WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Govt. of West Bengal Enterprise)

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TECHNICAL SPECIFICATION FOR EFFECTIVELY EARTHED 33 KV XLPE ARMOURED ALUMINUM 1 Core x 1000 sq.mm CABLE

Updated on 22.10.2016

TECHNICAL SPECIFICATION
FOR
XLPE CABLE SUITABLE FOR USE IN EFFECTIVELY EARTHED 33 KV SYSTEM

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1. **SCOPE** :

The specification covers the design, manufacture, testing, supply and delivery in proper packed condition of different grades of 1 core, Aluminium Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, Armoured, screened Power Cables.

2. **DEVIATION** :

Normally the offer should be as per Technical Specification without any deviation. However, any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the 'Deviation Schedule' with reasons duly supported by documentary evidences and advantages of such deviation. Such deviation suggested may or may not be accepted. **Deviations not mentioned in 'Deviation Schedule' will not be considered afterwards.**

3. **LOCATION** :

3.1 The Cables may be laid buried directly in ground at a depth of one metre in average, anywhere in West Bengal and terminate for outdoor connection to a power transformer or to overhead lines.

3.2 The Cables may also be laid within covered cable trenches, in cable racks or open air ladder trays etc. for certain portions of lengths.

4.0 **SYSTEM DEAILS** :

4.1	*Voltage grade (KV) of cable required* ::	*19/33*
4.2	*Service Voltage* ::	*33 KV*
4.3	*Highest Voltage* ::	*36 KV*
4.4	*Earthing System* ::	*Delta connected systemearthed through earthing transformer*
4.5	*B.I.L. for Cable* ::	*170 KV for 33 KV Grade*
4.6	*Fault Level (Maxm.)* ::	
4.7	*Frequency* ::	*50 C./S*

5.0 **WEATHER CONDITION** :

5.1 Monsoon prevails generally from the month of June to October with showers some times heavy, acidic, smoky, industrial and foggy.

5.2	*Maximum ambient temperature*	*:: 50 degree C.*
5.3	*Minimum ambient temperature*	*:: 4 degree C*
5.4	*Thermal resistance of soil*	*:: 150 degree C-Cm/Watt*
5.5	*Maximum Daily average ambient temp*	*:: 40 degree C*
5.6	*Maximum relatively humidity*	*:: 100.00%*
5.7	*Average rainfall per annum*	*:: 200 cm*
5.8	*Maximum height above the Sea level*	*:: 1000 Meters*

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6. STANDARDS:

6.1 The Cable shall conform to the following standards to the extent of WBSEDCL's requirement is fulfilled.

1) *IS: 7098 (Part-II) : Specification for cross-linked polyethylene Insulated PVC Sheathed (Latest) Cables for working Voltages from 3.3 KV up to and including 33 KV*
2) *IS:8130-1984 : Specification for Conductors for insulated electric cables and flexible cords*
3) *IS:5831-1984 : PVC insulation & sheath of electric cables*
4) *3975-1999: Armour for cables (for 1 Core)*
5) *IS:10810-1984 : Methods of test for Cables.*
6) *IS:10418-1982: Cable Drums for Electric Cables.*

6.2 The cable, joints, outdoor termination and their accessories and fittings may conform to other Indian and/or equivalent Standards or important publications to improve upon their performance, but shall not fall short of the requirement of this specification. The tenderer shall clearly indicate such standards in their offers.

7. ELECTRICAL CHARACTERISTICS & PERFORMANCE :		
7.01 Description of Cable		:
	19/33 KV Grade :	Standard compacted circular Aluminium (H4 Grade) Conductor, shielded with black extruded semi-conducting compound XLPE insulated, core shielded with black extruded semi-conducting compound, black semi-conducting compound and a copper tape.
7.02	Voltage Grade :	19/33KV (For 33 KV System)
7.03	Size of Cable :	1000 sq.mm.
7.04	Service Voltage :	33 KV

7.05	Maxm.Conductortemp. :	90 ° C at maxm. continuous current.
7.06	For ***33 K.V System***	
	Short Ckt. Current - 3 Phase Short Ckt on Conductor	1) 94.48 KA for 1 sec for 33 KV 1000 sq. mm.
	Short Ckt. Current - Single Ph to Earth	*2 KA for 3 Secs for all ratings combined with armour and screen without altering of copper tape thickness as per clause no. 7.12*

7.07	MaximumPermissible emergency overload temp. at 25% overload to 100 hrs. per year or 500 hrs. in life of Cable	:	130 degree C for one hour
7.08	Maxm. Permissible short circuit Temperature	:	250 degree C for one second
7.09	Conductor Material	:	Material confirming to IS: 8130, H4 Grade Aluminium Conductor, stranded compacted circular with Tensile

			stress greater than 150 N/mm2, No. of Strand 91, Diameter of strand 3.74mm, Resistance of conductor 0.0291 Ω/Km
7.10	Conductor screening	:	Extruded, cross linked, semi-conducting compound of 1.0 mm. thickness for 33 KV
7.11	Insulation	:	XLPE of thickness, 8.8 mm(Nominal) for 33 KV
7.12	Insulation Screening : For 33 KV:	::	Combination of black extruded semi-conducting compound & semiconducting tape as the non-metallic part and annealed copper 0.06 mm (minimum) thick tape lapping as metallic part to suit the Single phase to Earth Short Ckt Current as describe above. For 1 Core Cable, the non-magnetic metal armour will act as metallic part insulation screening.
7.13	Inner Sheathing	:	For Single Core layers of non conducting water swellable tape with 50% overlap.
7.14	Armouring	:	For 1 Core, there will be round wire armour made of non-magnetic metal. For 1 Core 1000 sq. mm. cable armour wire must be 2.4 mm. Minimum no of armour should be 71 nos.
7.15	Overall Sheathing	:	ST-7 for 1 Core 1000 sq. mm. Cable.
7.16	Approx length of Cable in a Drum & Over all Tolerance	:	500Metres ± 5% (for 1 Core) but overall Tolerance of Item wise PO Quantity shall be -1% (minus 1%).
7.17	End Sealing	:	H.S. Caps (See Clause 8.11) (Heat Shrinkable)
7.18 a)	Max. tan-delta at room temp., at nominal Phase to Neutral Voltage (Uo)	:	0.004
b)	Maxm. Increment of tandelta between 0.5 Uo to 2 Uo at room temp	:	0.002
7.19	Partial Discharge Value	:	10 pC (Maxm.) at 1.73 Uo
7.20	Impulse Tests	:	170 KV for 33 KV
7.21	H.V. Tests between Conductors & Screen/Armour	:	63 KV (rms) for 33 KV for 5 minutes
7.22	Maximum D.C Resistance per KM	:	As per relevant I.S.S
7.23	Current Carrying Capacity at air 40 degree C	:	a. 1C x 1000 sq. mm. 700 amps

* N.B. : The above parameters are applicable for 1-Core Cable, if not otherwise specified.

8. **CABLE CONSTRUCTION** :

8.1 XLPE Underground Cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials for XLPE

main insulation and XLPE semi-conducting Insulation & XLPE screen. The inner and outer semiconducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded during the Tripple Extrusion Process of manufacturing and main insulation of the Cable is to be extruded unfilled. The XLPE Cable in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armourwires which shall be ensured by guarding against corrosion.

8.2 **CONDUCTOR SCREEING** :

A semi-conducting cross-linked polyethylene (XLPE) screening shall be extruded over the conductor to act as an electrical shield which together with the elimination of the so called "Strand Effect" prevents to a great extent air ionization on the surface of the conductor.

8.3 **INSULATION** :

The main insulation of the Cable shall be extruded unfilled, chemically cross-linked polyethylene (XLPE) inert gas cured satisfying the requirement of IS: 7098 (Part-II)/ 2011.

8.4 **INSULATING SCREEN** :

The screen shall be made up as given in 7.12. The metal screen eliminates tangential stress of rotating electrostatic field surrounding the conductor and uniform electrical stress in the insulation.

The semi-conducting polyethylene (XLPE) screen shall be extruded over the main polyethylene insulating wall to prevent partial discharge at the surface of the insulation. The copper tape shall be wrapped over the semi conducting tape or extrusion as mentioned earlier for 3 core cables. The metal screen so formed around the cores shall be in contact with one another as the cores are laid up at triangular configuration. For single core cable, Aluminium wire armouring shall constitute the metallic part of insulation screen. Conductor screening, insulation and insulation screening shall be extruded in triple extrusion processes so as to obtain continuously smooth interfaces.

8.5 The mechanical and chemical properties of the materials for semi conducting screens are much more important than their electrical properties, but for obtaining the high overall degree of electrical properties of an E.H.V. cable, the inner and outer semi conducting screens and the main polyethylene insulation between the screens shall be simultaneously extruded during the manufacturing process known as "tripple extrusion". The advantages are :-

i) The partial discharge level at the surface of the insulation is brought to a minimum.
ii) There will be no displacement of the semi conducting screen and insulation during expansion and contraction due to load cycles and bending.
iii) The semi conducting screens are easily removable during jointing and termination operations.

8.6 **INNER SHEATH** :

For Single Core, Longitudinal moister barrier shall be provided by a layers of conducting water swellable tape with 50% overlap also a layer of non conducting water swellable tape applied with 50% overlap over the aluminiumarmour.

8.7 **ARMOUR** :

In case of Single Core Cable the armour should be of non-magnetic material. For 1Core 1000sq. mm. Single layer of hard drawn Aluminium round wire armour and completely cover completely leaving no gap.

8.8 **OUTER SEATH** :

A reliable serving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. The cable shall therefore be finished with acolouredextruded PVC/HDPE overseath of thickness as per para 7.15.

The quality of PVC/HDPE oversheath (Jacket) shall be ensured for service reliability against moisture intrusion and shall conform to type ST-2 of IS:5831/ST-7 of IEC.

The colour of the outer sheath shall be as follows :

For 33 KV Cable : GREEN

The sheaths shall be protected against white ants, vermin and termites by suitable, reliable and durable measures.

The supplier shall suggest suitable materials for use, in the event of damage to the oversheath to prevent passage of moisture along the cable.

8.9 **CABLE IDENTIFICATION** :

The following shall be embossed on the outer sheath for the identification.

a) Manufacturer's Name or Trade Mark.
b) Voltage Grade.
c) Nominal section & Material of conductor and number of crores.
d) Year of manufacture.
e) Inscription for length of cables at 1.0 meter interval.
f) Name of the purchaser : WBSEDCL
g) Marking "Electric" shall be embossed throughout the length of the Cable at 1.0metres spacing.
h) Type of insulation i.e. XLPE.
i) FRLS

8.11 **SEALING OF CABLE ENDS** :

The cable ends of cable in the wooden drum for delivery shall be sealed with heat shrinkable caps.

9. **WOODEN DRUMS**:

The Cable shall be packed in non-returnable wooden drums.

9.1 The following information shall be marked on each drum.

a) **Drum identification No.**
b) **Manufacturer's Name, Trade Name/Trade Mark, if any.**
c) Nominal sectional area of the conductor of the cable.
d) No. of Cores.
e) Type of Cable and Voltage Grade with Cable Code.
f) Length of the Cable in Cable Drum.
g) Direction of rotation of Drum (by means of an arrow)
h) Approximate Weight : Tare : Gross
i) Year and Country of Manufacture.
j) Purchase Order No.
k) Date of Delivery.
l) Name of the Purchaser : WBSEDCL

Drums shall be proofed against attack by white ants or termite conforming to IS : 10418. The Drums may also be marked with ISI Certificate Mark, if applicable.

9.2 Safe Pulling Force : 30 N/mm2 (for Conductor)

Non returnable Steel Drum for 33 KV may also be accepted in place of non returnable wooden drum without implication of additional cost.

10. Tests to be performed as per IS: 7098 (Part-II)/2011 and latest amendment

10.1 A Type Test: All the tests mentioned below are to be made as per details given in IS:10810

a) Tests on conductor.

i) Tensile Test (for aluminium)
ii) Wrapping Test (for luminium)
iii) Resistance Test.

b) Tests for armouring Wires strips.

c) Test for thickness of insulation and steath

d) Physical test for insulation.
i) Tensile strength and elongation at break.
ii) Ageing in air oven.
iii) Hot test.
iv) Shrinkage test
v) Water absorption (Gravimetric)

e) Physical tests for outer sheath
   i) Tensile strength and elongation at break.
   ii) Ageing in air oven.
   iii) Shrinkage test.
   iv) Hot deformation.
   v) Heat shock.
   vi) Loss of mass in air oven.
   vii) Thermal stability.

f) Partial discharge test.

g) Bending test.

h) Dielectric power factor test.
i) As a function voltage.
j) As a function of temperature.
i) Insulation resistance (Volume resistivity) Test.
j) Heating cycle test.
k) Impulse with stand test.
l) High voltage test.
m) Flammability test.

10.1 B The following tests on screened çable shall be performed successively on the same test sample of completed cable, not less than 10m. in length between the test accessories.

a) P.D. Test.
b) Bending Test followed by P.D. Test.
c) Dielectric power factor as a function of voltage.
d) Dielectric power factor as a function of temperature.
e) Heating cycle test followed by dielectric power factor as a function of voltage and P.D.tests.
f) Impulse withstand test and
g) High voltage test as per para 7.21.

If a sample fails in test (g) one more sample shall be taken for this test, preceded by tests (b) & (e).

10.2 **Acceptance Test**: The following shall constitute Acceptance Tests :

a) Conductor resistance test.
b) Test for thickness of insulation and sheath.
c) Hot set test for insulation.
d) Tensile strength and elogation at break test for insulation and outer sheath.
e) P. D. Test (for screened cables) only on full drum length.
f) High Voltage test, and
g) Insulation resistance (VOLUME RESISTIVITY) TEST

10.3 **ROUTINE TESTS** :

The routine test shall be carried out on all cables manufactured in accordance with this specification.

The following routine tests shall be made on cable length as specified in the ISS. a) Conductor resistance test.
b) Partial discharge test on full drum length.
c) High voltage test as per para 7.21

10.4 **TEST WITNESS** :

1. All Tests shall be performed in presence of Purchaser's representative if so desired by the Purchaser.
2. The contractor, shall give at least fifteen (15) days advance notice for witnessing such tests.

11. **TEST CERTIFICATE** :

11.1 Certified copies of all routine tests carried out at Works shall be furnished in Six (6) copies for approval of the purchaser.

11.2 The cables shall be dispatched from Works only after receipt of Purchaser's written approval of shop test reports.

11.3 Type Test Certificates of the Cable offered shall be furnished along with Bid.

12. **DESCRIPTIVE LITERATURES, TEST RESULTS ETC.** :

The following details for the cable shall be submitted with bid.

a) Manufacturer's Catalogue giving cable construction details and characteristics.
b) Manufacturing process in detail for cables highlighting the steps to control.
   i) Contamination.
   ii) Formation of water trees.
   iii) Effects of by products of cross-linking.
   iv) Stress control etc.
c) Cross section drawing of the cable.
d) Cable current ratings for different types of installation inclusive of all de rating factors due to ambient temperature, grouping etc.
e) Over-Load characteristics of the cable without endangering the normal life and electrical quality of the insulation.
f) Complete technical data of the cables.
g) List of Customers to whom the Cable of similar rating have been supplied.
h) Type Test Report conducted on similar type of Cable from NABL/ Central Govt./Jadavpur University approved Accredited Testing Laboratory within 5 years from the due date of opening of Tender is to be submitted.
i) Valid Calibration Certificate of instruments/equipment used for Testing purpose conducted by NABL accredited Laboratory provided the certificate bears an accreditation body logo. For testing equipment where NABL accreditation is not available, calibration certificate from educational institutions like IIT's, NIT's, J.U., C.U., B.H.U. only can be accepted provided they demonstrate traceability.
j) Documents to be submitted at the time of physical delivery at consignee stores :
   The following documents are to be submitted by the venders to the consignee stores at the time of dispatch to stores by the venders :

   i. Copy of Purchase Order
   ii. Copy of dispatch instruction
   iii. Inspection Test certificate
   iv. Guarantee certificate
   v. Proforma Invoice
   vi. Calculation Sheet for price variation on the basis of IEEMA or CACMAI as applicable with base date of order
   vii. Seal list and packing list
   viii. Challan in triplicate
   ix. Way bill, if applicable

GUARANTEED TECHNICAL PARTICULARS FOR SINGLE CORE 33 KV XLPE CABLE

1.	Name of Manufacturer& Address	:	
2.	Voltage Grade :19/33 KV	:	19/ 33 KV (for 33 KV sys.)
4.	Core & Cross section	:	1C x ----------Sq.mm
5.	Type & designation(as per ISS)	:	IS: 7098 /II/2011
6.	Suitable for System with		
a)	Service Voltage	:	33KV
b)	Neutral earthing	:	Effectively Earthed System
7.	Maximum conductor temperature		
a)	Continuous (in Deg.C)	:	
b)	Short time (in Deg. C)	:	
	(a) Shape of Conductor	:	
	(b) Diameter of Conductor	:	
8.	Conductor		
a)	Material to IS:8130 (Class/Grade)	:	Aluminium to IS :8130/ 84 (H4 Grade)
b)	Size (sq.mm)	:	---------sq.mm
c)	Conductor (no/ mm.) *** Shall be suitably selected to meet the DC** (resistance flexibility class to IS 8130)	:	
d)	Form of conductor (Circular/Shaped)	:	
9.	Shielding/Screening on conductor		
a)	Material	:	
b)	Type	:	
c)	Weather thermosetting	:	
10.	Insulation	:	
a)	Material	:	
b)	Type	:	
c)	Thickness (mm.)		
(i)	Non- metallic	:	
(ii)	Metallic	:	
11.	Shielding / Screening on Insulation		
a)	Material	:	
b)	Type	:	
c)	Thickness (mm.)		
(i)	Non- metallic	:	

(ii)	Metallic	:	
12.	Inner -Sheath		
(a)	Material	:	
(b)	Type	:	
(c)	Thickness (Min.)	:	
(d)	Extruded	:	
(e)	Approx.outside diameter over sheath (mm)	:	
13.	Armouring		
(a)	Material	:	
(b)	Size	:	
(c)	D.C. resistance at 20 deg. C		
(d)	A.C. resistance at 20 deg. C		
14.	Overall Sheath		
(a)	Material	:	
(b)	Type	:	
(c)	Thickness (mm.)	:	
15.	Approx. Overall diameter of the Cable(mm)	:	
16.	Standard Drum length with tolerance (Mtr.)	:	
17.	Net weight of Cable (approx.) Kg/ Km.	:	
18.	Continuous current rating forStandard condition, laid direct		
(a)	In ground at temp 30 deg.C	:	
(b)	In duct at temp 30 deg.C	:	
(c)	In air at temp 30 deg.C	:	
19.	Charging current at rated system voltage		
20.	Short Circuit Current (Maxm) in KV		
(a)	for 1 sec	:	
(b)	for 0.5 sec	:	
21.	ElectricalParameters		
(a)	Maxm. D.C. resistance /kmof Conductor at 20 deg.C	:	
(b)	AC resistance / kilometer ofconductor at 90deg.C (approx.)	:	
(c)	Reactance /kilometer (approx.)	:	
(d)	Capacitance / Kilometer (approx.)	:	

(e)	Di-electric losses at rated(Uo/U) SystemKV,50 cycles /sec	:	
(f) i.	tan-delta at 0.5 Uo	:	
(f) ii.	tan-delta at Uo	:	
(f) iii.	tan-delta at 1.5 Uo	:	
(f) iv.	tan-delta at 2 Uo	:	
22.	Vol.Resistivity at 27 deg.C (ohm/Cm)	:	
23.	Recommended minimum bending radius	:	
24.	Derating factor for following ambienttemperature in Air/ Ground.		
(a)	at 30 deg. C	:	
(b)	at 35 deg. C	:	
(c)	at 45 deg. C	:	
25.	Type Test results of the similar Cable to befurnished with Tender (as specified under Cluse-10 of the Spec.)		
(a) i.	Tensile Test (for aluminium)	:	
(a) ii.	Wrapping Test (for aluminium)	:	
(a) iii.	Resistance test	:	
(b)	Test for armouring wires / strips	:	
(c)	Test for thickness of insulation & sheath		
i.	Tensile strength & elongation at break	:	
ii.	Ageing in air oven	:	
iii.	Hot test	:	
iv.	Shrinkage Test	:	
v.	water absorption (Gravimetric)	:	
(d)	Physical		
i.	Tensile strength & elongation at break	:	
ii.	ageing in air oven	:	
iii.	Shrinkage Test	:	
iv.	Hot deformation	:	
v.	Loss of massin air oven	:	

vi.	Heat shock	:	
vii.	Thermal stability	:	
(e)	Partial discharge test	:	
(f)	Bending Test	:	
(g)	Di- electric power factor test		
i.	As a function of Voltage	:	
ii.	As a function of temperature	:	
(h)	Insulation resistance(volume resistivity) *Test	:	
(i)	HeatingCycle Test	:	
(j)	Impulsewithstand test	:	
(k)	High Voltage test	:	
(l)	Flammability Test core & cross section (no x sq mm)	:	
26.	Cable Drums		
(a)	Length /Drum(kg)	:	
(b)	Dimension of Drum	:	
(c)	Shipping weight (kg)	:	
27.	Safe pulling force (Kg)	:	
28.	Partial discharge value	:	
29.	Details of protective measuresagainst attack by white antevermin etc. to the XLPE'souter sheath during manufacture.	:	
30.	Type of curing of XLPE Insulations	:	
31.	Cut ends of the Cable shall be sealed	:	
32.	Cable identifications shall be made asper class 8.10 (Yes/ No)	:	
33.	Cable Drums shall be marked with thewith the information of Clauses 9.1conspicuously (yes / No)	:	
34.	Thickness of extruded conductor screening(mm) (Nom)	:	
35.	Earth fault current rating of armour for one second duration(KA)	:	
36.	Laying	:	
37.	Embossing	:	

Signature with Designation &
seal with Name of the Firm.