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GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION

FOR

MANUFACTURE & SUPPLY

OF

132 KV/220 KV XLPE UNDERGROUND CABLE AND ACCESSORIES

DRAFT SPECIFICATION No. TI/SPC/PSI/CABLE/0091

(Feb-2009)

**This Specification supersedes the Specification No.
TI/SPC/PSI/CABLE/0090 (02/2009)**

ISSUED BY

TRACTION INSTALLATION DIRECTORATE

RESEARCH DESIGNS AND STANDARDS ORGANIZATION

(MINISTRY OF RAILWAY)

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~~MANUFACTURE & SUPPLY OF 132 KV/220 KV XLPE UNDERGROUND CABLE AND ACCESSORIES~~

1.0 GENERAL

- 1.1 It is to be noted that "The Make in India Policy of Government of India shall be applicable."
- 1.2 All the provisions contained in RDSO's ISO procedures laid down in Document No. - QO - D-8.1-11 Ver. 1.2 dated 22.06.2020 (titled "Vendor changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.
- 1.3 This specification covers the design, manufacture, testing at manufacturers works/accredited laboratory and supply of the 132 kV/220 kV XLPE cable and accessories as per requirement of Indian Railways, hereafter called purchaser.
- 1.4 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service life.
- 1.5 The supplier shall furnish the type test reports of the cable and accessories along with the offer as per IEC from accredited laboratory (accredited by the national accreditation body of country where laboratory is located.)
- 1.6 The purchaser shall conduct the type tests on the first order. ~~The charges for various type tests shall be quoted separately and these charges shall be taken for evaluation.~~ The purchaser reserves the right to conduct the entire type test or any of the type tests as considered necessary.
- 1.7 Unless brought out clearly, the offer/~~tenderer~~ vendor shall be deemed to conform to this specification scrupulously. All deviations from this specification shall be brought out in the schedule of deviations. Any deviation between the specifications and catalogues or the tender offered if not clearly brought out in the schedule of deviations shall not be considered as valid deviation.
- 1.8 The ~~tenderer~~ vendor shall furnish the following information:-
- i) Name of manufacturer & country of manufacture.
 - ii) Credentials of firm as manufacturer of 132kV/220 kV cable and accessories.
 - iii) Description of cable and accessories of similar capacity to that quoted, supplied and installed during the last five years

with the name of the parties/buyers to whom supplies were made, size of cable, date of installation and performance certificate thereafter.

- iv) Details of testing facilities at manufacturer's works.
- v) Whether manufacturer has technical collaboration with another firm, if so provide details regarding the same.

1.9 The ~~tenderer~~ **vendor** shall bring out clearly any additional feature which he deems fit to include to give a complete and comprehensive offer. He shall, however, explain reasons for offering such additional features/ items in his proposal.

2.0 SCOPE:

The scope shall include:

1	Supply of 132/220 kV cable	As per tender document
2	132/220 kV cable end termination kit complete and suitable for termination in O/D type switchgear.	As per tender document
3	132 kV/ 220 kV XLPE cable straight through joint kit complete suitable for cables above.	As per tender document

3.0 CLIMIATIC CONDITIONS:

The XLPE cable and accessories covered under this specification shall be laid underground at a depth of 1.5 mtr from the top of the soil.

The climatic condition specified in this clause are average conditions, any specific conditions specified in the tender documents shall override these.

SN	Description	Value up to altitude 1000 m	Value at altitude above 1000 m and up to 2500 m
	<u>TEMPERATURE:</u> The reference ambient temperature as per IS-9676:1980 or latest is 53.3 deg. C.		
	(a) Max. Ambient temperature	50 deg. C	50 deg. C
	(b) Max daily average ambient temp.	40 deg. C	40 deg. C
	(c) Max. Soil temp. at cable depth	35 deg. C	35 deg. C
	(d) Minimum Ambient Temp.	-5 deg. C	-15 deg. C

	<u>RELATIVE HUMIDITY:</u>		
	a) Maximum	100 %	100 %
	b) Minimum	10%	10%
	Average Annual Rainfall	1750-6250 mm	1750-6250 mm
	Average No. of thunderstorm days	85 per annum	85 per annum
	Average No. of rainy days	120 per annum	120 per annum
	Average No. of dust storm days	35 per annum	35 per annum
	Altitude	not exceeding 1000 m above M.S.L	Above 1000 m and up to 2500 m M.S.L
	Maximum basic Wind pressure	150 kg/m sq.	200 216 kg/m sq.
	Pollution level	very heavy as Per IEC 815-1986 & IS: 13134	very heavy as Per IEC 815-1986 & IS: 13134

The design of cable and accessories system shall be earth quake resistance having seismic coefficient as per IS- 1893 (latest amendments).

4.0 STANDARDS

The XLPE cable and accessories shall conform to the following Indian and international standards as with latest amended/ revised till date, as applicable:

1	IEC60840 (1988)	Power cable with extruded insulation and their accessories for related voltage below 150 kV
2	IEC62067(2001)	Power cable with extruded insulation and their accessories for related voltage above 150 kV
3	IEC60228 (1978)	Conductor for insulated cables.
4	IEC60229 (1982)	Tests on cable over sheaths
5	IEC60230 (1966)	Impulse tests on cables and their accessories.
6	IEC60270 (1981)	Partial discharge measurements.
7	IEC60287 (1994)	Calculation of continuous current carrying capacity and losses.
8	IEC60502 (1998)	Cables with extruded insulation and their accessories.

9	IEEE48- 1996	Test procedure and requirement for high voltage cable termination
10	IEEE404-1993	Joint for use with solid dielectric cables
11	IEEE635- 1989(R1994)	Guide for selection and design of aluminium sheaths.
12	IS:7098 Part 3- 1993	XLPE insulated Thermo plastic sheathed cables. Specification.
13	IEC: 60071	Insulation co-ordination and system engineering of high voltage electrical power installations above 1.0 kV AC and 1.5 kV DC
14	IEC: 62271-1	High-voltage switchgear and control gear - Part 1: Common specifications

Other standards shall be applicable provided the stipulation of such a standard is at least equal to the requirement of the specified standards.

5.0 CABLE SPECIFICATION:

5.1 SYSTEM PARAMETERS:

The brief particulars of the 132 kV/220 kV system parameters are:

i	Nominal System Voltage	132 kV	220 kV
ii	Highest System Voltage	145 kV	245 kV
iii	Impulse withstand voltage (1.2/50 micro Seconds wave of positive/negative polarity)	650 kV (peak)	1050 kV (peak)
iv	System frequency	50 Hz	50 Hz
v	System Earthing	Solid	Solid
vi	Rated Short Circuit Current	31.5 kA for 3 second.	40 kA for 3 sec. solid
vii	One minute power frequency withstand voltage (rms)	275 kV	460 kV
viii	Conductor continuous temp.	90 deg. C	90 deg. C
ix	Conductor short circuit rating temp.	250 deg. C	250 deg. C
x	Sheath short circuit rating temp.	150 deg. C	150 deg. C

For altitude above 1000 m and up to 2500 m, the value of basic insulation level for 132 kV/220kV shall be calculated as per IEC 62271-1 and IEC 60071-1&2 by multiplying of correction factor (k) in value of insulation level up to 1000m at the required altitude.

As per IEC 62271-1, the formula for correction factor is

$$k = e^{m(H-1000)/8150}$$

Where,

H is the altitude, in meters;

$m = 1$ for power frequency and lightning impulse voltage;

$m = 0.75$ for switching impulse voltage.

5.2 CABLE:

5.2.1 The cross linked polyethylene insulated (XLPE) cable shall be manufactured in accordance with the internationally accepted standard and also conform to the requirements of IEC 60840/62067 or latest depending upon voltage level.

5.2.2 The cable shall be suitable laying in an area likely to be flooded by water and shall be designed to be protected against rodent and termite attack.

5.2.3 The manufacturing process of XLPE cable shall consist of conductor screen, insulation and insulation screen shall be extruded in a single process (triple extrusion) and cross linked by VCV process (vertical Continuous Vulcanization Process) dry curing technology to ensure homogeneity and absence of micro voids. The cables shall be manufactured by "Dry Curing" Process.

5.3 CONDUCTOR

The tenderer vendor shall quote for single core XLPE cable with copper conductor having following sizes as per tender documents:

132 kV: Cross section of 1 x 300, 1x 500, 1x 630, 1x800 sq. mm

220 kV: Cross section of 1x 500, 1x 630, 1x 800 sq. mm

The conductor shall consist of plain annealed copper wires in accordance with IEC 60228 or latest. The shape of the conductor shall be compact circular stranded.

The manufacturer shall indicate the following details:

- Number of wires
- Diameter of wires
- Quality of copper
- Thickness and construction of sheath.

5.4 CONDUCTOR SCREEN

A conductor screen made of semiconducting compound shall be provided over the conductor by extrusion. The extruded coat shall be continuous, with a constant mean depth, without bump, perfectly adhering to the insulation envelope. A semiconducting

tape(s) shall be provided below the extruded semi-conducting conductor screen to prevent penetration of the compound into the underlying conductor. Minimum thickness of the conductor screen shall be 0.95 mm for 132 kV and 2 mm for 220 kV. The electric resistivity of the conductor screen shall not be more than 5000 Ohm cm at 20 deg. C and not more than 25000 Ohm cm at the working rated temperature.

5.5 INSULATION:

The insulation envelope shall be of cross - linked polyethylene (XLPE) insulation applied by extrusion. The nominal thickness of insulation shall not be less than 18 mm for 132 kV & 27 mm for 220 kV, subject to tolerances as per IEC 840 or latest.

The voltage gradient in the rated working conditions shall be

- Equal to or less than 6 kV/mm at the level of internal semiconductor
- Equal to or less than 3 kV/mm at the level of external semiconductor.

The mechanical characteristics shall be as follow:

i.	Tensile strength before ageing	12.5N/m ² (min.)
ii.	Elongation at break before ageing	200% min.
iii.	Ageing in air oven a) Treatment: Temperature Duration b) Variation from corresponding values before ageing Tensile strength Elongation at break	135+-3 deg. C 168 hrs +-25% max +- 25 % max
iv.	Hot set a) Treatment: Temperature Time under load Mechanical stress b) Elongation under load c) Permanent elongation after cooling	200+-3 deg. C 15 minutes 20 N/m sq 175% max 15% max
v.	Shrinkage a) Treatment Temperature Duration b) Shrinkage	130+- 3 deg. C 6 hrs 4% max

The insulation compound shall be of high quality. It shall also be heat, moisture, ozone and corona resistant. XLPE compound should be of Borealis Sweden or NUC Japan. The insulation shall be suitable for operation in wet or dry locations at conductor

temperature not exceeding 90 deg C for normal operation, and 250 deg C for short circuit conditions.

The insulation shall be applied by extrusion and vulcanized using dry curing process to form a compact homogenous body free from micro voids and contaminants.

5.6 INSULATION SCREEN:

The insulation screening shall be applied direct upon the insulation and shall be of a layer of extruded semi conducting thermosetting compound firmly and totally bonded to the insulation. Minimum thickness of insulation screen should be 0.8 mm.

The conductor screen, insulation & insulation screen shall be extruded in a single process. (Triple extrusion).

5.7 WATER SWELLABLE TAPE

The tape shall be semi-conducting water swellable to be applied over the extruded insulation screen to block and prevent moisture propagation in a longitudinal direction. The semi-conducting tape shall be suitable for the operating temperature of the cable and compatible with the insulation.

5.8 METALLIC SHEATH:

Metallic sheath shall be either of corrugated Aluminium or corrugated copper. The metallic sheath shall be able to carry a short circuit current of 31.5 kA/40 kA for 3 seconds. In the case of metallic sheath of corrugated Aluminium or copper the tenderer shall submit the calculation of area of aluminium or copper sheath in this support.

5.9 BEDDING TAPE

The bedding shall be anti-corrosive layer of Bitumen compound.

5.10 OUTER SHEATH

The outer sheath shall be extruded red/yellow/blue colour or similar (as per phase), graphite coated high density polyethylene, type ST-7 conforming to IEC specifications and extruded continuously. The outer sheath should have embossing at every one meter for manufacturer name, purchaser, voltage grade, cross section area etc. The thickness of the inner sheath at any point shall not be less than the minimum specified in BIS 7098 Part 3 or latest.

The Mechanical Characteristics shall be as follow:

a	Tensile strength before ageing	12.5 N/m ² (Min.)
b	Elongation at break Before ageing After Ageing at 110 +- 3 Deg. C for 14 days.	300 % min. 300 % min.
c	Hot deformation test 115 +- 2 deg C for 6 hrs. Max depth of indentation	50%
d	Carbon Black content	2.5 +- .5 %

The variation is the difference between the medium value obtained after ageing and the medium value without ageing, expressed in percentage of the last.

5.11 ISO ACCREDITATION

The cable shall be manufactured by a company having ISO certification for cable manufacturing facility. The scope for certification shall include inter-alia VCV Line and for sheath manufacturing process.

The purchaser may decide to visit the works of cable manufacturer to confirm the manufacturing process and quality of the product.

5.12 RATING

The cable size shall be suitable to carry the load current at 132 kV/220 kV continuously followed by a 10 % overloading capacity for two hours without exceeding the maximum conductor temperature of 105 deg. C absolute (The manufacturer shall specify such final temperature which shall ensure that there is no loss of life of the cable insulation). The cable rating size shall be based on loading of 2 nos. three phase circuits at an ambient temperature of 50 deg. C and soil temperature of 35 deg C. A complete set of experimentally verified data and calculations made, in arriving at the conductor rating shall be enclosed with the offer.

5.13 CABLE JOINTING ACCESSORIES

5.13.1 The cable jointing accessories shall include the end terminating kit, straight through joint as also any special tools and tackles required for making these joints.

5.13.2 The straight through joints shall be pre-moulded or moulded type complete with all jointing components/ accessories. The joint shall preferably be built up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable.

The joints shall be suitable for tropical climatic conditions specified under clause 3.0 of this specification.

- 5.13.3 The end termination shall be of outdoor anti-fog type complete with porcelain insulators with metal fittings and finishing material required. The outdoor terminal should be suitable for heavily polluted atmospheric conditions with creepage distance of 25 mm / kV for highest system voltage.
- 5.13.4 The joints shall be of one of the following makes:
- Kabeldon, Sweden.
 - Bruggen, Switzerland.
 - Cefag, Germany
 - J- Power System Corporation, Japan (formerly Sumitomo Electric Industries, Japan)
 - Nexans Switzerland Ltd., Switzerland (Formerly Alcatel, Switzerland)
 - Fujjikiran, Japan
 - Tyco Electronics, Raychem GMBH, Germany.

The supply of joint kits and end termination shall be supported with summary of the type test reports for all type tests conducted at manufacturer's works or at a reputed testing laboratory/ institute such as keema, Netherlands or CESI, Milano, Italy. The jointing kits shall be provided with water logging proof jackets and boots. The terminations and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. Necessary devices required for termination and joints shall be provided. An installation instruction sheet as well as a list of kit contents shall be included in the kit/ package.

5.13.5 SHEATH BONDING:

The bidder shall design for the type of sheath bonding, duly considering the various parameters such as requirement of load current, rated current of cable, fault current various dating factors, length of the cable and various safety factors etc. as per laid down standards and suggest suitable bonding system among single point bonding, cross bonding & both end bonding. The design of the system shall be supported with calculations.

5.13.6 LINK BOXES

Link boxes, if required based on the type of bonding, shall be suitable for outdoor installation in heavily polluted atmosphere and shall be made completely weather proof. The link box for earthing wherever required shall have provisions with earth links, so as to isolate the sections to

check the integrity of sheath of each section independently. The connecting bar and disconnecting link shall be of tinned copper. Link Boxes shall be single phase, weather proof, metal clad, outdoor structure mounting type. The arrangement shall be installed in a water tight box having degree of protection of IP: 55 .

5.13.7 EARTH STATIONS:

The pipe earth station shall be as per provision of BIS: 3043 (Latest version). The earthing system is required for:

- i) Earthing of all non-current carrying metal parts.
- ii) Earthing system of cable- metallic screen and sheath bonding at terminations ends.

6.0 SCHEDULE OF TESTS

6.1 GENERAL

- 6.1.1 Prototype inspection shall be done by RDSO, Lucknow, and after successful completion of all the type and routine tests as per this specification, prototype approval shall be issued. After approval of prototype, acceptance & routine tests on the balance quantity shall be done by the authorized representative of the Indian Railways as per purchase order.
- 6.1.2 Only after all the designs and drawings have been approved and clearance given to this effect by RDSO, the manufacturer shall take up manufacture of the prototype for inspection/ testing by RDSO. It is to be clearly understood that any changes to be done on the prototype as required by RDSO, the same shall be done expeditiously.
- 6.1.3 Prior to giving a call for inspection and testing of the prototype, the successful tenderer **vendor**/manufacturer shall submit a detailed test schedule **of proto type testing indicating the name of the test with internal test report (Test report of Routine Test)** ~~consisting of test procedures, schematic circuit diagrams, items/ parameters to be checked and values required as per specification~~ for each of the tests and the number of days required to complete all the tests at one stretch. The schedule shall also indicate the venue of each of the tests. Once the schedule is approved, the tests shall invariably be done accordingly. However, during the process of type testing or even later, the DG/TI/RDSO, Lucknow, reserves the right to conduct any additional test(s), besides those specified herein, on any equipment/ item so as to test the equipment/ item to his satisfaction or for gaining additional information and knowledge.

- 6.1.4 In case any dispute or disagreement arises between the ~~successful tenderer~~ **vendor**/manufacturer and the representative of the DG/TI/RDSO, Lucknow, during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type tests, it shall be brought to the notice of the DG/TI/RDSO, Lucknow, as the case may be whose decision shall be final and binding. Only after the prototype of the equipment is manufactured and ready in all respects, shall the ~~successful tenderer~~ **vendor**/ manufacturer give the actual call for the inspection and testing with at least 30 days notice for the purpose.
- ~~6.1.5 In the event of the tests not being carried through to completion at one stretch for any reason attributable to the successful tenderer / manufacturer and it is required for the representative of the DG/TI/RDSO, Lucknow, to go again or more number of times to the works of the successful tenderer/ manufacturer or to any NABL approved testing house/ laboratory where tests are being done for continuing and /or completing the tests on the prototype(s) of the equipment, the successful tenderer/ manufacturer shall reimburse to the DG/TI/RDSO, Lucknow the cost for the representative(s) having to visit the works or other place(s) for the tests more than once. The cost as claimed by the DG/TI/RDSO, Lucknow, shall be paid through a demand draft to the concerned Accounts Officer of the DG/TI/RDSO, Lucknow, as shall be advised to the successful tenderer/ manufacturer.~~
- 6.1.6 The tests shall be conducted on the prototype of the cable at the works of the manufacturer or ~~at any NABL approved testing house or laboratory~~ **at any Government approved testing laboratory if testing is done in India** in the presence of DG(TI)/RDSO, Lucknow, or his authorized representative. The prototype shall be complete in all respects, as would be supplied if it had passed the tests. The tests shall be conducted to the governing specification as modified or amplified herein.
- 6.1.7 For tests conducted in the laboratories of Central Power Research Institute, Bhopal/ Bangalore, Electrical Research Development Association, Vadodara or any such testing house or laboratory, a certificate to the effect that the equipment has passed the tests as per specification shall be obtained by the manufacturer and submitted to the DG(TI)/RDSO, Lucknow. Full details of the tests and test parameters shall be furnished along with the test reports.

- 6.1.8 All the testing/ measuring equipments shall be duly calibrated by a master traceable to National /International standards.
- 6.1.9 Irrespective of the cables being a standard/proven item of the manufacturer for which type tests have already been conducted and the test results are available, the type tests shall nevertheless, be conducted for the procurement against this specification. The routine/ acceptance/ type tests to be carried out on the cables, as part of above inspection, are given in para 6.2.0, 6.3.0 & 6.4.0 below.
- 6.1.10 Six copies of the following test certificates shall be submitted to the purchaser for record:-
- i. Type test certificate as issued by RDSO for the power cable.
 - ii. Acceptance test certificate for complete lot of the cable.
 - iii. Routine test certificates for each drum of cable.
- 6.1.11 The test certificates shall be complete with all the results. Purchaser's approval shall be obtained before dispatch of cables from the works.
- 6.1.12 The manufacturer shall advise the purchaser one month in advance when the cable shall be ready for inspection and tests, so that the latter's representatives may be deputed to witness the test(s). No material shall be shipped or dispatched until inspection and tests upto the satisfaction of the purchaser have been carried out. Such inspection and approval shall not relieve the manufacturer from full responsibility as defined in scope to the requirement of the specification nor prejudice any claim, right or privilege which the purchaser may have because of the use of defective or unsatisfactory equipment.

6.2 ROUTINE TESTS

The manufactured cable shall be subjected to Routine test as per IEC 60840/62067 para 9.0 **or latest.**

6.3 ACCEPTANCE/SAMPLE TESTS

These tests shall be conducted on cable length from manufacturing and will be as per clause 10.0 of IEC 60840/62067 **or latest.**

6.4 TYPE TESTS(S)

The electrical test shall be carried out on cables in accordance with clause 12.0 of IEC- 60840/62067 **or latest.**

6.5 OTHER REQUIREMENTS

Only after approval of the original drawings incorporating changes, if any, as a result of the prototype tests and clear written approval of the results of the tests on the prototype is communicated by the Purchaser/DG(TI), RDSO, Lucknow, to the successful tenderer/manufacturer, shall be taken up bulk manufacture of the cable. In no circumstances shall materials other than those approved in the design/ drawings and/ or during the prototype testing be used for bulk manufacture on the plea that they had been obtained prior to the approval of the prototype.

7.0 DRAWINGS:

Drawing in triplicate incorporating the detailed dimensional cross-sectional drawing of the cable following particulars shall be submitted with the tender for the purpose of preliminary study. After award of the contract the ~~successful tenderer~~ Vendor shall be required to submit reproducible copies of final drawings for the cable ordered.

8.0 PACKING AND MARKING

8.1 The cable shall be wound on non-returnable drums of suitable size and packed conforming to international standards.

8.2 The cut ends of the cable shall be sealed by means of non-hygroscopic sealing materials so as to protect the cable from outside moisture during transit and laying. The following information shall be marked on the drum.

- i) Trade name or trade mark; if any
- ii) Name of the manufacturer;
- iii) Nominal sectional area of the conductor of the cable.
- iv) Type of cable and voltage class for which it is suitable.
- v) Length of the cable on the drum.
- vi) Direction of rotation of drum (an arrow) and
- vii) Gross weight of the drum.

8.3 The drum shall be of such construction so as to ensure delivery of cable at site free from displacement and damage and should be able to withstand all stresses during handling in transit and laying. The cable drum shall be suitable for wheel mounting.

8.4 All wooden component of the drum shall be constructed from wood, properly seasoned, sound and free from defects. Wood preservative treatment shall be applied to the entire drum.

8.5 Drums or parts of drums made from ferrous metals shall be treated with a suitable rust-preventive finish or coating to minimize rusting during transit or storage.

- 8.6 Bolts, screws, nails etc. if used in the construction of drums shall be counter sunk so that the heads are below the surface of the flange.
- 8.7 The tenderer **vendor** shall clearly indicate in the offer, the normal length of cable in one drum. Normal single length should not be less than 500 meters per drum. Lesser length preferably not less than 40 % of the normal drum length as per site conditions shall also be accepted subject to the approval of purchaser.

9.0 WARRANTY:

The cables and joints & termination must be guaranteed for satisfactory operation for a period of 60 months from the date of commissioning.

10.0 SCHEDULE OF GUARANTEED PARAMETERS

The following information shall be given by the tenderer in addition to any other relevant data.

S.N.	Description	Value	Unit
1	Name of Manufacturer		
2	Country of Manufacturer:		
3	Type of Cable	XLPE	
4	Conforming Standard	IEC/BIS	
5	Rated Voltage	132/220	kV
6	Nominal cross-sectional area of conductor		Mm sq.
7	Conductor material	Copper	
8	Impulse withstand voltage 1.2/50 micro second wave		kVP
9	Power frequency withstand voltage		kVrms

10	Maximum dielectric stress at the conductor		kV/cm
11	Minimum radial thickness of insulation between conductor & screen.		mm
12	Conductor screen		
	a) Material		
	b) Nominal thickness		mm
13	Metal sheath:		
	a) Minimum radial thickness		
	b) Composition		
	c) Maximum working stress		Kg/cm sq.
14	Nominal diameter over metal sheath		Mm
15	Nominal radial clearance allowed under metal sheath		Mm
16	Protective outer serving		
	a) Type and composition		
	b) Nominal thickness		mm
	c) Test voltage at works		KV
17.	Nominal Overall diameter of completed single core cable		Mm
18.	Nominal weight per meter of complete cable.		Kg/m
19.	Short circuit capacities with a conductor temperature of 90 deg C at the commencement:		
	a) 0.5 second duration		kA
	b) 1 second duration		kA
	c) 2 second duration.		kA
	d) 3 second duration.		kA
20.	Minimum radius of bend round which cable can be laid		
	a) Direct burial in ground		M
	b) In ducts		M
21	Maximum DC resistance of conductor per km. at 20 deg. C		Ohm
22.	Maximum AC resistance of conductor per Km. at 90 deg. C		Ohm
23.	Equivalent star reactance per km of 3-phase circuit at 50 Hz.		Ohm
24.	Maximum electrostatic capacitance per km of cable.		F
25.	Maximum continuous current carrying capacity per cable when laid in ground at a depth of 1.5 meters (ground temp 35 deg. C soil thermal resistivity 150 deg C/Watt/Cm. maximum conductor temperature 90 deg. C).		
	a) Only one 3-phase ckt. Loaded		A
	b) Both three phase ckts. Loaded.		A
26.	Maximum continuous current		

	carrying capacity per cable when drawn into pipes (conditions as in item 25 above).		
	a) Only one 3 phase ckt. loaded		A
	b) Both three phase ckts loaded.		A
27.	Continuous current carrying capacity which shall permit a further 10 % overload for two hours without exceeding maximum conductor temp. of 105 deg C as laid in item 26 above.		
	a) Only one 3 phase ckt. Loaded.		A
	b) Both three phase ckts. Loaded.		A
28.	Continuous current carrying capacity which shall permit a further 10 % overload for two hours as in item no. 27 above, but with cables drawn into pipes.		
	a) Only 3 phase ckt. Loaded.		A
	b) Both three phase ckts. Loaded.		A
29.	Maximum dielectric power loss of cable per km of 3 phase ckt., laid direct in ground, at normal voltage, frequency and maximum conductor temperature.		
30.	a) Sheath loss of cable per km. of 3 phase ckt. At normal voltage, frequency, at maximum continuous current rating.		
	a) Laid direct in ground (item 25 above)		
	b) drawn into ducts (item 26 above)		
31	Impedance per km of 3 phase ckt. At 50 Hz. And maximum conductor temperature.		
	a) Positive and negative sequence		Ohm
	b) Zero sequence		Ohm
32	Attention to carrier current signals operating over a frequency range of 50 to 200 kHz.		
	a) Phase to ground characteristic impedance at 50 to 200 KHz.		
	b) Screening factor.		
33	Maximum drum length of cable.		M
34	Approx. shipping weight & size of drums		Kg

35.	Guaranteed Power Transmission capacity		MVA
36.	Straight through joint		
	a) Make		
	b) Type		
37	End Terminations		
	a) Make		
	b) Type		

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