Drum (M)		
	ii. Width of Drum (M)		
	iii. Gross Weight (Kgs)		
	iv. Length of cable per Drum (M)		
	v. Weight of Cable (Kg/M)		

DERATING FACTORS

1 **VARIATION IN GROUND TEMPERATURE :**

Ground Temperature (deg. C) :	15	20	25	30	35	40	45
Rating Factor							

2 **VARIATION IN DEPTH OF LAYING :**

Depth of Laying (Meters):	0.7	0.9	1.0	1.2	1.3	1.5	
Rating Factor							

3 **VARIATION IN THERMAL RESISTIVITY OF SOIL**

Thermal Resistivity of Soil : (deg. C cm/watt)	100	120	150.0	200	250		
Rating Factor							

4 **VARIATION IN AIR TEMPERATURE :**

Air Temperature (deg. C) :	25	30	35	40	45	50	55
Rating Factor							

5 **VARIATION DISTANCE (MM) :**

Axial Distance (mm) Between circuits :	100	200	300.0	400	600	800	
Rating Factor							

Current Rating Factor	

Particulars	Single Point Bonded		Both End Bonded	
	65 deg. C Amps	90 deg. C Amps	65 deg. C Amps	90 deg. C Amps
Current Rating conductor size 400 Sq. mm				
a) In Ground				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
b) In Duct				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
c) In pipe, one cable per pipe.				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
d) In Air				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				