WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED
(A Govt. of West Bengal Enterprise)

TECHNICAL SPECIFICATION FOR XLPE CABLE

SUITABLE FOR 3 Core & 1 Core

For Armoured/Unarmoured Cable

(i) NON-EFFECTIVELY EARTHED 33 KV SYSTEM

AND

(ii) EFFECTIVELY EARTHED 11 KV SYSTEM

TECHNICAL SPECIFICATION
FOR
XLPE CABLE SUITABLE FOR USE IN NON-EFFECTIVELY EARTHED 33 KV SYSTEM AND EFFECTIVELY EARTHED 11 KV SYSTEMS (UpdatedApril,2008)

1. SCOPE :

1.1 The specification covers the design, manufacture, testing, supply and delivery in proper packed condition of different grades of 1 or 3 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. But 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. But 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, any where 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*	*6.35/11*
4.2	*Service Voltage*	*::*	*33 KV*	*11 KV*
4.3	*Highest Voltage*	*::*	*36 KV*	*12 KV*
4.4	*Earthing System*	*::*	*Delta connected system earthed through earthing transformer*	*Solidly earthed*
4.5	*B.I.L. For Cable*	*::*	*170 KV for 33 KV Grade*	*75 KV for 11 KV Grade*
4.6	*Fault Level (Maxm.)*	*::*	*See Clause 7.6*	
4.7	*Frequency*	*::*	*50 C./S*	*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. <u>STANDARDS</u> :

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

1)	*IS: 7098 (Part-II) (Latest)*	:	*Specification for cross-linked polyethylene Insulated PVC Sheathed 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)	3975-1970	:	*Armour for cables (for 3 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. <u>ELECTRICAL CHARACTERISTICS & PERFORMANCE</u> :

7.01 <u>Description of Cable</u> :

a) 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 tape and a copper tape, coloured strips having Red, Yellow & Blue for core identification, shielded cores laid up with fillers, binder taped and Black extruded PVC (Type ST-2) inner sheath, single layer of round galvanised steel wire armoured and black extruded PVC (Type ST-2), overall sheathed, conforming generally to IS:7098(Part-II).

b) 6.35/11KV Grade : Same as above but insulation shielding with black semi-conducting tape not necessary. Inner sheath to be wrapped not extruded and strip armoured not wire armoured. The design shall fully confirm to IS:7098 (Part-II)

7.02	Voltage Grade:		<u>19/33KV (For 33 KV System)</u>	<u>6.36/11KV (For 11 KV System)</u>
7.03	Size of Cable	:	95 sq.mm.	95 sq.mm.
			185 sq.mm.	185 sq.mm.
			240 sq.mm.	240 sq.mm.
			300 sq.mm.	300 sq.mm.
			400 sq.mm.	400 sq.mm.
			500 sq.mm.	500 sq.mm.
7.04	Service Voltage	:	33 KV	11 KV
7.05	Maxm.Conductor temp.	:	90 degree C at maxm. continuous current.	

		33 K.V System	***11K.V. System***
7.06	Short ckt. Current	1) 47.1 KA for 1Sec for 33 KV 500 sq.mm	*1)* 47.0 KA(895.47MVA) for 1 sec for 11 KV 500 sq.mm
		2) 37.6 KA for 1Sec for 33 KV 400 sq.mm	2) 37.6 KA (716.37MVA) for 1 sec for 11 KV 400 sq mm

		3)28.2K.A(1612 MVA)for 1Sec for 33 KV 300 Sq mm	*3)28.2K.A(537MVA)for 1Sec for 11KV 300 Sq mm*
		4)22.56 K.A(1289 MVA)for 1Sec for 33 KV 240 Sq mm	*4)22.6 K.A(429MVA)for 1Sec for 11KV 240 Sq mm*
		5)17.39 K.A(994 MVA)for 1Sec for 33KV 185 Sq mm	*5)17.39 K.A(331 MVA)for 1Sec for 11KV 185 Sq mm*

7.07	Maximum Permissible 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 to IS: 8130, H4 Grade Aluminium Conductor, stranded compacted circular
7.10	Conductor screening	:	Extruded, cross linked, semi-conducting compound of 1.0 mm. thickness for 33 KV and 0.5 mm. thickness for 11 KV
7.11	Insulation	:	XLPE of thickness, 8.8 (Minimum) for 33 KV and 3.6 mm. (Nominal) for 11 KV
7.12	Insulation Screening : For 33 KV	::	Combination of black extruded semi-conducting compound & semi-conducting tape as the non-metallic part and annealed copper 0.06 mm (minimum) thick tape lapping as metallic part. For 1 Core Cable, the non-magnetic metal armour will act as metallic part insulation screening.
	For 11 KV :	:	It is same but semi-conducting tape is not required
7.13	Inner Sheathing	:	Black extruded PVC Type ST-2 compound for 33 KV and wrapped PVC tape for 11 KV as per ISS. For 1 Core there will be no inner sheath.
7.14	Armouring	:	Single layer of round galvanised steel wires/strips for 33 KV (3 Core) and galvanised steel strips/wire for 11 KV)3 core) as per IS. For 1 Core, there will be round wire armour made of non-magnetic metal.
7.15	Overall Sheathing	:	Coloured PVC Type ST-2 compound to IS:5831, extruded for both 33 KV and 11 KV thickness shall be as per ISS.
7.16	Approx length of Cable in a Drum	:	250 metres with a tolerance of ± 5% (for 3-Core). 500Metres ± 5% (for 1 Core)
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 tan-delta between 0.5 Uo to 2 Uo at room temp	:	0.002
7.19	Partial Discharge Value	:	20 Pc (Maxm.) at 1.6 Uo
7.20	Impulse Tests	:	170 KV for 33 KV and as per ISS for 11 KV
7.21	H.V. Tests between Conductors & Screen/Armour	:	48 KV (rms) for 33 KV for 5 minutes and as per ISS for 11 KV
7.22	Maximum D.C Resistance per KM	:	As per relevant I.S.S

* N.B. : The above parameters are applicable for 3-Core and 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 semi-conducting 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 armour wires 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 ionisation 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 ISS: 7098(Part-II).

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 LAYING UP :

The phase identification of the cores shall be either by colour or numerals as per I.S.S. for 3 core cables only.

Core Colour	Numaral
Red	1
Yellow	2
Blue	3

The screened cores shall be laid up with interstices filled with PVC fillers and taped with a binder tape as to obtain a reasonably circular cable.

8.7 **INNER SHEATH** :

The cable core shall be supplied with bedding of PVC (inner sheath) in the form of extruded PVC sheath for 33KV cables. Wrapped PVC tapes shall be used for 11 KV thickness as per Para 7.13 and as per ISS.

8.8 **ARMOUR** :

The cable shall be wire armoured/Steel strip in case of 33KV and wire/Strip armoured in case of 11 KV, 3 Core cables to ensure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. The Steel Wires/Aluminium Wires/Steel Strips of required size in requisite number as per para 7.14 shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cross sectional area for flow of maximum fault current within limits of specified temperature rise and duration of fault. The direction of the lay of the armour shall be opposite to that of the cable cores. In case of Single Core Cable the armour should be of non-magnetic material.

8.9 **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 an extruded PVC overseath of thickness as per para 7.15.

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

The colour of the outer sheath shall be as follows :
For 33 KV Cable : GREEN & For 11 KV Cable : BLUE
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.

8.10 **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 10 metres spacing.
h) Type of insulation i.e. XLPE.

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)

10. Tests to be performed as per IS: 7098 (Part-II)

10.1A 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 aluminium)
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.
ii) 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 cable 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) Tensile test (for aluminium)
b) Wrapping test (for aluminium)
c) Conductor resistance test.
d) Test for thickness of insulation and sheath.
e) Hot set test for insulation.
f) Tensile strength and elogation at break test for insulation and outer sheath.
g) P.D.test (for screened cables) only on full drum length.
h) High Voltage test, and
i) 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 despatched 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. Otherwise the cable shall have to be type tested on similar rating as per Clause – 10 free of any charges to prove the design.

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 used for Testing purpose conducted by NABL accredited Laboratory.

SECTION – III **SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS**

FOR XLPE CABLES

(To be filled in by the Supplier)

1.	Manufacturer's Name & Address	::		
2.	Voltage Grade.	::19/33 KV (For 33 KV Sys.)		6.35/11 KV (For 11 KV Sys.)
3.	Core & Cross Section	::		
4.	Type & Designation(as per ISS)	::		
5.	List of Standards applicable	::		
6.	Suitable for system with			
	(a) Service Voltage	::		
	(b) Neutral Earthing	::		
7.	Maximum Conductor temperature	::		
	(a) Continuous (in Deg. C)	::		
	(b) Short time (in Deg.C)	::		
8.	Conductor :			
	(a) Material to IS-8130(Class/Grade)	::		
	(b) Size (Sq.mm.)	::		
	(c) No./Nominal diameter of wires in each Conductor (no./mm.)	::		
	(d) Form of Conductor (Circular/shaped)	::		
9.	Shielding/screening on Conductor	::		
	(a) Material.	::		
	(b) Type.	::		
	(c) Whether thermosetting ?	::	(Yes/No.)	
10.	Insulation	::		
	(a) Material.	::		
	(b) Type	::		
	(c) Minimum Thickness (mm)		::	
	(d) Whether tripple co-extrusion With radiant curing process ?	::	(Yes/No)	
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 (mm.) ::

(d) Extruded/Wrapped. ::

(e) Approx. outside diameter over sheath (mm.) ::

13. Armouring ::
(a) Material. ::

(b) Size ::

(c) D.C. resistance at 20 deg.C (Ohm/Km.) ::

(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 for <u>standard condition, laid direct</u> ::
(a) In ground at temp. 30 deg.C ::
(b) In duct at temp. 30 deg.C ::
(c) In air at temp. 40 deg.C ::

19. Charging current at rated system voltage ::

20. <u>Short Circuit Current (Maxm.)</u> ::
(a) for 1 sec. ::
(b) for 0.5 sec. ::

21. <u>Electrical Parameters</u> ::
(a) Maxm. D.C. resistance/km of conductor at 20 deg.C ::
(b) AC resistance/kilometer of conductor at 90 deg.C(approx.) ::

(c) Reactance/kilometer(approx.) ::
(d) Capacitance/Kilometer(approx.) ::
(e) Di-electric losses at rated (Uo/U) system KV, 50 cycles/sec. in Watts/KV/Phase) ::
(f) i) tan-delta at 0.5 Uo ::
ii) tan-Delta at Uo ::
iii) tan-Delta at 1.5 Uo ::
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 ambient temperature in Air/Ground. ::
(a) at 30 deg. C ::

(b) at 35 deg. C ::

(c) at 45 deg. C ::

(d) at 50 deg. C ::

25. Type test results of the similar Cable to be furnished with Tender (as specified under Clause-10 of the Spec.) ::

(a) Tests on Conductor :
(i) Tensile test (for aluminium) ::
(ii) Wrapping test (for aluminium) ::
(iii) Resistance test ::

(b) Test for armouring wires/strips ::

(c) Test for thickness of insulation & steath :

(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 and elongation at break ::
(ii) Ageing in air oven ::
(iii) Shrinkage test ::
(iv) Hot deformation ::

(v) Loss of mass in air oven ::

(vi) Heat shock ::

(vii) Thermal stability ::

(e) Partial discharge test ::

(f) Banding 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) Heating Cycle test ::

(j) Impulse with stand test ::

(k) High Voltage test ::

(l) Flammability test ::

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 the protective measures against attack by white ante, vermins etc. to be XLPE's outer sheath during manufacture. ::

30. Type of curing of XLPE insulations ::

31. Cut ends of the Cable shall be sealed with …….. ::

32. Cable identification shall be made as per per class 8.10 (Yes/No) ::

33. Cable Drums shall be marked with the with the informations of Clauses 9.1 conspicuously (Yes/No) ::

Signature ……

Name……

Seal of the Farm……

Name of the Farm……