TECHNICAL SPECIFICATIONS

(Volume-III)

Cables, Supports, Accessories

उत्तराखण्ड पावर
कारपोरेशन लि०

Uttarakhand Power Corporation Ltd.

CONTENTS

LIST OF TABLES

1. Technical Specification for 11 kV XLPE, PVC sheathed, armored cable.

1.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of HT (33 kV & 11 kV) 1 or 3 core, dry/nitrogen gas cured, XLPE insulated, PVC sheathed, armored cable for effectively earthed system. This specification covers following sizes of cables.

1) HT – 3 core cable: 95, 120, 150, 185, 240, 300 ,400 sq mm

1.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 1-1: Tropical conditions for continuous operation

Sr. No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

1.3. Standards

The cables shall comply with latest revision of the following Indian / International Standards unless otherwise stipulated in the specification. All references to Standards shall be deemed to be complying with latest amendments, if any.

Table 1-2: Standards of compliance

Sr.No.	Standard	Title
1	IS: 7098 (Part 2)-2011	Specification for XLPE insulated cables for working voltages from 3.3 kV up to and including 33kV.
2	IS : 5831-1984	Specification for PVC insulation and sheath of electric cables.
3	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.
4	IS: 3975-1988	Specification for Mild Steel wires, formed wires and tapes for armoring of cables.

Sr.No.	Standard	Title
5	IS:10810-1984	Method of test for cables
6	IS:3961	Recommended current ratings for cables
7	IS:10418-1982	Drums for electric cables.
8	IS: 398 (Part-IV)- 1979	Aluminum Alloy Conductors
9	IEEE-383:1974	Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.
10	ASTM-D2843,1993	Standard test method for density of smoke from burning or decomposition of plastics.
11	ASTM-D2863, 1991	Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).
12	NEMA-WC5,1992	Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.
13	IEC:754	Test on gases evolved during combustion of electric cables -
	(Part-1):1994	Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.
14	IEC:332	Test on electric cables under fire conditions

1.4. Principal Parameters

33 kV and 11 kV XLPE, 1 & 3 - core, power cable shall be of high conductivity, stranded compacted, H.D. aluminum circular shaped conductor with XLPE (cross linked Poly Ethylene) dry/gas cured insulation provided with shielding of extruded semi- conducting materials over conductor and XLPE insulation. Each insulated core shall have copper tape screen, laid together and provided with common covering of PVC inner sheath (extruded). Overall galvanized steel strip armor and PVC outer sheath shall be provided.

Outer sheath shall be designed to afford high degree of mechanical protection and shall also be heat, oil, chemical and weather resistant, common acid, alkalis and sealing solution shall not have adverse effect on material of PVC sheath.

Cable shall be suitable for lying in covered trenches and / or buried under-ground in outdoor.

1.4.1. Cable Parameters

Table 1-3: Cable Parameters

S.No.	Item	Particulars (11 kV)	Particulars (33 kV)
(i)	Voltage grade - Uo / U (kV)	6.3 / 11	19/33
(ii)	Cores (Nos.)	1 & 3	1 & 3
(iii)	Nominal system voltage (kV)	11 – Earthed	33-Earthed
(iv)	Highest system voltage (kV)	12	36
(v)	System frequency (Hz)	50	50
(vi)	Variation in frequency (%)	3	3

S.No.	Item	Particulars (11 kV)	Particulars (33 kV)
(vii)	Lightning impulse withstand voltage (kVp)	75	170
(viii)	Power frequency withstand voltage (kV rms)	28	70
(ix)	Short Circuit Current	13.12, 18.35 for 3 secs	13.12, 26.24 for 3 secs
(x)	System earthing	Effectively earthed	Effectively earthed
(xi)	Continuous withstand temperature	90^0C	90^0C
(xii)	Short circuit withstand temperature	250^0C	250^0C
(xiii)	Oxygen Index	Min 29 (as per ASTMD 2863)	Min 29 (as per ASTMD 2863)
(xiv)	Acid Gas Generation	Max 20% (as per IEC 754-1)	Max 20% (as per IEC 754-1)
(xv)	Smoke Density Generation	60% (As per ASTMD 2843)	60% (As per ASTMD 2843)
(xvi)	Flammability Test	As per Swedish Chimney test (as per SEN 4241475)	As per Swedish Chimney test (as per SEN 4241475)

1.5. General Technical Requirements

1.5.1. Conductor

The stranded conductor shall be high conductivity, high density aluminum to form compacted circular shaped conductor wire complying with IS: 8130/1984. Maximum resistance of conductor at 20 ^{0}C shall be as follows.

Table 1-4: Conductor wise maximum resistance

Nominal cross sectional area (mm)	Max. resistance at 20 ^{0}C (ohm/km)
70	0.320
120	0.253
150	0.206
185	0.164
240	0.125
300	0.100
400	0.0778

1.5.2. Conductor Shield

The conductor having nonmagnetic semi-conducting screen shall ensure perfectly smooth profile & avoid concentration of stress. The conductor screen shall be extruded in the same operation as the insulation. The semi-conducting polymer shall be cross linked.

1.5.3. Insulation

The XLPE insulation shall be suitable for 11 kV, 33 kV system voltages and should be manufactured with dry / nitrogen gas curing process. The vendor shall submit description of dry /gas curing process, with the clear inclusion of equipment's / parameters involved. The manufacturing process shall ensure that the insulation shall be free of voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality generally conforming to IS: 7098 (Part – 2) –1985.

Nominal thickness of insulation shall be as follows:

Table 1-5: Nominal thickness of XLPE insulation

Nominal area of conductor (sq mm)	Nominal thickness of insulation (mm)	
95, 120, 150, 185, 240, 300 ,400	6.3/11 kV	19/33 kV
	3.6	8.8

1.5.4. Insulation Shield

To confine electrical field to the insulation, insulation screening consisting of two parts, namely metallic (non-magnetic) and non-metallic (semi conducting) shall be provided. The non-metallic semi- conducting shield shall be put over the insulation of each core. The insulation shield shall be extruded in the same operation as the conductor shield and insulation by triple extrusion process. The insulation shield shall be bonded and strippable on adequate heat treatment. Metallic shield shall be provided over non – metallic portion as per provision of IS: 7098 (Part – II) 1985 and amendment thereof.

1.5.5. Filler and Inner-Sheath

The inner- sheath shall be suitable to withstand the operating conditions and the desired temperature rating of the cable. It shall be of adequate thickness, consistent quality and free from all defects. The PVC sheath shall be extruded type. The binding tape used over the lead up cores shall not be construed as part of the inner sheath. The inner sheath shall conform to the provisions of IS: 7098 (Part –II) 1985 or latest amendment thereof. The inner sheath shall be so applied that it fit closely on the laid-up cores and it shall be possible to remove it without damaging the insulation. Thickness of inner sheath shall be as follows.

Table 1-6: Thickness of inner sheath

Calculated diameter over laid up cores Refer to IS:10462 (Part-1) (mm)		Thickness of inner sheath minimum (mm)
Over	**Up to and including**	
-	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	-	0.7

The material of fillers and inner-sheath shall be compatible with the temperature ratings of the cable and shall have no adverse effect on any other component of the cable. Central PVC filler shall also, be provided with other peripheral PVC fillers to have proper circular section.

1.5.6. Armor

- Armoring of low carbon galvanized steel wire/strip shall be provided. The dimensions of wire/steel strips shall be as per IS: 3975 – 1979.
- Steel wire armor has high short circuit current handling capacity and has higher mechanical strength. Therefore, steel wire armor shall be used for cables to be used in substation yard. Steel strip armor shall be used applications other than substation yard.
- Armouring shall have minimum 90% coverage.
- Breaking load of the joints shall be minimum 95% of the normal armour.

1.5.7. Outer-Sheath

Extruded type ST-2 PVC outer-sheath, conforming to IS: 5831-(1984) (latest edition) over armoring with suitable additives (to prevent attack by termites), shall be provided. Extruded PVC outer sheath of types ST – 2 as per IS: 5831/ 1984 and its latest amendment shall be applied over armoring with suitable additives to prevent attack by rodent and termites and its thickness shall be in accordance with Clause 17.32 of IS: 7098 (Part –II) 1985 and latest amendment thereof.

Outer sheath shall be of black color with cable size and voltage grade etc. embossed on it. Sequential marking shall be to every 1-meter distance. Word "FRLS" (Flame Retardant Low Smoke) shall also be embossed on it at every 5meter distance.

Outer sheath shall have the following properties:

i. Oxygen Index: in 29(as per ASTMD 2863)
ii. Acid Gas Generation: max 20% (as per IEC 754-1)
iii. Smoke density rating: 60%(Max) (as per ASTMD 2843)
iv. Flammability test: As per Swedish chimney test F3 as per SS 4241475 as per IEC part-3 (Category B).
v. Minimum bending radius shall be 15XOD.

1.5.8. Construction

- The cable shall have suitable PVC fillers laid up with insulation cores to have subsequently circular cross-section before the inner sheath is applied. The fillers shall be suitable for operating temperature of the cable.
- All materials used in manufacturing of cable shall be new, unused and of finest quality. All materials should comply with the requirements / Tests as per applicable IS / IEC specification and any other statutory provision of rules & regulations.
- The PVC material used in the manufacture of cable shall be of reputed manufacturer. No recycling of PVC is permitted. The purchaser reserves the right to ask for documentary evidence of the purchase of various materials, (to be used for the manufacture of cable) to ensure quality control. Quality Assurance plans shall be submitted.

1.5.9. Core Identification

The core shall be identified by different colouring of XLPE insulation as follows:

a. Core: coloured strip applied on core
b. Cores: red, yellow and blue coloured strip applied on core

1.5.10. Sequential marking of length on cable

Non-erasable sequential marking of length shall be provided by embossing on outer sheath of the cable for each meter length. Word "FRLS" (Flame retardant, Low Smoke) shall also be embossed on it at every 5 (Five) meter distance.

1.5.11. Laying Up Of Cores

The cores shall be laid up together with the suitable right hand lay. Where necessary the interstices shall be filled with non-hygroscopic material.

1.5.12. Current Rating

The indicative value of continuous current carrying capacities at maximum conductor temperature of 90 °C (for design purpose by field) of the various sizes of the cables is given below:

Table 1-7: Current carrying capacities for different size of cables

Cable size		3x70 Sq.mm	3x120 Sq.mm	3x185 Sq.mm	3x240 Sq.mm	3x300 Sq.mm	3x400 Sq.mm
(i) Cable in air	Amps	190	260	335	395	450	520
(ii) Cable in ground	Amps	160	220	275	315	355	400

Short circuit ratings of various sizes of cable calculated for duration of one second at maximum temperature of 250 °C, are given below:

Table 1-8: Short circuit ratings of various sizes of cable

S.No.	Size of cable (sq.mm)	Conductor short circuit rating in kA (rms)
1	70	8.93
2	120	11.28
3	150	14.10
4	185	17.39
5	240	22.56
6	300	28.20
7	400	37.60

The current rating shall be based on maximum conductor temperature of 900 with ambient site condition specified for continuous operation at the rated current.

Cable shall be suitable for operation under frequency variation under ±3% and voltage variation of +10% to -15% and combined frequency-Voltage variation of 10% (Absolute sum)

Cable shall have heat and moisture resistance properties. This shall be of type and design with proven record on distribution network service.

1.5.13. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of opening the tender should be submitted with the offer failing which, the offer shall be rejected.

BIS license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

1.5.14. Type Test Reports

Type Test Reports (less than five years old as on date of opening of tender) of Tests carried out at NABL accredited laboratory as per relevant IS/IEC shall be furnished by the bidder along with offer otherwise offer shall be rejected.

1.6. Tests

1.6.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:
   - Tensile test
   - Wrapping test
   - Resistance test

b) Tests for armoring strips

c) Tests for thickness of insulation and sheath

d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption

e) Test on extruded semi conducting screens
   - Test for stripability of semiconducting strippable insulation screen
   - Volume resistivity

f) Physical Tests on outer sheath:
   - Tensile strength and elongation at break
   - Ageing in air oven
   - Shrinkage test
   - Hot deformation
   - Loss of mass in air oven
   - Heat shock
   - Thermal stability
   - Carbon black content of polythene sheath
   - Bleeding and blooming test

g) Thermal ageing

h) Partial discharge test

i) Bending test

j) Dielectric power factor test

- as a function of voltage
- as a function of temperature

k) Insulation resistance test (volume resistivity)
l) Heating cycle test
m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

1.6.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
j) Test for cross linking for extruded semi conducting screen
q) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

1.6.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

1.6.4. Routine Tests

The vendor shall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

1.6.5. Optional Tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests

1.6.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

1.7. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

1.7.1. Verification of Length

a) Minimum 1 drum of every size of cables offered for inspection in each lot shall be checked for workmanship and length verification at vendors works.
b) If the cable is found short in length, the difference in average length thus obtained from the length declared by vendor shall be applied to all the drums.

1.8. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

1.9. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

1.10. Engineering Data and Manual

Following documents and information shall be furnished along with the offer**.**

- Sectional view, showing the general constructional feature with conductor / conductor screen / insulation / armoring / inner and outer sheath etc.
- Drawing of cable drums with details of material dimension and paint etc shall be submitted
- Leaflet giving construction details, dimensions and characteristics of cables.
- Current rating, de-rating factor due to grouping, ambient temperature and type of installation etc
- Write up with drawings for splitting, jointing and termination of cables.

1.10.1. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian standard.

1.11. Packing and Forwarding

1.11.1. Packing

- The cable shall be supplied on non-returnable wooden or steel drums of heavy construction and drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.
- The drums shall be suitable for wheel mounting and letting of the cable under a minimum controlled tension of the order of 5KN. The drums shall be provided with necessary clamping arrangements so as to be suitable for tension stringing of power cables.
- The bidders should submit their drawings of the cables drums along with the bid. After placement of letter of intent the supplier should submit four copies of fully dimensioned drawing of the purchaser's approval the drum design should be in accordance to IS: 10418-1982 or subsequent amendments, being suitable for transport by goods road.
- A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.
- A clear space of at least 40mm shall be left between the cables and the logging.
- All ferrous parts shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.
- Both cables ends shall be sealed with PVC / Rubber caps so as to eliminate ingress of water during transportation and erection.

Each drum shall have the following information marked on it with indelible ink along with other important information including technical data: -

(a) Uttarakhand Power Corporation Ltd. Specn No.
(b) Consignee & Destination Station.
(c) Trade name or trade mark , if any
(d) Name of the manufacturer.
(e) Nominal sectional area of the conductor of the cable.
(f) Drum No.
(g) No. of cores.
(h) Type of cable & voltage for which it is suitable
(i) Gross weight of the drum (Approx.)
(j) Length of cable in the drum with individual lengths if more than one.
(k) Net weight of the cable.
(l) ISI certification mark, if available
(m) Month & year of manufacture.

1.11.2. Marking

Following particulars shall be properly legible embossed on the outer sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

(i) Name of manufacturer or trade mark
(ii) Year of manufacture
(iii) Voltage grade
(iv) Size
(v) Successive length
(vi) ISI mark
(vii) Name of purchaser "UPCL"

The following information may be stenciled on the drum in indelible ink:

(i) Reference of IS / IEC standard.
(ii) Manufacturer's name or trademark
(iii) Type of cable and voltage grade
(iv) ISI mark
(v) No. of cores
(vi) Nominal cross-sectional area of conductor
(vii) Cable code
(viii) Length of cable on the drum
(ix) Direction of rotation of drum (by means of an arrow)
(x) Position of outer end of cable
(xi) Gross weight
(xii) Year of manufacture
(xiii) Reference of A/T No. & date
(xiv) Property of UPCL
(xv) Name of consignee and the destination

Over and above, name plate of Aluminium of suitable size and thickness, containing all the above information, shall be fixed on the drum in addition to the painting.

1.12. Schedules

1.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for item 11 kV and 33 kV XLPE Cable (To be confirmed by the vendor)]

Table 1-9: Guaranteed Technical Particulars for 11kV and 33kV XLPE cable (Part 1)

Sl. No.	Particulars	Unit	11kV XLPE Cable					
	Name of Manufacturer							
	Cable Sizes		3x70 Sq.mm	3x120 Sq.mm	3x185 Sq.mm	3x240 Sq.mm	3x300 Sq.mm	3x400 Sq.mm
1.	Rated voltage	kV	11					
2.	Highest system voltage	kV	12					
3.	System		11kV effectively earthed					
4.	Type of insulation		Extruded XLPE insulation					
5.	No of cores	No.	3Core					
6.	Details of Conductor							
	(i) Material of conductor		Aluminium					
	(ii)Flexibility Class As per IS:8130:85		Class-2					
	(iii) Form of conductor		Stranded compacted circular					
	(iv) No. of wire per core (Min.)		12	15	30	30	30	53
	(v) Guaranteed wt. of aluminium (Min.)	Kg/Km	568	973	1499	1944	2430	3128
7.	Continuous current rating							
	(i) Cable in air	Amps	190	260	335	395	450	520
	(ii) Cable in ground	Amps	160	220	275	315	355	400
8.	Short ckt. Current for 1 sec. duration	KA	6.58	11.30	17.40	22.60	28.20	37.60
9.	D.C. resistance at 20ºc (max.)	Ohm /Km	0.443	0.253	0.164	0.125	0.100	0.077
10.	A.C. resistance at operating temp of 90ºc (max.)	Ohm /Km	0.568	0.325	0.211	0.162	0.130	0.102
11.	CONDUCTOR SCREEN							
	(i) Material		Non metallic Semi-conducting compound					
	(ii) Thickness	mm	0.3 (min.)					
12.	INSULATION							
	(i) Material		XLPE as per IS:7098 Part-2					
	(ii) Minimum Thickness	mm	3.6					

1.12.2. Schedule – III [Information Regarding BIS license]

Table 1-10: Format for information regarding BIS license

Sr. No.	Particulars	Value/ Date
1	Manufacturer's name and address	
2	Manufacturer's trade mark, if any	
3	ISI license number for IS: 7098 (Part 2) 2011	

Sr. No.	Particulars	Value/ Date
4	ISI license for IS: 7098 (Part 2)2011 is valid up to	

1.12.3. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 1-11: Format for information regarding manufacturing and testing facilities

Sr. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed (specifying order date and quantity)	
A	With UPCL	
B	With other agencies, other than 6.a	

2. Technical Specification for 33 kV XLPE, of size 3X400 sq. mm. XLPE cable with nitrogen gas curing CCV line method.

2.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of HT 11 kV 3 core, nitrogen gas cured, XLPE insulated, PVC sheathed, armored cable for effectively earthed system. This specification covers following sizes of cables.

HT – 3 core cable: ***400 sq. mm***

2.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 2-1: Tropical conditions for continuous operation

Sr. No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

2.3. Standards

The cables shall comply with latest revision of the following Indian / International Standards unless otherwise stipulated in the specification. All references to Standards shall be deemed to be complying with latest amendments, if any.

Table 2-2: Standards of compliance

Sr.No.	Standard	Title
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13	IEC:754	Test on gases evolved during combustion of electric cables -
	(Part-1):1994	Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.
14	IEC:332	Test on electric cables under fire conditions

2.4. Principal Parameters

All cables shall be suitable to meet the low / high ambient temp. high humid tropical/ seasonal snow-covered climatic conditions of Uttarakhand. Cables shall be designed to withstand the mechanical electrical and thermal stresses under the unforeseen steady state and transient conditions and shall be suitable for proposed method of installation.

2.5. General Technical Requirements

2.5.1. Conductor

The stranded conductor shall be high conductivity, high density aluminum to form compacted circular shaped conductor wire complying with IS: 8130/1984. Maximum resistance of conductor at 20 ^{0}C shall be as follows.

2.5.2. Conductor Shield

The conductor shall have a non-magnetic semi – conducting screen, which will ensure perfectly smooth profile to avoid stress concentration. The conductor screen shall be an extruded layer of black, semi-conducting compound. The allowable operating temperatures of the conductor shield shall be equal to or greater than those of the insulation. The conductor screen shall be extruded in the same operation as the insulation. The semi-conducting screens should be effectively cross linked to achieve 90ºC cable

rating. The interface between the extruded conductor screen and insulation shall be free of any voids. The volume resistivity of the screen material shall not exceed 1000 Ωm at 90^0 C

2.5.3. Insulation

The XLPE insulation shall be suitable for specified 33 kV system voltages. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method shall give very smooth interface between semi – conducting screen and insulation. The insulation of the cables shall be of high standard quality and conform to IS: 7098 (Part-II) 1985 or latest amendment thereof. The insulation shall be so applied that it fit closely on the conductor or conductor screening and it shall be possible to remove it without damaging the conductor. The insulating material shall be Cross Linked Polyethylene (XLPE) cured by dry curing process i.e nitrogen gas curing CCV line method and applied by extrusion process as per IS-7098 and its latest amendments. The insulating material shall have excellent electrical properties with regard to resistivity, dielectric constant and loss factor and shall have high tensile strength and resistance to abrasion. This shall not deteriorate at elevated temperatures or when immersed in water. The insulation shall be preferably fire resistant and resistant to chemicals like acids, alkalis, oils and ozone. The insulation properties shall be stable under thermal conditions arising out of continuous operation at conductor temperature of 90ºC rising momentarily to 250ºC under short circuit conditions. It shall be free from any foreign material or porosity visible to the unaided eye. The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damaging the conductor. XLPE insulation shall be of very high degree of purity. The insulation compound shall be clean with low levels of contamination. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions. The average thickness of insulation shall not be less than the nominal value as specified in IS: 7098 (Part II) with latest amendments. No tolerance on the negative side shall be acceptable.

2.5.4. Insulation Shield

To confine electrical field to the insulation, insulation screening consisting of two parts, namely metallic (non-magnetic) and non-metallic (semi conducting) shall be provided. The non-metallic semi- conducting shield shall be put over the insulation of each core. The insulation shield shall be extruded in the same operation as the conductor shield and insulation by dry curing process i.e nitrogen gas curing CCV line method . The insulation shield shall be bonded and strippable on adequate heat treatment. Metallic shield shall be provided over non – metallic portion as per provision of IS: 7098 (Part – II) 1985 and amendment thereof.

2.5.5. Filler and Inner-Sheath

The inner- sheath shall be suitable to withstand the operating conditions and the desired temperature rating of the cable. It shall be of adequate thickness, consistent quality and free from all defects. The PVC sheath shall be extruded type. The binding tape used over the lead up cores shall not be construed as part of the inner sheath. The inner sheath shall conform to the provisions of IS: 7098 (Part –II) 1985 or latest amendment thereof. The inner sheath shall be so applied that it fit closely on the laid-up cores and it shall be possible to remove it without damaging the insulation.

The material of fillers and inner-sheath shall be compatible with the temperature ratings of the cable and shall have no adverse effect on any other component of the cable. Central PVC filler shall also, be provided with other peripheral PVC fillers to have proper circular section.

2.5.6. Armor

- Armoring of low carbon galvanized steel wire/strip shall be provided. The dimensions of wire/steel strips shall be as per IS: 3975 – 1979.
- Steel wire armor has high short circuit current handling capacity and has higher mechanical strength. Therefore, steel wire armor shall be used for cables to be used in substation yard. Steel strip armor shall be used applications other than substation yard.
- Armouring shall have minimum 90% coverage.
- Breaking load of the joints shall be minimum 95% of the normal armour.

2.5.7. Outer-Sheath

Extruded type ST-2 PVC outer-sheath, conforming to IS: 5831-(1984) (latest edition) over armoring with suitable additives (to prevent attack by termites), shall be provided. Extruded PVC outer sheath of types ST – 2 as per IS: 5831/ 1984 and its latest amendment shall be applied over armoring with suitable additives to prevent attack by rodent and termites and its thickness shall be in accordance with Clause 17.32 of IS: 7098 (Part –II) 1985 and latest amendment thereof.

Outer sheath shall be of black color with cable size and voltage grade etc embossed on it. Sequential marking shall be to every 1 meter distance. Word "FRLS" (Flame Retardant Low Smoke) shall also be embossed on it at every 5meter distance.

Outer sheath shall have the following properties:

a) Oxygen Index: in 29(as per ASTMD 2863)

b) Acid Gas Generation: max 20% (as per IEC 754-1)

c) Smoke density rating: 60 %(Max) (as per ASTMD 2843)

d) Flammability test: As per Swedish chimney test F3 as per SS 4241475 as per IEC part-3 (Category B).

e) Minimum bending radius shall be 15XOD.

2.5.8. Construction

- The cable shall have suitable PVC fillers laid up with insulation cores to have subsequently circular cross-section before the inner sheath is applied. The fillers shall be suitable for operating temperature of the cable.
- All materials used in manufacturing of cable shall be new, unused and of finest quality. All materials should comply with the requirements / Tests as per applicable IS / IEC specification and any other statutory provision of rules & regulations.
- The PVC material used in the manufacture of cable shall be of reputed manufacturer. No recycling of PVC is permitted. The purchaser reserves the right to ask for documentary evidence of the purchase of various materials, (to be used for the manufacture of cable) to ensure quality control. Quality Assurance plans shall be submitted.
- Discharge Free Construction: Inner conductor shielding, XLPE insulation and outer core shielding shall be extruded in one operation by special process (viz. Triple Extrusion Process i.e nitrogen gas curing CCV line method) to ensure that the insulation is free from contamination and voids and perfect bonding of inner and outer shielding with insulation is achieved. The firm shall submit an undertaking with effect that they are manufacturing the cable with by special process viz. Triple Extrusion Process i.e nitrogen gas curing CCV line method, otherwise their offer shall be rejected

2.5.9. Core Identification

The core shall be identified by different coloring of XLPE insulation as follows;

3 Cores: Red, Yellow And Blue Colored Strip Applied on Core

Sequential marking of length on cable

Non-erasable sequential marking of length shall be provided by embossing on outer sheath of the cable for each meter length. Word "FRLS" (Flame retardant, Low Smoke) shall also be embossed on it at every 5 (Five) meter distance.

2.5.10. Laying Up of Cores

The cores shall be laid up together with the suitable right hand lay. Where necessary the interstices shall be filled with non-hygroscopic material.

2.5.11. Current Rating

The indicative value of continuous current carrying capacities at maximum conductor temperature of 90^0 C (for design purpose by field) of the various sizes of the cables is given below:

Table 2-3: Current carrying capacities for different size of cables

Cable size		3x400 Sq.mm
(i) Cable in air	Amps	530
(ii) Cable in ground	Amps	395

Short circuit ratings of various sizes of cable calculated for duration of one second at maximum temperature of 250^0 C, are given below:

Table 2-4: Short circuit ratings of various sizes of cable

S.No.	Size of cable (sq.mm)	Conductor short circuit rating in kA (rms)
1	400	37.60

The current rating shall be based on maximum conductor temperature of 900 with ambient site condition specified for continuous operation at the rated current.

Cable shall be suitable for operation under frequency variation under ±3% and voltage variation of +10% to -15% and combined frequency-Voltage variation of 10% (Absolute sum)

Cable shall have heat and moisture resistance properties. This shall be of type and design with proven record on distribution network service.

2.5.12. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

BIS license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

2.5.13. Type Test Reports

Type Test Reports (less than five years old as on due date of tender) of Tests carried out at NABL accredited laboratory and approved international labs shall be furnished by the bidder along with offer otherwise offer shall be rejected.

2.6. Tests

2.6.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:
   - Tensile test
   - Wrapping test
   - Resistance test

b) Tests for armoring strips

c) Tests for thickness of insulation and sheath

d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption

e) Test on extruded semi conducting screens
   - Test for stripability of semiconducting strippable insulation screen
   - Volume resistivity

f) Physical Tests on outer sheath:
   - Tensile strength and elongation at break
   - Ageing in air oven
   - Shrinkage test
   - Hot deformation
   - Loss of mass in air oven
   - Heat shock
   - Thermal stability
   - Carbon black content of polythene sheath
   - Bleeding and blooming test

g) Thermal ageing

h) Partial discharge test

i) Bending test

j) Dielectric power factor test
   - as a function of voltage
   - as a function of temperature

k) Insulation resistance test (volume resistivity)

l) Heating cycle test

m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

2.6.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
j) Test for cross linking for extruded semi conducting screen
q) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

2.6.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

2.6.4. Routine Tests

The vendor shall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

2.6.5. Optional Tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests.

2.6.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

2.7. Pre-Delivery Inspection at Manufacturer's Works

1. All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
2. The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
3. Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
4. Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
5. In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
6. The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
7. The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

2.7.1. Verification of Length

a) Minimum 1 drum of every size of cables offered for inspection in each lot shall be checked for workmanship and length verification at vendors works.
b) If the cable is found short in length, the difference in average length thus obtained from the length declared by vendor shall be applied to all the drums.

2.8. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

2.9. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

2.10. Engineering Data and Manual

Following documents and information shall be furnished along with the offer**.**

- Sectional view, showing the general constructional feature with conductor / conductor screen / insulation / armoring / inner and outer sheath etc.
- Drawing of cable drums with details of material dimension and paint etc shall be submitted
- Leaflet giving construction details, dimensions and characteristics of cables.
- Current rating, de-rating factor due to grouping, ambient temperature and type of installation etc
- Write up with drawings for splitting, jointing and termination of cables.

2.10.1. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian standard.

2.11. Packing and Forwarding

2.11.1. Packing

i. The cable shall be supplied on non-returnable wooden or steel drums of heavy construction and drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.

ii. The drums shall be suitable for wheel mounting and letting of the cable under a minimum controlled tension of the order of 5KN. The drums shall be provided with necessary clamping arrangements so as to be suitable for tension stringing of power cables.

iii. The bidders should submit their drawings of the cables drums along with the bid. After placement of letter of intent the supplier should submit four copies of fully dimensioned drawing of the purchaser's approval the drum design should be in accordance to IS: 10418-1982 or subsequent amendments, being suitable for transport by goods road.

iv. A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

v. A clear space of at least 40mm shall be left between the cables and the logging.

vi. All ferrous parts shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

vii. Both cables ends shall be sealed with PVC / Rubber caps so as to eliminate ingress of water during transportation and erection.

Each drum shall have the following information marked on it with indelible ink along with other important information including technical data:-

(a) Uttarakhand Power Corporation Ltd. Specn No.
(b) Consignee & Destination Station.
(c) Trade name or trade mark , if any
(d) Name of the manufacturer.

(e) Nominal sectional area of the conductor of the cable.
(f) Drum No.
(g) No. of cores.
(h) Type of cable & voltage for which it is suitable
(i) Gross weight of the drum (Approx.)
(j) Length of cable in the drum with individual lengths if more than one.
(k) Net weight of the cable.
(l) ISI certification mark, if available
(m) Month & year of manufacture.

2.11.2. Marking

Following particulars shall be properly legible embossed on the outer sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

(viii) Name of manufacturer or trade mark
(ix) Year of manufacture
(x) Voltage grade
(xi) Size
(xii) Successive length
(xiii) ISI mark
(xiv) Name of purchaser "UPCL"

The following information may be stenciled on the drum in indelible ink:

(xvi) Reference of IS / IEC standard.
(xvii) Manufacturer's name or trademark
(xviii) Type of cable and voltage grade
(xix) ISI mark
(xx) No. of cores
(xxi) Nominal cross-sectional area of conductor
(xxii) Cable code
(xxiii) Length of cable on the drum
(xxiv) Direction of rotation of drum (by means of an arrow)
(xxv) Position of outer end of cable
(xxvi) Gross weight
(xxvii) Year of manufacture
(xxviii) Reference of A/T No. & date
(xxix) Property of UPCL
(xxx) Name of consignee and the destination

Over and above, name plate of Aluminum of suitable size and thickness, containing all the above information, shall be fixed on the drum in addition to the painting.

2.12. Schedules

2.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for item 11 kV and 33 kV XLPE Cable (To be confirmed by the vendor)]

Table 2-5: Guaranteed Technical Particulars for 11kV and 33kV XLPE cable (Part 1)

Sl. No	Particulars	Unit	33KV XLPE Cable
	Name of Manufacturer		
	Cable Sizes		3x400 Sq.mm
1.	Rated voltage	KV	33
2.	Highest system voltage	KV	36
3.	System		33KV effectively earthed
4.	Type of insulation		Extruded XLPE insulation by dry curing process i.e nitrogen gas curing CCV line method
5.	No of cores	No.	3Core
6.	Details of Conductor		
	(i) Material of conductor		Aluminium
	(ii)Flexibility Class As per IS:8130:85		Class-2
	(iii) Form of conductor		Stranded compacted circular
	(iv) No. of wire per core (Min.)		53
	(v) Guaranteed wt. of aluminium (Min)	Kg/Km	3240
7.	Continuous current rating		
	(i) Cable in air	Amps	530
	(ii) Cable in ground	Amps	395
8.	Short ckt. Current for 1 sec. duration	KA	37.60
9.	D.C. resistance at 20°c (max.)	Ohm/Km	0.0778
10.	A.C. resistance at operating temp of 90°c (max.)	Ohm/Km	0.1016
11.	CONDUCTOR SCREEN		
	(iii) Material		Non metallic Semi-conducting compound
	(iv) Minimum Thickness	mm	0.3
12.	INSULATION		
	(iii) Material		XLPE as per IS:7098 Part-2
	(iv) Nominal Thickness	mm	8.8

2.12.2. Schedule – III [Information Regarding BIS license]

Table 2-6: Format for information regarding BIS license

Sr. No.	Particulars	Value/ Date
1	Manufacturer's name and address	
2	Manufacturer's trade mark, if any	
3	ISI license number for IS: 7098 (Part 2) 2011	
4	ISI license for IS: 7098 (Part 2)2011 is valid up to	

2.12.3. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 2-7: Format for information regarding manufacturing and testing facilities

Sr. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed (specifying order date and quantity)	
A	With UPCL	
B	With other agencies, other than 6.a	

3. Technical Specification for 11 kV Aerial Bunch Cable

3.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of ISI marked 11 kV Aerial Bunched Cable having XLPE insulated cable (three power core) for the following standard sizes:

1. ***3c x 185 + 1c x 210 sq. mm***
2. ***3c x 150 + 1c x 150 sq. mm***
3. ***3c x 120 + 1c x 120 sq. mm***
4. ***3c x 50 + 1c x 70 sq. mm***
5. ***3c x 70 + 1c x 70 sq. mm***
6. ***3c x 95 + 1c x 70 sq. mm***
7. ***3c x 95 + 1c x 80 sq. mm***

with stranded compact circular Aluminum conductors twisted over an insulated Aluminum alloy messenger wire for use as overhead distribution feeder for use on 3-Phase AC system.

3.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 3-1: Tropical conditions for continuous operation

Sr. No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

3.3. Standards

The cables shall comply with latest revision of the following Indian and International Standards unless otherwise stipulated in the specification.

All references to Indian and International Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 3-2: Standards of compliance

S.No.	Standard	Title
1	IS-7098 PART -2, 1985	Specification for cross linked polyethelene insulated PVC sheathed cables
2	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords
3	IS: 398 (PART-4)	Specification for Aluminium Alloy conductors
4	IEC-60502	Specification for polyethelene outer sheath
5	IS:10418-1982	Specification for drums for electric cables
6	IS: 10810/1984	Methods of test of cable

3.4. General Technical Requirements

Material used for construction of cables shall be of best quality complying with the requirements of relevant Standards. Cable shall be suitable for outdoor installation free in air and shall be capable of withstanding the normal stress associated with transportation erection, reeling and un-reeling operations without getting deformed.

3.4.1. Conductor

The Aluminum conductors for phase/street lightning conductor shall be H2 or H4 grade Aluminum complying with the requirements of IS-8130-1984 with up to date amendments.

For messenger wire stranded All Aluminum conductor shall be of heat-treated Aluminum Magnesium-Silicon Alloy Wires containing approximate 0.5% magnesium and 0.5% silicon conforming to IS-398 (Part-IV)/1984 with up to date amendments. The stranded conductor shall be clean & reasonably uniform in size and shape and its surface shall be free from sharp edges.

There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wires before finally drawing.

Standard size and technical characteristics of phase conductors shall be as shown in the following table.

Table 3-3: Standard size and technical characteristics of phase conductors

Nominal Sectional Area (sq.mm)	Nominal dia. Of conductor / No. of wires in conductor (mm)	Max. DC Resistance at 20 Deg. (0hm/km)	Max. SC current for 1 sec, kA	Max. continuous load (Amp)
(1)	(2)	(4)	(5)	(6)
35	6.8/6	0.868	3.4	120
50	7.6/6	0.641	4.72	150
70	10/12	0.443	6.7	180

Nominal Sectional Area (sq.mm)	Nominal dia. Of conductor / No. of wires in conductor (mm)	Max. DC Resistance at 20 Deg. (0hm/km)	Max. SC current for 1 sec, kA	Max. continuous load (Amp)
95	11.5/15	0.320	8.96	230
120	12.7/15	0.253	11.32	265
150	14.1/15	0.206	14.16	300
185	-/30	0.164	17.46	345

3.4.2. Conductor Screen

The conductor screen shall be of extruded semi-conducting cross-linked polyethylene compound of thickness not less than 0.5 mm.

3.4.3. Insulation

The Conductor shall be provided with cross linked polyethylene applied by extrusion, dry gas cured of nominal thickness 3.6 mm conforming to the standard Specification as per IS 7098 –Part-2. Upper surface of Cable insulation should be Ultra Violet Ray resistant. Colour of insulation shall be black.

3.4.4. Insulation Screen:

The insulation screen shall comprise of extruded semi conducting compound and/or semiconducting tape. Thickness of screen shall not be less than 0.6 mm.

3.4.5. Metallic Screen

The metallic screen shall consist of Copper tape of thickness not less than 0.045mm.

3.4.6. Outer Sheath

The outer sheath shall be black polyethylene. The nominal thickness of sheath shall be 2 mm and it shall conform to the technical requirements of ST-7 of IEC-60502 (Part-II) 2005

3.4.7. Messenger Wire

The insulated messenger wire shall be of 125mm2 / 148mm2 / 173 mm2 (actual area) aluminum alloy, generally conforming to IS:398 (Part-IV) - 1994, shall be suitably compacted to have smooth round surface to avoid damage to the outer insulating sheath of single-core phase cables twisted around the messenger.

There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wires before finally drawing.

Table 3-4: Messenger wire technical characteristics

S. No.	Item	Nominal specifications of Messenger				
i)	Nominal sectional area (mm2)	70	80	125	150	173
ii)	Stranding and wire dia. (No.)/(mm)	19/3.57	19/3.57	19/2.89	19/3.15	19/3.40

S. No.	Item	Nominal specifications of Messenger				
iii)	Approx. over all dia. (mm)	10.5	11.4	14.45	15.75	17.00
iv)	Approx. mass (kg/km)	184	218.6	342.51	406.91	474.02
v)	DC resistance at 20° C Ohm/km	0.48	0.48	0.273	0.229	0.197
vi)	Breaking load (kN)	20	23.41	36.64	43.50	50.54

3.4.8. Laying up of Cores

Three power cores having ridges (one, two and three) should be twisted over insulated messenger wire with right hand direction of lay.

3.4.9. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

3.4.10. Type Test Reports

Type Test Reports (less than five years old as on date of opening of tender) of Tests carried out at NABL accredited laboratory, as per relevant IS/IEC shall be furnished by the bidder along with offer otherwise offer shall be rejected.

Also Test Reports from reputed internationally approved foreign labs will be accepted provided the bidder informs in advance to UPCL.

3.5. Tests

3.5.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:
   - Tensile test
   - Wrapping test
   - Resistance test

b) Tests for armoring strips

c) Tests for thickness of insulation and sheath

d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption

e) Test on extruded semi conducting screens
   - Test for stripability of semiconducting strippable insulation screen
   - Volume resistivity

f) Physical Tests on outer sheath:
   - Tensile strength and elongation at break
   - Ageing in air oven
   - Shrinkage test
   - Hot deformation
   - Loss of mass in air oven
   - Heat shock
   - Thermal stability
   - Carbon black content of polythene sheath
   - Bleeding and blooming test

g) Thermal ageing
h) Partial discharge test
i) Bending test
j) Dielectric power factor test
   - as a function of voltage
   - as a function of temperature

k) Insulation resistance test (volume resistivity)
l) Heating cycle test
m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

3.5.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
j) Test for cross linking for extruded semi conducting screen
q) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

3.5.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

3.5.4. Routine Tests

The vendor hall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

3.5.5. Optional Tests

Cold impact tests for outer sheath (IS: 5831-1984) shall constitute the optional tests

3.5.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

3.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any

pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

3.6.1. Verification of Length & Mass

a) Minimum 2 drums of every size of cables offered for inspection in each lot shall be checked for workmanship, length and weight verification at vendors works.
b) If the cable is found short in length, the difference in average length thus obtained from the length declared by vendor shall be applied to all the drums.

3.7. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

3.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

3.9. Engineering Data and Manual

Following information shall be furnished along with the offer.

- Leaflet giving construction details, dimensions and characteristics of cables.
- Method of installation etc
- Write up with drawings for jointing and termination of cables.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

3.10. Packing and Marking

The standard length of cable per drum will be 500 metre with tolerance of +/- 5%.

The Cable shall be supplied on suitable sized wooden non-returnable drum of robust construction for each length of Cables as per I.S. 10418. A layer of water proof paper shall be applied to the surface of the drums and over the outer cable layer. A clear space at least 40 mm. shall be left between the Cable and Logging.

Wood preservative shall be applied to the entire drum. Packing shall be sturdy to protect the cable from any injury during transportation handling and storage. Each cable drum shall have following information stencilled in indelible ink on it.

a) Manufacturer's name
b) Brand name / Trade Mark
c) Year and month of manufacture
d) Type designation of the cable
e) Voltage grade
f) Length of the Cable
g) ISI Certification Mark
h) Direction of rotation of drum (by means of an arrow)
i) Gross weight in kg
j) UPCL

3.11. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian Standard.

3.12. Schedules

3.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: 11 kV Aerial Bunch Cables]

(To be confirmed by the vendor)

Table 3-5: Guaranteed Technical Particulars for 11kV Aerial bunch cables (Part 1)

S. No.	Particulars	Confirmation
1	Cables shall be manufactured and supplied confirming to IS:7098 Part-2 , IEC - 60502 Part2 and UPCL specifications	
2	Cable drum shall bear ISI mark	
3	Rated voltage 11 kV	
4	11 kV Aerial Bunch Cable size	
6	Stranded phase conductor shall be H2 or H4 grade Aluminium complying with IS:8130	
7	Insulated messenger conductor shall be Aluminium alloy as per IS:398 Part-4	
8	Insulation shall be dry/ gas cured cross linked polyethylene applied by extrusion complying with IS: 7098 Part-2	
9	Minimum thickness of insulation shall be 3.6 mm	
10	Tensile strength and elongation at break of insulation shall be as per IS: 7098 Part-2	
11	Tensile strength elongation at break for outer sheath shall be as per IEC-60502 Part-2	
12	Core identification shall be as specified in this spec	
13	Conductor screen shall be extruded semi conducting XLPE of thickness not less than 0.5 mm	

S. No.	Particulars	Confirmation
14	Insulation screen shall be extruded semi conducting compound of thickness not less than 0.6 mm	
15	The metallic screen shall consist of Copper tape of thickness not less than 0.045mm	
16	Max. dc resistance of conductor at 20 ^{0}C shall be as specified in this spec	
17	Max. dc resistance of messenger conductor at 20 ^{0}C shall be as per this spec	
18	Current ratings shall be as per IS:3961 Part-2	
19	Marking in indelible ink on each drum shall be as per this specs	
20	Standard length of conductor shall be 500 mtr	
21	Cables shall be supplied in wooden drums complying to IS :14048	
22	Cable drums shall contain only one length	

3.12.2. Schedule – II [Guaranteed Technical Particulars (II/II) for Item: 11kV Aerial Bunch Cables]

(Information to be furnished by the vendor)

Table 3-6: Guaranteed Technical Particulars for 11kV Aerial bunch cables

Sl. No.	Descriptions	Unit	3x185+150 Sq.mm AB Cable	3x150+120 Sq.mm AB Cable	3x120+95 Sq.mm AB Cable	3x95+70 Sq.mm AB Cable
1.	Manufacturer's Name And Address					
2.	List of standards applicable		IS: 8130:84, IS:7098(P2):85 & IS:398(P4) with upto date amendments.			
3.	Voltage Grade of Power Cable					
(i)	Service Voltage		6.35/11 KV			
(ii)	Neutral earthing		Suitable for earthed system			
4.	No. of Cores					
(i)	Power Cores	Nos.	3			
(ii)	Bare Messenger	No.	1			
5.	Details of power /messenger core conductor					
A	Phase Core					
(i)	Material		H4 Grade Aluminum To IS:8130:84			
(ii)	Nominal Cross Sectional Area	Sq.mm	185	150	120	95
(iii)	Flexibility Class as per IS:8130:84		Class-2			
(iv)	Form of conductor		Stranded Compacted circular			
(v)	No. of wire (Min)	Nos.	30	15	15	15

	Wire Dia		Shall be so chosen so as the meet conductor resistance requirement as per IS: 8130:84			
(vi)	Max. D.C. Resistance of conductor at 20 deg. C	Ohm/ Km	0.164	0.206	0.253	0.320
B	Messenger Core (Bare)					
(i)	Material		Aluminium Magnesium Silicon Alloy generally to IS:398 (P-4)			
(ii)	Nominal Cross Sectional Area	Sq.mm	150	120	95	70
(iii)	Form of conductor		Stranded Compacted circular			
(iv)	No. of wire (Min)	No/mm	19	19	7	7
(v)	Max. D.C. Resistance of conductor at 20 deg. C	Ohm/ Km	0.229	0.283	0.351	0.493
(vi)	Approx. Breaking Load	(KN)	43.90 (min)	35.2 (min)	27.55(min)	20(min)
6	Insulation (Power Cores)					
(i)	Material		XLPE To IS:7098 (P-2):85			
(ii)	Process		Nitrogen gas curing CCV line method or SIOPLAS Technology (Dry Cured)			
(iii)	Nominal Thickness	mm	3.6			
7	Conductor Screening					
(i)	Material		Extruded Layer of semi conduction compound			
(ii)	Approx. Thickness	mm	0.5			
8	Insulation Screening					
(i)	Material		Extruded Layer of semi conduction compound			
(ii)	Approx. Thickness	mm	0.6			
9	Metallic Screening					
(i)	Material		Copper Tape Applied Helically on Core			
(ii)	Normal Thickness	mm	0.05			
10	Outer Sheath					
(i)	Material		PVC Type ST2 to as per IS:7098(P-2)			
(ii)	Normal Thickness	mm	2.2	2.0	1.8	1.8
11	Identification of Power		The core identification shall be done by Ridges One, Two and Three on PVC Covering over cores & by colored strips of Red, Yellow and Blue Colour below copper tape.			
12	Maximum Conductor Temperature					

(i)	Continuous	Deg. C	90 Deg. C
(ii)	Short time	Deg. C	250 Deg. C
13	Cable Drum		
(i)	Standard Length per Drum		500± 5%
(ii)	Non Standard Length.		5% of the ordered qty. Not length less than 100m.
(iii)	Ordered Qty. tolerance		± 5%

3.12.3. Schedule – III [Information regarding BIS license]

Table 3-7: Format for information regarding BIS license

Sr. No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license number for IS:7098 Part-2	
4	ISI license for IS: 7098 Part-2 is valid up to	

3.12.4. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 3-8: Format for information regarding manufacturing and testing facilities

Sr. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed (Specifying order date and quantity)	
A	With UPCL	
B	With other agencies, other than 6.a	

4. Technical Specification for LT PVC cable

4.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of 1.1 kV grade single and multicore PVC insulated and PVC sheathed LT Cables for use in distribution system. This specification covers following sizes of cables.

a) ***Twin core service cables: 2.5, 4, 6, 10 sq mm***
b) ***Single core: 10, 25, 35, 50, 70, 95, 120, 150, 185, 240, 300 sq mm***
c) ***3.5 core cables: 25, 35, 50, 70, 95, 120, 150, 185, 240, 300 sq mm***

4.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows.

Table 4-1: Tropical conditions for continuous operation

Sr. No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind speed zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

4.3. Standards

The cables shall comply with latest revision of the following Indian standards (IS) unless otherwise stipulated in the specification. All references to Indian standards shall be deemed to be complying with latest amendments to the respective is, if any.

Table 4-2: Standards of compliance

S. No.	Standard No.	Title
1	IS: 1554 (Part 1)-1988	Specification for PVC insulated (Heavy Duty) electric cables for working voltages up to and including 1100 Volts.
2	IS :14255/1995	ABC cables 1100 volts.
3	IS : 5831-1984	Specification for PVC insulation and sheath of electric cables.

S. No.	Standard No.	Title
4	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.
5	IS: 3975-1988	Specification for Mild Steel wires, formed wires and tapes for armoring of cables.
6	IS: 3961 (Part-II)-1967	Recommended current ratings for PVC insulated and PVC sheathed Heavy Duty Cables.
7	IS: 10462 (Part-I)-1983	Fictitious calculation method for determination of dimensions of protective covering of cables.
8	IS:10810 of 1984	Method of test's for cables
9	IS:10418-1982	Drums for electric cables.
10	IS: 398/Pt.IV/1994	Aluminium alloy conductor

4.4. General Technical Requirements

Material used for construction of cables shall be of best quality complying with the requirements of relevant Standards. Cable shall be suitable for outdoor/indoor installation free in air and shall be capable of withstanding the normal stress associated with transportation erection, reeling and un-reeling operations without getting deformed.

4.4.1. Conductor

The shaped stranded conductor shall be aluminum wire complying with IS: 8130/1984.

DC resistance of conductor shall be complying with IS: 8130-1984.

Table 4-3: Standard size and technical characteristics

Cable Size	No. of Strands	Nominal Dia of Armor Wire (mm)	Approx. Weight of Cable (Kg/KM) for round wire armored cable	Max. DC Resistance at 20 degree C (Ohm/km)	Insulation Thickness (mm)	Short Circuit Current Rating for 1 Second Duration	Normal Current Rating	
							In Ground	In Air
2 core 2.5 sq mm	0.33	1.4	390	12.1	1	0.19	25	21
2 core 4 sq mm	0.33	1.4	460	7.41	1	0.304	32	27
2 core 6 sq mm	0.33	1.4	530	4.61	1	0.456	40	35
2 core 10 sq mm	0.14	1.4	620	3.08	1	0.76	55	47
1 core 10 sq mm	0.14	1.4	170	3.08	1.3	0.76	51	47
1 core 25 sq mm	6	1.4	300	1.2	1.5	1.9	86	84
1 core 35 sq mm	6	1.4	350	0.868	1.5	2.66	100	105

Cable Size	No. of Strands	Nominal Dia of Armor Wire (mm)	Approx. Weight of Cable (Kg/KM) for round wire armored cable	Max. DC Resistance at 20 degree C (Ohm/km)	Insulation Thickness (mm)	Short Circuit Current Rating for 1 Second Duration	Normal Current Rating	
							In Ground	In Air
1 core 50 sq mm	6	1.4	400	0.641	1.7	3.8	120	130
1 core 70 sq mm	12	1.4	500	0.443	1.7	5.32	140	155
1 core 95 sq mm	15	1.6	700	0.32	1.9	7.22	175	190
1 core 120 sq mm	15	1.6	800	0.253	1.9	9.12	195	220
1 core 150 sq mm	15	1.6	900	0.206	2.1	11.4	220	250
1 core 185 sq mm	30	1.6	1050	0.164	2.3	14.1	240	290
1 core 240 sq mm	30	1.6	1350	0.125	2.5	18.2	270	335
1 core 300 sq mm	30	1.6	1600	0.1	2.7	22.8	295	380
3.5 core 25 sq mm	1	1.6	1150	1.2	1.2	1.9	76	70
3.5 core 35 sq mm	1	1.6	1350	0.868	1.2	2.66	92	86
3.5 core 50 sq mm	1	2	1650	0.641	1.167	3.8	110	105
3.5 core 70 sq mm	2	2	2200	0.443	1.167	5.32	135	130
3.5 core 95 sq mm	2.5	2	2800	0.32	1.143	7.22	165	155
3.5 core 120 sq mm	1.25	2	3300	0.253	1.143	9.12	185	180
3.5 core 150 sq mm	1.25	2	3750	0.206	1.286	11.4	210	205
3.5 core 185 sq mm	2	2.5	4850	0.164	1.25	14.1	235	240
3.5 core 240 sq mm	2	2.5	5850	0.125	1.375	18.2	275	280
3.5 core 300 sq mm	2	3.15	7600	0.1	1.333	22.8	305	315

4.4.2. Insulation

The conductor shall be provided with PVC insulation, Type-A, applied by extrusion, confirming to the requirements of IS: 5831 / 1984.

The average thickness of insulation and its tolerances shall be as per Table - 2, Thickness of Insulation of IS: 1554 (part-I)/1988.

The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

4.4.3. Fillers

The filler shall be of vulcanized rubber or thermoplastic material and shall be provided to fill the gaps between cores.

The filler material shall be so chosen as to be compatible with temperature of cable and shall have no deleterious effect on other components of the cable. These shall not be harder than PVC used for insulation and outer sheath.

4.4.4. Core Identification

The core shall be identified by different colouring of PVC insulation as per follows:

1 Core: red, black, yellow, blue or neutral (non-pigmented)

2 Cores: red and black

3 Cores: red, yellow and blue

4 Cores: red, yellow, blue and black

Above 5 cores by numbers.

For reduced neutral conductors, the insulation color shall be black.

4.4.5. Laying Up Of Cores

The cores shall be laid up together with the suitable right hand lay.

4.4.6. Inner Sheath

The laid-up cores shall be provided with an inner sheath applied by extrusion. It shall be ensured that it is as circular as possible.

Bedding of PVC tape for inner sheath is not acceptable.

The thickness of inner sheath shall be as given in Table- 4 of IS: 1554 (part-I) 1988.

4.4.7. Armoring

- Armoring shall be applied over the insulation in case of single core cables and over the inner sheath in case of multi core cables.
- The armor wires or strips shall be applied as closely as possible.
- The direction of lay of armor shall be left hand.
- A binder tape shall be provided on the armor.

Type of armor and dimensions

- The armor shall consist of galvanized round steel wires for cables up to 16 sq mm and galvanized steel strip for cable sizes above 16 sq mm, with the dimensions as specified in is : 1554 (part-I)1988.

4.4.8. Joints

Joints in armor wires/strips shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire / strip shall be at least 300 mm from the nearest joint in any other armor strip/wire of the completed cable.

4.4.9. Outer Sheath

The outer sheath shall be of Type ST 1 PVC compound conforming to the requirements of IS: 5831-1984.

The outer sheath shall be applied by extrusion. It shall be applied:

- Over the insulation in case of un-armored single-core cables.
- Over the inner sheath in case of un-armored multi core cables.
- Over the armoring in case of armored cables.

Color of outer sheath shall be black.

Average thickness of PVC outer sheath of armored / un-armored cables shall be as specified in IS: 1554 (part-I) 1988.

4.4.10. Sequential Marking of Length on Cable

Non-erasable sequential marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

4.4.11. Continuous A.C. Current Capacity

Continuous A. C. current capacity shall be conforming to IS: 3961 (Part-II)-1967.

4.4.12. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected and no further correspondence shall be entertained in this regard.

4.4.13. Type Test Reports

Type Test Reports (less than five years old as on the due date of tender) of Tests carried out at NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected.

4.5. Tests

4.5.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:

- Tensile test
- Wrapping test
- Resistance test

b) Tests for armoring strips
c) Tests for thickness of insulation and sheath
d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption
e) Test on extruded semi conducting screens
   - Test for stripability of semiconducting strippable insulation screen
   - Volume resistivity
f) Physical Tests on outer sheath :
   - Tensile strength and elongation at break
   - Ageing in air oven
   - Shrinkage test
   - Hot deformation
   - Loss of mass in air oven
   - Heat shock
   - Thermal stability
   - Carbon black content of polythene sheath
   - Bleeding and blooming test
g) Thermal ageing
h) Partial discharge test
i) Bending test
j) Dielectric power factor test
   - as a function of voltage
   - as a function of temperature
k) Insulation resistance test (volume resistivity)
l) Heating cycle test
m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

4.5.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath

e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
j) Test for cross linking for extruded semi conducting screen
q) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

4.5.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

4.5.4. Routine Tests

The vendor hall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

4.5.5. Optional Tests

Cold impact tests for outer sheath (IS: 5831-1984) shall constitute the optional tests

4.5.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

4.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.

d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

4.7. Verification of Length & Mass

- Minimum 2 drums of every size of cables (above 10 sq mm) offered for inspection in each lot shall be checked for workmanship and length verification at vendors works.
- Minimum 5 coils of every size of cables (up to 10 sq mm) offered for inspection in each lot shall be checked for workmanship and length verification at vendors works.
- If the cable is found short in length, the difference in average length thus obtained from the length declared by vendor shall be applied to all the drums.

4.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

4.9. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

4.10. Packing & Marking

4.10.1. Packing

Twin core service cables up to 10 sq. mm size shall be packed in coils of 100-meter length each. Each coil shall be protected against damage by polythene wrapping.

Multi core cable shall be supplied in 500-meter length.

Single core cables shall be supplied in following lengths:

- 25 to 120 sq. mm - 1000 meters
- Above 120 sq. mm - 500 meters

Three phase core cables shall be supplied in following lengths:

- 25 to 120 sq. mm - 500 meters
- Above 120 sq. mm - 250 meters

A tolerance of +/- 5 % shall be allowed in standard length.

All cables (25 sq. mm and above) shall be supplied in non-returnable wooden drums, which shall comply with IS: 10418-1982, Specifications for Drums for Electric Cables.

Cable ends shall be sealed by means of non-hygroscopic sealing material.

4.10.2. Marking

Following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

a) Manufactures name or trade mark
b) Voltage grade
c) Size of cable
d) Successive Length
e) ISI mark
f) Year of manufacture
g) UPCL

Following information shall be marked on each drum, in indelible ink.

a) Manufacturers name or trade mark
b) Type of cable and voltage grade
c) Nominal cross-sectional area of the conductor
d) Length of cable on drum
e) Number of lengths on drum
f) Direction of rotation of drum (an arrow)
g) Approximate gross weight
h) Month & year of manufacture
i) Contract number

4.10.3. Engineering Data and Manual

Following information shall be furnished along with the offer.

- Leaflet giving construction details, dimensions and characteristics of cables.

- Current rating, de-rating factor due to grouping, ambient temperature and type of installation etc
- Write up with drawings for splitting, jointing and termination of cables.

4.11. Rejection and Tests

Rejection and retests shall be as per the provisions of relevant Indian Standard.

4.12. Schedules

4.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: LT PVC Cables]

(To be confirmed by the vendor)

Table 4-4: Guaranteed Technical Particulars for LT PVC cables (Part 1)

S. No.	Particulars	Confirmation
1	Cables shall be manufactured and supplied confirming to IS:1554 and UPCL specifications	
2	Cable drum shall bear ISI mark	
3	Rated voltage 1.1 kV	
4	LT PVC Cable size, Twin Core	
	Twin Core 2.5 sq mm	
	Twin Core 4 sq mm	
	Twin Core 6 sq mm	
	Twin Core 10 sq mm	
5	LT PVC Cable size, 1 Core	
	1 Core 10 sq mm	
	1 Core 25 sq mm	
	1 Core 35 sq mm	
	1 Core 50 sq mm	
	1 Core 70 sq mm	
	1 Core 95 sq mm	
	1 Core 120 sq mm	
	1 Core 150 sq mm	
	1 Core 185 sq mm	
	1 Core 240 sq mm	
	1 Core 300 sq mm	
6	LT PVC Cable size, 3.5 Core	
	3.5 Core 10 sq mm	

S. No.	Particulars	Confirmation
	3.5 Core 25 sq mm	
	3.5 Core 35 sq mm	
	3.5 Core 50 sq mm	
	3.5 Core 70 sq mm	
	3.5 Core 95 sq mm	
	3.5 Core 120 sq mm	
	3.5 Core 150 sq mm	
	3.5 Core 185 sq mm	
	3.5 Core 240 sq mm	
7	Stranded conductor shall be Aluminium wire complying with IS:8130	
8	Insulation shall be PVC , Type-A applied by extrusion complying with IS:1554 (Part-I)	
9	Thickness of insulation shall be as per IS: 1554 (Part- I)	
10	Inner sheath shall be applied by extrusion	
11	Thickness of inner sheath shall be as per IS: 1554 (Part- I)	
12	Dimensions of armor shall be as per IS: 1554 (Part- I)	
13	Outer sheath shall be Type ST 1 PVC compound complying to IS:5831	
14	Thickness of outer sheath shall be as per IS: 1554 (Part- I)	
15	Core identification shall be as per IS: 1554 (Part- I)	
16	Colour of outer sheath shall be Black	
17	Min. volume resistivity of insulation at 27 ºC, min. Ohm-cm , as per IS:5831	
18	Min. volume resistivity of insulation at 70 ºC, min. Ohm-cm , as per IS:5831	
19	Max. resistance of conductor at 20 ºC shall be as per IS:8130	
20	Tensile strength of insulation and sheath, as per IS:5831	
21	Elongation at break of insulation and sheath , as per IS:5831	
22	Current ratings shall be as per IS:3961 Part-2	
23	Embossing on every meter length shall be as per this specs	
24	Marking in indelible ink on each drum shall be as per this specs	
25	Standard length of conductor as per this spec (km)	
26	Twin core cables up to 10 sq mm shall be supplied in 100 meter length, duly wrapped by polyethylene	
27	3.5 core cables shall be supplied in wooden drums complying to IS :14048	
28	Cable drums shall contain only one length	
29	Cable ends shall be sealed with non-hygroscopic material	

S. No.	Particulars	Confirmation
30	Progressive length of cable shall be marked on outer sheath for each meter length	

4.12.2. Schedule – II [Guaranteed Technical Particulars (II/II) for Item: LT PVC Cables]

(Information not covered in IS)

Table 4-5: Guaranteed Technical Particulars for LT PVC Cables (Part 2)

Sr. No.	Item	Twin core cable		1 core cable		3.5 core cable	
		xx sq mm	xx sq mm	xx sq mm	xx sq mm	xx sq mm	xx sq mm
	Approx. weight of 1 (one) meter length of cable in kg						
a	Aluminum						
b	PVC						
c	Armor						
1	Total						
2	Gross weight of drum (kg)						

4.12.3. Schedule – III [Information regarding BIS license]

Table 4-6: Format for information regarding BIS license

S.No.	Particulars	Data/Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license for IS: 1554 - number	
4	ISI license for IS: 1554 - valid up to	

4.12.4. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 4-7: Format for information regarding manufacturing and testing facilities

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
a	With UPCL	
b	With other agencies, other than 6.a	

5. Technical Specification for LT XLPE cable, PVC sheathed cables

5.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of 1.1 kV grade single and multicore XLPE insulated, PVC sheathed LT Cables for use on distribution transformers and LT underground lines. This specification covers following sizes of cables.

Single Core and 3.5 Core Cables: 25, 50, 70, 120, 185 sq. mm.

5.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows.

Table 5-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

5.3. Standards

The cables shall comply with latest revision of the following Indian Standards unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 5-2: Standards of compliance

S.No.	Standard	Title
1	IS: 7098 (Part 1)-1988	Specification for XLPE insulated cables for working voltages up to and including 1100 Volts.
2	IS : 5831-1984	Specification for PVC insulation and sheath of electric cables.
3	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.

S.No.	Standard	Title
4	IS: 3975-1988	Specification for Mild Steel wires, formed wires and tapes for armoring of cables.
5	IS: 10462 (Part-I)-1983	Fictitious calculation method for determination of dimensions of protective covering of cables.
6	IS:10810 -1984	Method of test for cables
7	IS:10418-1982	Specification For Drums For Electric Cables.

5.4. General Technical Requirements

Material used for construction of cables shall be of best quality complying with the requirements of relevant Standards. Cable shall be suitable for outdoor/indoor installation free in air and shall be capable of withstanding the normal stress associated with transportation erection, reeling and un-reeling operations without getting deformed.

5.4.1. Conductor

The stranded conductor shall be Aluminum wire complying with IS:8130/1984.

DC resistance of conductor shall be complying with IS: 8130-1984.

Table 5-3: Standard size and technical characteristics

Cable Size	No. of Strands	Nominal Dia of Armor Wire (mm)	Approx. Weight of Cable (Kg/KM) for round wire armored cable	Max. DC Resistance at 20 C degree (Ohm/km)	Insulation Thickness (mm)	Short Circuit Current Rating for 1 Second Duration	Normal Current Rating	
							In Ground	In Air
1 core 25 sq mm	6	1.4	250	1.2	1.2	2.35	99	115
1 core 50 sq mm	6	1.4	360	0.641	1.3	4.7	138	170
1 core 70 sq mm	12	1.4	450	0.443	1.4	6.58	168	210
1 core 120 sq mm	15	1.6	700	0.253	1.5	11.28	230	300
1 core 185 sq mm	30	1.6	950	0.164	1.9	17.39	295	385
3.5 core 25 sq mm	1	1.6	1000	1.2	0.90/0.70	2.35	95	99
3.5 core 50 sq mm	1	1.6	1450	0.641	1.00/0.90	4.7	140	140
3.5 core 70 sq mm	2	2	2000	0.443	1.10/0.90	6.58	170	176
3.5 core 120 sq mm	1.25	2	2900	0.253	1.20/1.10	11.28	225	258
3.5 core 185 sq mm	2	2.5	4450	0.164	1.60/1.10	17.39	285	339

5.4.2. Insulation

The conductor shall be provided with Cross Linked Polyethylene (XLPE) insulation applied by extrusion, confirming to the requirements of IS: 7098 / 1988.

The average thickness of insulation and it's tolerances shall be as per Table - 2, Thickness of Insulation of IS: 7098 (part-I)/1988.

The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

5.4.3. Fillers

The filler shall be of vulcanized rubber or thermoplastic material and shall be provided to fill the gaps between cores.

The filler material shall be so chosen as to be compatible with temperature of cable and shall have no deleterious effect on other components of the cable. These shall not be harder than XLPE used for insulation and outer sheath.

5.4.4. Core Identification

The core shall be identified by different coloring of XLPE insulation as per follows.

1 Core: red, black, yellow, blue or neutral (non-pigmented)

2 Cores: red and black

3 Cores: red, yellow and blue

4 Cores: red, yellow, blue and black

For reduced neutral conductors, the insulation colour shall be black.

5.4.5. Laying Up Of Cores

The cores shall be laid up together with the suitable right hand lay.

5.4.6. Inner sheath

The laid up cores shall be provided with an inner sheath applied by extrusion. It shall be ensured that it is as circular as possible.

Bedding of XLPE tape for inner sheath is not acceptable.

The thickness of inner sheath shall be as per IS : 7098 (part-I)1988.

5.4.7. Armoring

Application

- Armoring shall be applied over the inner sheath. The armor wires or strips shall be applied as closely as possible.
- The direction of lay of armor shall be left hand. A binder tape shall be provided on the armor.

Type of Armor and Dimensions.

- The armor shall consist of galvanised steel strip complying with the requirements of IS: 3975-1979.

5.4.8. Joints

Joints in armor wires/strips shall be made by brazing or welding and the surface irregularities shall be removed. a joint in any wire / strip shall be at least 300 mm from the nearest joint in any other armor strip/wire of the completed cable.

5.4.9. Outer Sheath

The outer sheath shall be of Type ST 2 PVC compound conforming to the requirements of IS : 5831-1984.

The outer sheath shall be applied by extrusion.

It shall be applied:

i. Over the insulation in case of un-armored single-core cables.
ii. Over the inner sheath in case of un-armored multi core cables.
iii. Over the armoring in case of armored cables.

Colour of outer sheath shall be black.

Average thickness of PVC outer sheath of un-armored / armored cables shall be as specified in IS: 7098 (part-I) 1988.

5.4.10. Sequential Marking of Length on Cable

Non erasable sequential marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

5.4.11. Type Test Reports

Type Test Reports (Less Than Three Years Old As On Due Date Of Tender) Of Tests Carried Out At NABL Accredited Laboratory Shall Be Furnished By The Bidder Along With Offer Otherwise Offer Shall Be Rejected.

5.4.12. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

The BIS license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

5.5. Tests

5.5.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:
   - Tensile test
   - Wrapping test
   - Resistance test
b) Tests for armoring strips
c) Tests for thickness of insulation and sheath
d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption
e) Test on extruded semi conducting screens

- Test for stripability of semiconducting strippable insulation screen
- Volume resistivity

f) Physical Tests on outer sheath :
- Tensile strength and elongation at break
- Ageing in air oven
- Shrinkage test
- Hot deformation
- Loss of mass in air oven
- Heat shock
- Thermal stability
- Carbon black content of polythene sheath
- Bleeding and blooming test

g) Thermal ageing
h) Partial discharge test
i) Bending test
j) Dielectric power factor test
- as a function of voltage
- as a function of temperature

k) Insulation resistance test (volume resistivity)
l) Heating cycle test
m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
- Breaking load test on finished wire
- Elongation test
- Resistance test

5.5.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
j) Test for cross linking for extruded semi conducting screen
q) Tests on messenger wire as per IS:398 Part-4 (if applicable)
- Breaking load test on finished wire
- Elongation test
- Resistance test

5.5.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

5.5.4. Routine Tests

The vendor hall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

5.5.5. Optional Tests

Cold impact tests for outer sheath (IS: 5831-1984) shall constitute the optional tests

5.5.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

5.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the

Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

5.6.1. Verification of Length & Mass

- Minimum 2 Drums of Every Size Of Cables Offered For Inspection In Each Lot Shall Be Checked For Workmanship And Length Verification At Vendors Works.
- If the Cable Is Found Short in Length, The Difference In Average Length Thus Obtained From The Length Declared By Vendor Shall Be Applied To All The Drums.

5.7. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

5.8. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

5.9. Packing & Marking

5.9.1. Packing

Single core cables shall be supplied in following lengths:

- Up to 120 sq. mm - 1000 meters
- Above 120 sq. mm - 500 meters

Three phase multi core cables shall be supplied in following lengths:

- Up to 120 sq. mm - 500 meters
- Above 120 sq. mm - 250 meters

A tolerance of +/- 5 % shall be allowed in standard length.

All cables shall be supplied in non-returnable wooden drums, which shall comply with IS: 10418-1982, Specifications for Drums for Electric Cables.

Cable ends shall be sealed by means of non-hygroscopic sealing material.

5.9.2. Marking

Following Particulars Shall Be Properly Legible Embossed On The Cable Sheath At The Intervals Of Not Exceeding One Meter Throughout The Length Of The Cable. The Cables With Poor And Illegible Embossing Shall Be Liable For Rejection.

a. Manufactures name or trade mark
b. Voltage grade
c. Size of cable
d. Successive Length
e. ISI mark
f. Year of manufacture
g. UPCL

Following Information Shall Be Marked On Each Drum, In Indelible Ink.

a. Manufacturers name or trade mark
b. Type of cable and voltage grade
c. Nominal cross-sectional area of the conductor
d. Length of cable on drum
e. Number of lengths on drum
f. Direction of rotation of drum (an arrow)
g. Approximate gross weight
h. Month & year of manufacture
i. Contract number

5.10. Engineering Data and Manual

Following information shall be furnished along with the offer.

- Leaflet giving construction details, dimensions and characteristics of cables.
- Current rating, de-rating factor due to grouping, ambient temperature and type of installation etc
- Write up with drawings for splitting, jointing and termination of cables.

5.11. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian Standard.

5.12. Schedules

5.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: LT XLPE Cables]

(To be confirmed by the vendor)

Table 5-4: Guaranteed Technical Particulars for LT XLPE Cables (Part 1)

S. No.	Particulars	Confirmation
1	Cables shall be manufactured and supplied confirming to IS:7098 (Part 1) 1988 and UPCL specifications	
2	Cable drum shall bear ISI mark	
3	Rated voltage 1.1 kV	
4	LT XLPE Cable size, 1 Core	
	1 Core 25 sq mm	
	1 Core 50 sq mm	
	1 Core 70 sq mm	
	1 Core 120 sq mm	
	1 Core 185 sq mm	
6	LT XLPE Cable size, 3.5 Core	
	3.5 Core 25 sq mm	
	3.5 Core 50 sq mm	
	3.5 Core 70 sq mm	
	3.5 Core 120 sq mm	
	3.5 Core 185 sq mm	
7	Stranded conductor shall be Aluminum wire complying with IS:8130	
8	Insulation shall be provide with cross linked Polyethylene insulation applied by extrusion complying with IS:7098 (Part-I)	
9	Thickness of insulation shall be as per IS: 7098 (Part- I)	
10	Inner sheath shall be applied by extrusion	
11	Thickness of inner sheath shall be as per IS: 7098 (Part- I)	
12	Dimensions of armor shall be as per IS: 7098 (Part- I)	
13	Outer sheath shall be Type ST 1 PVC compound complying to IS:5831	
14	Thickness of outer sheath shall be as per IS: 7098 (Part- I)	
15	Core identification shall be as per IS: 7098 (Part- I)	
16	Color of outer sheath shall be Black	
17	Min. Volume resistivity of insulation at 27 ° C, min. Ohm-cm , as per IS:7098(Part- I)	
18	Min. Volume resistivity of insulation at 900C, min. Ohm-cm , as per IS:7098 (Part- I)	

S. No.	Particulars	Confirmation
19	Max. resistance of conductor at 20 °C shall be as per IS:8130	
20	Tensile strength of insulation and sheath, as per IS: 7098 (Part- I)	
21	Elongation at break of insulation and sheath , as per IS: 7098 (Part- I)	
22	Current ratings shall be as per IS:3961 Part-2	
23	Embossing on every meter length shall be as per this specs	
24	Marking in indelible ink on each drum shall be as per this specs	
25	Standard length of conductor as per this spec (km)	
26	Progressive length of cable shall be marked on outer sheath for each meter length	
27	Cables shall be supplied in wooden drums complying to IS :14048	
28	Cable drums shall contain only one length	
29	Cable ends shall be sealed with non-hygroscopic material	

5.12.2. Schedule – II [Guaranteed Technical Particulars (II/II) for Item: LT XLPE Cables]

(Information not covered in IS)

Table 5-5: Guaranteed Technical Particulars for LT XLPE Cables (Part 2)

S. No.	Item	Twin core cable		1 core cable		3.5 core cable	
		xx sq mm	xx sq mm	xx sq mm	xx sq mm	xx sq mm	xx sq mm
	Approx. weight of 1 (one) meter length of cable in kg						
A	Aluminum						
B	PVC						
C	Armor						
1	Total						
2	Gross weight of drum (kg)						

5.12.3. Schedule – III [Information regarding BIS license]

Table 5-6: Format for information regarding BIS License

S. No.	Particulars	Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license number for IS: 7098 (Part 1)1998	
4	ISI license for IS: 7098 (Part 1)1998 is valid up to -	

5.12.4. Schedule – IV [Information regarding manufacturing and testing facilities]

(Vendor to enclose following documents and to confirm the same)

Table 5-7: Format for information regarding manufacturing and testing facilities

S. No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed	
A	With UPCL	
B	With other agencies, other than 6.a	

6. Technical Specification for LT Aerial Bunch Cables

6.1. Scope

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of ISI marked 1100V Aerial Bunched Cable having XLPE insulated Cable (three power core) with stranded compact circular aluminum conductors twisted over an insulated aluminum alloy messenger wire for use as overhead distribution feeder, with/without one street lighting core with stranded compacted circular aluminum conductor XLPE insulated suitable for use on 3-Phase AC System.

This specification covers following sizes of cables:

3x25+1x16+1x25 sq. mm

3x35+1x16+1x25 sq. mm

3x50+1x16+1x35 sq. mm

3x70+1x16+1x50 sq. mm

3x95+1x16+1x70 sq. mm

3x120+1x16+1x95 sq. mm

6.2. Service Conditions

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows.

Table 6-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum Temperature (Deg. Celsius)	-5
3	Relative Humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

6.3. Standards

The Cables Shall Comply with Latest Revision Of The Following Indian Standards Unless Otherwise Stipulated In The Specification.

All References to Indian Standards Shall Be Deemed To Be Complying With Latest Amendments To The Respective IS, If Any.

Table 6-2: Standards of compliance

S.No.	Standard	Title
1	IS-14255/1995	Specification for aerial bunch cables for working voltages up to and including 1100 volts.
2	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.
3	IS: 398 (PART-IV)	Specification for aluminum alloy conductors.
4	IS:10418-1982	Specification for drums for electric cables.

6.4. General Technical Requirements

Material used for construction of cables shall be of best quality complying with the requirements of relevant Standards. Cable shall be suitable for outdoor installation free in air and shall be capable of withstanding the normal stress associated with transportation erection, reeling and un-reeling operations without getting deformed.

6.4.1. Conductor

The Aluminum Conductors for phase/street lightning conductor shall be H2 or H4 grade Aluminum complying with the requirements of IS-8130-1984 with up to date amendments. For messenger wire stranded All Aluminum Conductor shall be of heat-treated Aluminum Magnesium-Silicon Alloy Wires containing approximate 0.5% magnesium and 0.5% silicon conforming to IS-398 (Part-IV)/1984 with up to date amendments. The stranded conductor shall be clean & reasonably uniform in size and shape and its surface shall be free from sharp edges.

Not more than two joints shall be allowed in any of the wires forming every complete length of conductor and no joint shall be within 300 mm. of any other joint in the same layer. The joint shall be brazed, silver soldered or electric or gas welded. No joint shall be made in the conductor, once it has been stranded.

Table 6-3: Standard size and technical characteristics of phase and street lighting conductors

Nominal Sectional Area (sq.mm)	Diameter of compacted conductor (mm)	Max. DC resistance at 20 Deg. (0hm/km)	Insulation thickness (mm)	Approx. mass (kg/km)	Minimum no. of Strands
(1)	(2)	(3)	(4)	(5)	(6)
16	4.4	1.91	1.2	42	4
25	5.5	1.20	1.2	65	7
35	6.8	0.868	1.2	95	7
50	7.9	0.641	1.5	127	7
70	9.6	0.443	1.5	184	12
95	11.3	0.320	1.5	254	15

Nominal Sectional Area (sq.mm)	Diameter of compacted conductor (mm)	Max. DC resistance at 20 Deg. (0hm/km)	Insulation thickness (mm)	Approx. mass (kg/km)	Minimum no. of Strands
120	12.7	0.253	1.6	320	15

6.4.2. Insulation

The Conductor (with protective barrier, wherever applied) shall be provided with cross linked polyethylene applied by extrusion conforming to the standard Specification as per IS 4255/95.The average thickness of insulation when measured in accordance with relevant clause of the specification, shall not be less than standard value specified. Upper surface of Cable insulation should be Ultra Violet Ray resistant Colour of insulation shall be black.

6.4.3. Core Identification

The Phase Conductors shall be insulated with black weather resistant, XLPE suitable for 1100 Volt insulation. The Phase Conductor shall be provided with one, two and three ridges for quick identification. The individual cores thus formed shall then be laid up around insulated messenger wire. The insulated street lighting conductor shall not have any identification mark.

6.4.4. Messenger cum Neutral Wire

The insulated messenger wire shall be of aluminum alloy, generally conforming to IS 398 (Part-IV)/1994 and suitably compacted to have smooth round surface to avoid damage to the other insulating sheath of phase conductor twisted around the messenger.

Standard size and characteristics of messenger conductor shall be as shown in the following table.

Table 6-4: Standard size and characteristics of messenger conductor

SI No.	Normal Cross-Sectional Area of Phase Conductor	Messenger Conductor		
		Nominal Cross Sectional Area	Maximum DC Resistance at 20°C	Minimum Breaking Load
	mm2	mm2	ohm/km	kN
i)	16	25	1.38	7.0
ii)	25	25	1.38	7.0
iii)	35	25	1.38	7.0
iv)	50	35	0.986	9.8
v)	70	50	0 492	19.7
vi)	95	70	0.357	26.5

6.4.5. Laying Up Of Cores

Three Power Cores having Ridges one, two and three and one street lighting without any ridge, if any should be twisted over insulated messenger wire with right hand direction of lay. This will from the Aerial Bunched Cable. Lay ratio shall be as specified in IS:14255/ 1995.

6.4.6. Type Test Reports

Type Test Reports (less than five years old as on due date of tender) of Tests carried out at NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected.

6.4.7. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

BIS license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

6.5. Tests

6.5.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:
   - Tensile test
   - Wrapping test
   - Resistance test

b) Tests for armoring strips

c) Tests for thickness of insulation and sheath

d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption

e) Test on extruded semi conducting screens
   - Test for stripability of semiconducting strippable insulation screen
   - Volume resistivity

f) Physical Tests on outer sheath:
   - Tensile strength and elongation at break
   - Ageing in air oven
   - Shrinkage test
   - Hot deformation
   - Loss of mass in air oven
   - Heat shock
   - Thermal stability
   - Carbon black content of polythene sheath
   - Bleeding and blooming test

g) Thermal ageing

h) Partial discharge test

i) Bending test

j) Dielectric power factor test
   - as a function of voltage
   - as a function of temperature

k) Insulation resistance test (volume resistivity)
l) Heating cycle test
m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

6.5.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
j) Test for cross linking for extruded semi conducting screen
q) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

6.5.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

6.5.4. Routine Tests

The vendor shall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

6.5.5. Optional Tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests

6.5.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

6.6. *Pre-Delivery Inspection at Manufacturer's Works*

a) All acceptance Tests, length and mass verification etc. shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

6.6.1. Verification of Length & Mass

Minimum 2 drums of every size of cables offered for inspection in each lot shall be checked for workmanship, length and weight verification at vendors works.

If the cable is found short in length, the difference in average length thus obtained from the length declared by vendor shall be applied to all the drums.

6.6.2. Quality Assurance Plan & Material Quality Plan:

Following quality plans shall be submitted within 30 days from the date of placement of contract.

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

6.7. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

6.8. Packing & Marking

6.8.1. Standard Length

The standard length of cable per drum will be 500 meter with tolerance of +/- 5%.

6.8.2. Non-Standard Length:

Non-standard length not less than 50% of the standard length shall be accepted to the extent of 10% of the ordered quantity.

The Cable shall be supplied on suitable sized wooden non-returnable drum of robust construction for each length of Cables as per I.S. 10418. A layer of water proof paper shall be applied to the surface of the drums and over the outer cable layer. A clear space at least 40 mm. shall be left between the Cable and Logging. Wood preservative shall be applied to the entire drum. Packing shall be sturdy to protect the cable from any injury during transportation handling and storage. Each cable drum shall have following information stenciled in indelible ink on it.

a) Manufacturer's name
b) Brand name / Trade Mark
c) Year and month of manufacture
d) Type designation of the cable
e) Voltage grade
f) Length of the Cable
g) ISI Certification Mark
h) Direction of rotation of drum (by means of an arrow)
i) Gross weight in kg
j) Property of UPCL

6.8.3. Sequential Marking:

Due To Technical Difficulty Marking Of The Sequential Length Is Not Required. Instead The Weight Per Meter Length Of Cable For All Sizes Shall Be Mentioned.

6.9. Standard Specifications

Sl No.	Particular		3x120+1 x 95Sq.mm	3x95+ 1x70 Sq. mm	3x25+ 1x 25 Sq. mm	3x16 + 1x 25 Sq. mm	1x16+ 1x25 Sq. mm
1.	Manufacture name & address						
2.	Rated voltage		1100 V				
	Phase conductor details						
3 .	i)	No of phase conductors	3	3	3	3	1
	ii)	Nominal sectional area of each conductor in sq. mm	120	95	25	16	16
	iii)	Minimum Tensile strength of each strand in N/sq. mm	90	90	90	90	90
	iv)	Diameter of compacted conductor in mm (Approx)	13.2	12.00	5.9	4.8	4.8
	v)	Max. D.C. resistance at 20°c (Ohm/Km)	0.253	0.320	1.20	1.91	1.91
	vi)	Insulation thickness (mm) minimum	1.80	1.50	1.20	1.20	1.20
	vii)	Carbon Content					
		Content	As per relevant IS				
		Dispersion	As per relevant IS				
	viii)	Standard specification to which this material shall conform	IS-8130/1984& IS:14255/1995				
4	Total Minimum Guaranteed weight of aluminum in Phase conductors kg/km		973	770	195	126	42
5	Messenger details:						
	i)	Nominal sectional area of the conductor in sq.mm	95	70	25	25	25
	ii)	No. of strands-	7	7	7	7	7
	iii)	approximate overall dia of competed conductor (mm)	11.7	10.1	5.9	5.9	5.9
	iv)	Minimum Guaranteed weight of messenger (Al. alloy) Kg/Km	256.7	189.2	65	65	65
	v)	Minimum breaking load of the conductor in KN	26.5	19.7	7	7	7

	vi)	Standard specification to which this material shall conform	IS:398(Part-IV)/1994 &IS:14255/1995				
	vii)	Max. D.C. resistance at 20°c (Ohm /Km)	0.357	0.492	1.38	1.38	1.38
6	Insulation of phase						
	i)	Material	XLPE				
	ii)	Standard specification to which this material shall coform	7098 (Part-I/1988)				
7	Other details						
	i)	Standard length (Meter)	500/250	500	1000 /500	1000/500	2000/ 1000/500
	ii)	Tolerance in drum length	±5%				
	(iii)	Non-standard length (Meter)	100				
No negative tolerance in size of wire/ area of conductor/messenger and thickness of insulation will be allowed.							

6.10. Engineering Data and Manual

Following Information Shall Be Furnished Along with The Offer.

a) Leaflet giving construction details, dimensions and characteristics of cables.
b) Current rating
c) Write up with drawings for tapping, jointing and termination of cables.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

6.11. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian Standard.

6.12. Schedules

6.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: LT Aerial bunch Cables]

(To be confirmed by the vendor)

Table 6-5: Guaranteed Technical Particulars for LT Aerial Bunch Cables (Part 1)

S.No.	Particulars	Confirmation
1	Cables shall be manufactured and supplied confirming to IS:14255 and UPCL specifications	
2	Cable drum shall bear ISI mark	

S.No.	Particulars	Confirmation
3	Rated voltage 1.1 kV	
4	LT Aerial Bunch Cable size	
	3x35+1x16+1x25 sq. mm	
	3x50+1x16+1x35 sq. mm	
	3x70+1x16+1x50 sq. mm	
	3x120+1x16+1x70 sq. mm	
5	Stranded conductor shall be H2 or H4 grade Aluminium complying with IS:8130	
6	Insulated Messenger conductor shall be Aluminium alloy as per IS:14255	
7	Insulation shall be cross linked polyethylene applied by extrusion complying with IS:14255	
8	Thickness of insulation shall be as per IS: 14255	
9	Volume resistivity of insulation at 27 °C, min. Ohm-cm , as per IS:14255	
10	Volume resistivity of insulation at 70 °C, min. Ohm-cm , as per IS:14255	
11	Core identification shall be as per IS: 14255	
12	Max. dc resistance of conductor at 20 °C shall be as per IS:8130	
13	Max. dc resistance of messenger conductor at 20 °C shall be as per IS:14255	
14	Tensile strength of insulation and sheath, as per IS:14255	
15	Elongation at break of insulation and sheath , as per IS:14255	
16	Current ratings shall be as per IS:3961 Part-2	
17	Marking in indelible ink on each drum shall be as per this specs	
18	Standard length of conductor as per this spec (km)	
19	Cables shall be supplied in wooden drums complying to IS :14048	
20	Cable drums shall contain only one length	

6.12.2. Schedule – II [Guaranteed Technical Particulars (II/II) Item: LT Aerial Bunch Cables]

(Information not covered in IS)

Table 6-6: Guaranteed Technical Particulars for LT Aerial Bunch Cables (Part 2)

S.No.	Item	3x35+1x16 +1x25 sq mm	3x50+1x16 +1x35 sq mm	3x70+1x16 +1x50 sq mm	3x120+1x16+1 x70 sq. mm
	Approx. weight of 1 (one) meter length of cable in kg				
	Aluminum				
	Insulation				
	Total				

6.12.3. Schedule – III [Information regarding BIS license]

Table 6-7: Format for information regarding BIS license

S.No.	Particulars	Information
1	Name of supplier and address	
2	Trade mark, if any	
3	ISI license number for IS: 14255 (1995)	
4	ISI license for IS: 14255 (1995) is valid up to	

6.12.4. Schedule – IV [Information regarding manufacturing and testing facilities etc]

(Vendor to enclose following documents and to confirm the same)

Table 6-8: Format for information regarding manufacturing and testing facilities

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed (Specifying order date and quantity)	
A	With UPCL	
B	With other agencies, other than 6.a	

7. Technical Specification of LT Control Cables

7.1. Scope- Technical Specification for Copper Control Cables

This specification covers minimum technical requirements for design, engineering, manufacture, inspection, supply and performance of 1.1 kV grade multi core, PVC insulated and PVC sheathed, copper control cables for use in distribution substations. This specification covers following sizes of cables.

2.5 sq mm cables: 2, 4, 7, 12,10 core

7.2. Service Conditions:

Equipment / material to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as follows:

Table 7-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

7.3. Standards

The cables shall comply with latest revision of the following Indian Standards (IS) unless otherwise stipulated in the specification.

All references to Indian Standards shall be deemed to be complying with latest amendments to the respective IS, if any.

Table 7-2: Standards of compliance

S.No.	Standard No.	Title
1	IS: 1554 (Part 1)-1988	Specification for PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 Volts.
2	IS : 5831-1984	Specification for PVC insulation and sheath of electric cables.

S.No.	Standard No.	Title
3	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.
4	IS: 3975-1988	Specification for Mild Steel wires, formed wires and tapes for armoring of cables.
5	IS: 3961 (Part-II)-1967	Recommended current ratings for PVC insulated and PVC sheathed Heavy Duty Cables.
6	IS: 10462 (Part-I)-1983	Fictitious calculation method for determination of dimensions of protective covering of cables.
7	IS:10810 of 1984	Method of test's for cables
8	IS:10418-1982	Drums for electric cables.

7.4. General Technical Requirements

Material used for construction of cables shall be of best quality complying with the requirements of relevant Standards. Cable shall be suitable for outdoor/indoor installation free in air and shall be capable of withstanding the normal stress associated with transportation erection, reeling and un-reeling operations without getting deformed.

7.4.1. Conductor

The stranded conductor shall be high conductivity, annealed, un-tinned copper wire complying with IS:8130/1984.

DC resistance of conductor shall be complying with IS: 8130-1984

Table 7-3: Standard size and technical characteristics

No. of cores	Minimum Inner Sheath thickness (mm)	Minimum Outer Sheath thickness (mm)	Nominal Dia. of armor wire (mm)	Approx. overall Dia. of cable		Approx. weight of cable	Max. DC Resistance at 20-degree C (Ohm/km)	Short Circuit Current Rating for 1 Second Duration	Normal Current Rating	
				Solid Cond (mm)	Std Cond (mm)	Std Cond (kg/km)			In Ground	In Air
2	0.3	1.24	1.4	14	14	480	7.41	0.288	32	27
4	0.3	1.24	1.4	16	16	605	7.41	0.288	27	24
7	0.3	1.24	1.4	18	18	775	7.41	0.288	20	17
						895	7.41	0.288	18	15
12	0.3	1.4	1.6	23	24	970	7.41	0.288	17	14

7.4.2. Insulation

The conductor shall be provided with PVC insulation, Type-A, applied by extrusion, confirming to the requirements of IS: 5831 / 1984.

The thickness of insulation and its tolerances shall be as per Table - 2, Thickness of Insulation of IS: 1554 (part-I)/1988.

The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

7.4.3. Core Identification

The core shall be identified as per follows.

- Up to 5 cores: by color coding
- Above 5 cores: by numbers

7.4.4. Laying Up of Cores

The cores shall be laid up together with the suitable right hand lay.

7.4.5. Inner Sheath

The laid-up cores shall be provided with an inner sheath applied by extrusion. It shall be ensured that it is as circular as possible.

Bedding of PVC tape for inner sheath is not acceptable.

The thickness of inner sheath shall be as given in Table- 4 of IS: 1554 (part-I)1988.

7.4.6. Armoring

Application

- Armoring shall be applied over the inner sheath of cable.
- The armor wires shall be applied as closely as possible.
- The direction of lay of armor shall be left hand.
- A binder tape shall be provided on the armor.

Type of Armor and Dimensions

- The armor shall consist of galvanized round steel wires with the dimensions as specified in is: 1554 (part-I)1988.

7.4.7. Joints

Joints in armor wires shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire shall be at least 300 mm from the nearest joint in any other armor of the completed cable.

7.4.8. Outer Sheath

The outer sheath shall be of Type ST 1 PVC compound conforming to the requirements of IS: 5831-1984.

The outer sheath shall be applied by extrusion. It shall be applied over the armoring.

Color of outer sheath shall be black.

Thickness of PVC outer sheath of armored / un-armored cables shall be as specified in IS: 1554 (part-I)1988.

7.4.9. Sequential Marking of Length on Cable

Non-erasable sequential marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

7.4.10. Continuous A.C. Current Capacity

Continuous A.C. current capacity shall be conforming to IS: 3961 (Part-II)-1967.

7.4.11. Type Test Reports

Type Test Reports (less than five years old as on due date of tender) of Tests carried out on all sizes of cables at NABL accredited laboratory shall be furnished by the bidder along with offer otherwise offer shall be rejected.

7.4.12. ISI Certification Mark

The cables with ISI marking only are required against this tender specification. A copy of BIS license valid on the due date of the tender should be submitted with the offer failing which, the offer shall be rejected.

The BIS (ISI) license shall be valid on the date of supply & material supplied shall have ISI marking. If the material received at site is found without ISI marking, the lot shall be rejected.

7.5. Tests

7.5.1. Type Tests

The following shall constitute type test:

a) Tests on conductor:
   - Tensile test
   - Wrapping test
   - Resistance test

b) Tests for armoring strips

c) Tests for thickness of insulation and sheath

d) Physical Tests for insulation
   - Tensile strength and elongation at break.
   - Ageing in air oven
   - Hot set
   - Shrinkage test
   - Water absorption

e) Test on extruded semi conducting screens
   - Test for stripability of semiconducting strippable insulation screen
   - Volume resistivity

f) Physical Tests on outer sheath:
   - Tensile strength and elongation at break
   - Ageing in air oven
   - Shrinkage test
   - Hot deformation
   - Loss of mass in air oven
   - Heat shock
   - Thermal stability
   - Carbon black content of polythene sheath
   - Bleeding and blooming test

g) Thermal ageing

h) Partial discharge test

i) Bending test
j) Dielectric power factor test
   - as a function of voltage
   - as a function of temperature
k) Insulation resistance test (volume resistivity)
l) Heating cycle test
m) Impulse withstand test
n) High voltage test
o) Flammability test
p) Tests on messenger wire as per IS:398 Part-4 (if applicable)
   - Breaking load test on finished wire
   - Elongation test
   - Resistance test

7.5.2. Acceptance Test

The following shall constitute Acceptance Tests:

a) Tensile test (for aluminum)
b) Wrapping test (for aluminum)
c) Conductor resistance test
d) Test for thickness of insulation (eccentricity) and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and sheath.
g) Partial discharge test (for screened cables only)
h) High voltage test
i) Insulation resistance (volume resistivity) test
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   - Resistance test

7.5.3. Additional Acceptance Tests for PVC Compound of Outer Sheath (if any)

a) Hot Deformation
b) Flammability

7.5.4. Routine Tests

The vendor hall have to submit, well in advance, the test certificates for the following routine test for approval prior to inspection of the materials for the complete lot offered for inspection at a time.

- Conductor resistance test
- Partial discharge test
- High-voltage test for 5 minutes [as per Clause 20.7.2 of IS: 7098 (Part-II) – 1985].

The selection of sample pieces for acceptance test shall be from 10% drums of each lot offered for inspection or part thereof. The minimum shall be one drum. Routine Tests: Routine Tests shall be carried out on each length of cable.

7.5.5. Optional Tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests

7.5.6. Testing Equipment / Meter Calibration

All testing equipment/ meter used shall be calibrated within valid time limit at NABL accredited laboratory. Calibration seals provided by the calibrating agency on testing equipment's / meters shall be in good condition.

7.6. Pre-Delivery Inspection at Manufacturer's Works

a) All acceptance Tests, length and mass verification etc shall be witnessed and certified by purchaser's representative at manufacturer's works. The vendor shall give at least 10 days advance intimation to the purchaser to enable them to depute their representative for witnessing the Tests. The said representative shall have full facilities for unrestricted inspection of supplier's works, raw materials, manufacturing processes and conducting necessary Tests.
b) The said representative shall verify the calibration seals provided by the calibrating agency on testing equipment's/ meters.
c) Test reports of routine Tests carried out by the manufacturer shall be submitted to the inspecting authority at the time of inspection for his approval.
d) Acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.
e) In case of waiver of inspection, vendor shall carry out all (i) routine and (ii) acceptance Tests and submit test reports for approval of the purchaser, before dispatch of material.
f) The entire cost of testing for acceptance & routine rests and checking of length etc shall be borne by the supplier.
g) The purchaser reserves the right to select sample from any material offered for inspection /inspected and dispatched, which will be got type tested at any NABL accredited laboratory. The results of this type-tested sample shall be applicable for the entire quantity of the particular lot offered or supplied by the supplier. The Purchaser shall bear the testing charges, if sample passes all the Tests and if sample fails in any one of the Tests, supplier shall have to bear testing charges, same are recoverable from the supplier's any pending bill, security deposit, Bank Guarantee or by any suitable means, whichever deem fit by the Purchaser. In case of sample failing in aforesaid type Tests, supplier shall have to replace the whole lot materials, which should pass through the type Tests, the re-testing charges will have to be paid by supplier. If any quantity against the particular lot is consumed by the Purchaser, the supplier will agree for any penalty/deduction in price as may be mutually agreed.

7.6.1. Verification of Length & Mass

Minimum 1 drum of every size of cables offered for inspection in each lot shall be checked for workmanship and length verification at vendors works.

If the cable is found short in length, the difference in average length thus obtained from the length declared by vendor shall be applied to all the drums.

7.7. Quality Assurance Plan & Material Quality Plan

Following quality plans shall be submitted within 30 days from the date of placement of contract:

- Quality Assurance Plan (QAP) to be adopted by manufacturer in respect of raw materials and bought out items, including source and test reports of (i) important raw materials and (ii) bought out items.
- Material Quality Plan (MQP) to be adopted by manufacturer in respect of manufacturing process.

The QAP & MQP shall be approved by the purchaser within 15 days from the receipt of compliance, if any. The vendor shall follow the approved QAP & MQP in true spirit. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that QAP & MQP are being properly followed.

7.8. Guarantee

The equipment/material shall be guaranteed for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier.

7.9. Packing & Marking

- Control cables shall be supplied in 250/ 500-meter length.
- A tolerance of +/- 5 % shall be allowed in standard length.
- All cables shall be supplied in non-returnable wooden drums, which shall comply with IS: 10418-1982, Specifications for Drums for Electric Cables.
- Cable ends shall be sealed by means of non-hygroscopic sealing material.

Following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection:

a. Manufactures name or trade mark
b. Voltage grade
c. Size of cable
d. Successive length
e. ISI mark
f. Month & year of manufacture
g. UPCL

Following information shall be marked on each drum, in indelible ink:

a. Manufacturers name or trade mark
b. Type of cable and voltage grade
c. Nominal cross-sectional area of the conductor
d. Length of cable on drum
e. Number of lengths on drum
f. Direction of rotation of drum (an arrow)
g. Approximate gross weight
h. Month & year of manufacture
i. Contract number

7.10. Engineering Data and Manual

Following information shall be furnished along with the offer.

- Leaflet giving construction details, dimensions and characteristics of cables.
- Current rating, de-rating factor due to grouping, ambient temperature etc.

Executive Engineer (Stores), UPCL will be the final authority for approving the drawings submitted by the tenderer.

7.11. Rejection and Retests

Rejection and retests shall be as per the provisions of relevant Indian Standard.

7.12. Schedule

7.12.1. Schedule – I [Guaranteed Technical Particulars (I/II) for Item: Control Cables]

(To be confirmed by the vendor)

Table 7-4: Guaranteed Technical Particulars for control cables (Part 1)

S.No.	Particulars	Confirmation
1	Cables shall be manufactured and supplied confirming to IS:1554 and UPCL specifications	
2	Cable drum shall bear ISI mark	
3	Rated voltage 1.1 kV	
4	Control Cable size	
	2.5 sq mm, 2 core	
	2.5 sq mm, 4 core	
	2.5 sq mm, 7 core	
	2.5 sq mm, 10 core	
	2.5 sq mm, 12 core	
6	Stranded conductor shall be annealed, high conductivity, un-tinned copper wire complying with IS:8130	
7	Insulation shall be PVC , Type-A applied by extrusion complying with IS:1554 (Part-I)	
8	Thickness of insulation shall be as per IS: 1554 (Part- I)	
9	Inner sheath shall be applied by extrusion	
10	Thickness of inner sheath shall be as per IS: 1554 (Part- I)	
11	Dimensions of armor wire shall be as per IS: 1554 (Part- I)	
12	Outer sheath shall be Type ST 1 PVC compound complying to IS:5831	
13	Thickness of outer sheath shall be as per IS: 1554 (Part- I)	
14	Core identification shall be as per IS: 1554 (Part- I)	
15	Colour of outer sheath shall be Black	
16	Min. volume resistivity of insulation at 27 °C, min. Ohm-cm , as per IS:5831	

S.No.	Particulars	Confirmation
17	Min. volume resistivity of insulation at 70 °C, min. Ohm-cm , as per IS:5831	
18	Max. resistance of conductor at 20 °C shall be as per IS:8130	
19	Tensile strength of insulation and sheath, as per IS:5831	
20	Elongation at break of insulation and sheath , as per IS:5831	
21	Current ratings shall be as per IS:3961 Part-2	
22	Embossing on every meter length shall be as per this specs	
23	Marking in indelible ink on each drum shall be as per this specs	
24	Standard length of conductor as per this spec	
25	Control cables shall be supplied in wooden drums complying to IS :14048	
26	Cable drums shall contain only one length	
27	Cable ends shall be sealed with non-hygroscopic material	
28	Progressive length of cable shall be marked on outer sheath for each meter length	

7.12.2. Schedule – II [Guaranteed Technical Particulars (II/II) for Item: LT PVC Cables]

(Information not covered in IS)

Table 7-5: Guaranteed Technical Particulars for control cables (Part 2)

S.No.	Item	2.5sq mm, 2 core	2.5sq mm, 4 core	2.5sq mm, 7 core	2.5sq mm, 10 core	2.5sq mm, 12 core
	Approx. weight of 1 (one) meter length of cable in kg					
	Copper					
	PVC					
	Armor					
	Total					

7.12.3. Schedule – III [Information regarding BIS license]

Table 7-6: Format for information regarding BIS license

S.No.	Particulars	Data/Information
1	Name of manufacturer and address	
2	Trade mark, if any	
3	ISI license number for IS: 1554	
4	ISI license for IS: 1554 is valid up to	

7.12.4. Schedule – IV [Information regarding manufacturing and testing facilities etc.]

(Vendor to enclose following documents and to confirm the same)

Table 7-7: Information regarding manufacturing and testing facilities

S.No.	Particulars	Confirmation
1	Type test report from NABL accredited lab (less than 5 years old as on date of opening of offer)	
2	ISI license	
3	Proof if applied for renewal of ISI license	
4	List of plant and machinery	
5	List of testing facility available	
6	List of orders pending and executed (specifying order date and quantity)	
	With UPCL	
	With other agencies, other than 6.A	

8. Technical Specifications for Clamps and Connectors

8.1. Scope

This specification cover, design, manufacture, testing, supply delivery at site of the terminal Connectors and Clamps. All clamps and connectors shall be suitable as per application of Al. pipe bus of different sizes suitable for ACSR Moose Conductor, Panther Conductor, Zebra Conductor, Dog Conductor, Wolf Conductor and Rabbit Conductor etc.

8.2. Standards Applicable

Unless specified elsewhere in this specification, the performance & testing of the meters should conform to the following Indian/International standards, to be read with up to date and latest amendments/revisions thereof as on 90 days prior to floating of tender.

Table 8-1 Standards Applicable

S. No.	Standard No.	Title
1	IS – 5561	Electric Power Connectors
2	IS-2121 Part I & II	Conductor and earth wire accessories for overhead line.
3	IS-2633	Method for testing weight, thickness and uniformity of coating on hot dipped galvanized articles.
4	IS-5082	Wrought Aluminum and Aluminum Alloy section for electrical purpose.
5	IS-1285	Wrought Aluminum and Aluminum Alloy Round Tube and hollow sections.
6	IS - 617	Aluminum and aluminum alloy ingots and casting for general engineering purpose.

8.3. Specific Technical Parameters

Table 8-2 Technial parameters

S. No.	Description	Technical Parameter (33 kV)
(i)	Rated voltage of the system (kV)	33 kV
(ii)	Rated Short time current (kA for 3 Secs.)	25 for 3 sec

S. No.	Description	Technical Parameter (33 kV)
(iii)	Rated Current (Amp)	400 Amps for 25 to 120 mm2 800 Amps upto 300 mm2
(iv)	Current density of Al. /Copper (A/Sq. mm.)	0.75 / 1.75
(v)	Type of Clamps & connectors	Made from cold forged Al. Alloy plate i.e. Extruded Al. Compression / Bolted or both as per technical specification and requirement.
(vi)	Minimum thickness of bimetal in bimetallic connections	2 mm

8.4. Deviation and Modification from Technical Specification

Normally the offer should be as per Technical Specification without any deviation.

If any modification felt necessary to improve performance, efficiency and utility of equipment, the same must be mentioned in the 'Modification schedule' with reasons duly supported by documentary evidences and advantages. Such modifications suggested may or may not be accepted, but the same must be submitted along with Pre-Bid Queries. The modifications not mentioned in Schedule will not be considered

8.5. Design Criteria of Clamps & Connectors

Clamps and connectors shall be made from cold forged Aluminum Alloy plate i.e. Extruded Aluminum Clamps and Connectors shall be processed through Cold forging of Aluminum Alloy.

The Nuts and Bolts associated with equipment of Connector pieces shall be of MS Hot dip Galvanized, Quality of nuts and bolts shall conform to relevant IS of latest edition.

Minimum thickness at any point of current carrying part of any clamp and connector shall not be less than 20 mm.

Bidder has to submit detail calculation in support of withstanding of continuous current rating of connector as well as short circuit current withstand for specified duration as mentioned under general specification without increase of temperature beyond allowable limit as per relevant IS.

The clamps and connectors shall be of best quality and workmanship, free from blowholes, cracks, cavities, surface blisters, claws and any other defect which may effect the performance of the clamp.

Wherever connector will bridge Aluminum & Copper for bimetallic clamps, pure copper with tin coated liner having minimum thickness of 2 mm. shall be used.

The connectors shall be designed Corona free. The voltage gradient at any corner surface shall be at a level that will not cause any resultant radio interference.

Flexible connectors shall be made from all aluminum conductors having suitable current rating.

All connectors or its components to be connected with ACSR conductor shall be of compression type having Aluminum purity not less than 99.0%.

All clamps and connectors shall be made from cold forged Aluminum plate i.e. extruded Aluminum having purity of Aluminum not less than 97.5%.

From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

Sharp Corners and edges shall be rounded off.

The connectors are to be designed to prevent accumulation of moisture and can withstand the corrosive atmosphere condition.

The connector shall be mechanically strong so that it can withstand loads imposed during erection, normal service, electro-mechanical force due to temperature variation and short circuit condition.

The bolts shall be so located that pressure is properly distributed from the bolts over the entire contact surface.

The current density of Aluminum / copper shall be considered as 0.75 / 1.75 A / sq. mm.

The normal rated continuous current of clamps and connectors shall be selected as per point of application, use of type of conductors/Aluminum tube and also the stipulation of Clause No. 12.1 (a), (b) & (c) of IS : 5561 which are stated below:

(i) Equipment Connectors – The values of current shall be selected on the basis of the rating of the equipment to which the connector is connected or on the basis of the rating of the conductor for which the opening is designed as per current ratings in clause 1.3, whichever is smaller.

(ii) Junction Connectors – The values of current shall be selected on the basis of the conductor which has the lower current carrying value where the openings are of two sizes and on the basis of the conductor as per Current ratings in clause 1.3 which is common to both openings where the openings are of the same size.

(iii) 'T' Connectors – The values of current shall be selected on the basis of the full rated current in the tap conductor.

The rated frequency of connector shall be 50 HZ.

Rated short time current shall be as laid in the general specification.

The temperature rise of connector above an ambient temp. of 50oC when carrying rated continuous current shall not exceed 35oC.

Power connector shall be so designed and proportioned that they are capable of safely withstanding stresses to which they may be subjected (including those due to short-circuit and climatic condition) and that the effect of vibration both on the conductor and the connector itself are minimized. They shall be designed, manufactured and finished so as to avoid sharp radii of curvature, ridges and excrescences which might lead to localised pressure on or damage to the conductor in service.

Sufficient contact pressure should be maintained at the joint by the provision of the required number of bolts or other fixing arrangement. But the contact pressure should not be so great as to cause relaxation of the joint. The joint should be such that the pressure is maintained within the range under all conditions of service. To avoid excessive local pressure, the contact pressure should be evenly distributed by the use of pressure plates, washers or suitable saddles of adequate area and thickness.

All connector should be so designed and manufactured so as to offer ease of installation, as these are to be in overhead installation.

The connectors shall be indelibly marked with rated current or any identifying mark to enable full particulars of the connector to be obtained.

The electric power connector may also be marked with the ISI Certification Mark.

All the clamps and connectors to be supplied along with all equipment i.e. Breaker, C.T., P.T. Earthing Transformer., L.A., CVT, Isolator, Stn. Service Transformer etc. shall be guided by this technical specification.

8.6. Guarantee

Electrical characteristics shall be guaranteed by the bidder. In case of failure of materials to meet the guarantee, UPCL shall have right to reject the material. Guaranteed Technical Particulars are to be submitted by successful bidder during detailed engineering along with submitted drawings/documents. However, format for submission of GTP shall be handed over to intending bidders at the time of sale of tender documents.

8.7. Type tests

Only type tested Clamps and Connectors are to be offered conforming to our technical specification, and relevant IS and IEC. Clamps and Connectors offered should be similar with ones on which type testing has been carried out as per relevant IS and IEC. Three sets of complete type test reports carried out in Govt. recognized Test House or Laboratory /NABL accredited laboratory shall have to be submitted by successful bidder positively along with submission of drawings during detailed Engineering. The submitted type test report shall proof that the type test have been carried out within five years from the date of submission of bid. Successful bidder may require to produce original copies of type test reports at the time of detail engineering if asked by UPCL.

Each type test report shall comply the following information with test result

i. Compete identification, date and serial no.
ii. Method of application, where applied, duration and interpretation of each test.
iii. Relevant drawings as documented with test report.

8.7.1. Test at Manufacturer's works and Test certificates

Bidders shall have adequate testing facilities at their works to conduct all acceptance and routine tests as stipulated below as per relevant IS in presence of engineers of UPCL.

Acceptance Test for Clamps &Connectors

i. Tensile test
ii. Resistance test
iii. Dimensional check
iv. Galvanizing test

8.7.2. Routine Tests for clamps and connectors.

All routine tests at manufacturer's works shall be carried out for each clamp & connectors as per stipulation of relevant IS and test reports are to be submitted.

All routine tests at manufacturer's works shall be carried out for each equipotential Ring as per stipulation of relevant IS and test reports are to be submitted.

All acceptance tests are to be carried out in presence of representatives of UPCL on clamps & connectors at manufacturer's works on every lot offered for inspection.

Three (3) copies of routine and acceptance test results shall be submitted to the Executive Engineer, Stores, UPCL, Dehradun for approval & distribution. The contractor shall give at least 15 (fifteen) days advance notice to the Executive Engineer, Stores, UPCL, Dehradun, intimating the actual date of inspection and details of all tests that are to be carried out.

The entire cost of acceptance and routine tests that are to be carried out as per relevant IS shall be treated as included in the quoted price of Clamps and Connectors.

8.8. Contract Drawings Manuals

In the event of placement of Letter of Award, contractor shall submit drawings and manuals in six (6) copies to the Executive Engineer, Stores, UPCL, Dehradun for approval.

8.9. Schedules

8.9.1. Schedule – I [Guaranteed Technical Particulars of Clamps and Connectors]

S. No.	Description	Parameters for 33 kV
I	**General Parameters**	
A	Name of Manufacturer	
B	Location of Factory	
C	Conforming Standard	
D	Material	
E	Type of clamps and connector (conventional or compression or both)	
F	Thickness of Connectors (mm)	
G	Minimum thickness of bimetallic element (mm)	
H	Temperature rise at full load and above 50oC ambient (oC)	
I	Tensile strength (Kgf)	
II	**Electrical Parameters**	
A	Designed rated current (A)	
B	Designed short time current (KArms for 3 sec.)	

S. No.	Description	Parameters for 33 kV
C	Composition of aluminium alloy in percentage	
D	Current density (A/Sq.mm)	
D. i	Aluminium	
D. ii	Copper	
E	Corona Extinction voltage (kVrms)	
F	Electrical conductivity	
G	Magnetic power loss	
H	Radio Interference voltage (microV)	

9. Technical Specification for Steel Tubular Poles SP-10, SP-21, SP-23, SP-33, SP-55 & SP-72 Swaged Type

9.1. Scope

This specification covers the design, manufacture, testing, and transportation of Steel Tubular poles for use of Electricity distribution in urban and rural areas. These should be basically confirming to REC standard.

The manufacturer can only quote against this enquiry and shall have proven experience of 3 years of manufacturing of similar products and supplying to electrical utilities.

9.2. Service Conditions

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

Table 9-1Tropical Conditions for Continuous Operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

9.3. Applicable standards

Except when they conflict with specific requirements in this Specification, the poles shall comply with the relevant provisions made in the following Indian Standards or the latest versions thereof.

The tubular steel poles shall conform to the latest edition of Indian Standard specification IS: 2713 (Part – I, III) : 1980 or any other authoritative standards (as amended up-to- date) except where specified otherwise in this specification.

9.4. Terminology

For the purpose of this standard, the following definitions shall apply.

9.4.1. Average Permanent Load

That fraction of the working load which may be considered of long duration over a period of one year.

9.4.2. Load Factor

The ratio of ultimate transverse load to the transverse load at first crack.

9.4.3. Transverse

The direction of the line bisecting the angle contained by the conductor at the pole. In the case of a straight run, this will be normal to the run of the line.

9.4.4. Transverse Load at First Crack

For design, the transverse load at first crack shall be taken as not less than the value of the
Working load

9.4.5. Working Load

The maximum load in the transverse direction, that is ever likely to occur, including the wind pressure on the pole. This load is assumed to act at a point 600mm below the top with the butt end of the pole planted to the required depth as intended in the design.

9.4.6. Ultimate Failure

The condition existing when the pole ceases to sustain a load increment owing to either crushing of concrete, or snapping of the pre-stressing tendon or permanent stretching of the steel in any part of the pole.

9.4.7. Ultimate Transverse Load

The load at which failure occurs, when it is applied at a point 600 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

9.5. Material

The materials used in construction of tubular steel poles shall be of the tested quality of steels of minimum tensile strength 540 MPa (: 55 Kgf/mm2). The materials, when analyzed in accordance with IS : 228 (Part-III : 1972) and IS : 228 (Part-IX) shall not show Sulphur and phosphorous contents of more than 0.060 percent each.

9.6. Design requirements

The poles shall be designed for the following requirements:

a) Tubular Steel Poles shall be swaged type.
b) Swaged poles shall be made of seamless or welded tubes of suitable lengths swaged and jointed

together. No circumferential joints shall be permitted in the individual tube lengths of the poles. If welded tubes are used they shall have one longitudinal weld seam only: and the longitudinal welds shall be staggered at each swaged joint.

c) Swaging may be done by any mechanical process. The upper edge of each joint shall be chamfered if at an angle of about 45°. The upper edge need not be chamfered if a circumferential weld is to be deposited in accordance with clause No. 5.3 2 of IS: 2713 (Part-I) :1980.

d) The length of joints on swaged poles shall be in accordance with clause No. 5.4 of IS: 2713 (Par-I): 1980.

e) Poles shall be well-finished, clean and free from harmful surface defects. Ends of the poles shall be cut square. Poles shall be straight, smooth and culindrical. The weld joints, if any, shall be of good quality, free from scale, surface defects, cracks, etc.

f) Tolerances for outside diameter, thickness, length, weight and straightness shall be in accordance with IS: 2713 (Part-I) : 1980.

g) The poles shall be coated with black bituminous paint conforming to IS : 158-1968 throughout, internally and externally, upto the level which goes inside the earth. The remaining portion of the exterior shall be painted with one coat of red oxide primer as specified in IS: 2074-1979.

9.6.1. Dimensions and Reinforcements

The cross-sectional dimensions and the details of pre-stressing wires should conform to REC standards. The provisions of holes for fixing cross-arms and other fixtures also should conform to the REC standards and in accordance with the construction practices adopted by the State Electricity Boards.

9.7. Manufacture

Poles shall be made of steel tubes having minimum tensile strength 42 Kg. / mm2 and minimum percentage elongation is as specified in IS:1161-1979. The pole shall be made in three sections of dimensions as detailed in specified technical particulars annexed hereto. The tubes used should be made by ERW process. The tube should be swaged jointed to form the desired pole to give a strong joint which should withstand all the tests as per ISS without any circumferential welding. The circumferential weld is only to be done after carrying out all the tests, no circumferential joints shall be permitted in the individual tube length of poles. The poles shall be coated with bituminous paints internally and externally up to the level which goes inside the earth and the remaining portion of exterior shall be painted with one coat of red oxide primer as specified in IS:2713/1980, with amendments thereof if any.

Bottom portion of the pole shall be galvanized as per IS; 4736/1986 and latest amendments thereof. Minimum Zinc coating shall be 360gsm per sq. mt. Zinc thickness shall be minimum 51 microns.

9.7.1. Earthing

For earthing arrangement, a through hole of 14mm diameter shall be provided in each pole at a height of 300mm above the planting depth.

9.8. Tests and Manufacturing facilities

The following tests shall be conducted on finished poles:

a) Tensile test and chemical analysis for Sulphur and phosphorous.
b) Deflocation test.

c) Permanent set test.
d) Drop test.

In addition to above verification of dimensions as per IS : 2713 (Part-III) : 1980 shall be carried out during acceptance lots. Tests shall be carried out before supply of each consignment at the manufacturers woks and test certificates should be submitted to the purchaser for approval prior to delivery. Purchaser reserves the right to inspect during manufacturing and depute his representative to inspect/test at the works.

9.9. Sampling and inspection

9.9.1. Scale of Sampling

Lot: In any batch, all poles of the same class and same dimensions shall be grouped together to constitute a lot.

Sub-lot: If the number of poles in a lot exceeds 500, the lot shall be divided into a suitable number of sub lots such that the number of poles in any sub-lot shall not exceed 500. The acceptance or otherwise of sub-lot shall be determined on the basis of performance of samples selected from it.

The number of poles to be selected from a lot or a sublot shall depend upon its size and shall be in accordance with Col. 1 and 2 of the following table:

Table 9-2 No. of Poles to be Tested

SAMPLE SIZE AND CRITERION FOR CONFORMITY			
Size of lot or sub-lot	Dimensional Requirement		No. of poles for transverse strength test
	Sample size	Permissible No. of defective samples	
1	2	3	4
Upto 100	10	1	*
101-200	15	1	3
201-300	20	2	4
301-400	30	3	5

*The no. of poles to be tested shall be subject to the agreement between employer & manufacture.

These poles shall be selected at random. In order to ensure randomness, all the poles in the lot or the sub-lot may be arranged in a serial order and starting from any random pole, every r^{th} pole may be included in the sample, r being the integral part of N/n where N is size of the lot or the sub-lot and n is the sample size

9.10. Marking

Firm will forge / engrave the words "UPCL", Name of Manufacturer & Year of Manufacture on each pole at the height of 2.5 meter from the bottom. Engravation of letter should be very clear and should be readable at least from the distance of two meters and size of each letter should be approximately 1"x1" each.

9.11. Principal Technical Particulars

Table 9-3: Principal Technical Particulars: Steel Tubular Poles

Sl. No.	Technical Particulars	8Meter Long Steel Tubular Pole (SP – 10)	8.5Meter Long Steel Tubular Pole (SP – 21)	8.5Meter Long Steel Tubular Pole (SP – 23)	9Meter Long Steel Tubular Pole (SP – 33)	11Meter Long Steel Tubular Pole (SP –55)	13Meter Long Steel Tubular Pole (SP –72)
1	Type of pole	Swaged type	Swaged type	Swaged type	Swaged type	Swaged type	Swaged type
2	Total length	8Meter	8.5Meter	8.5Meter	9Meter	11Meter	13Meter
3	Outside diameter and Thickness of section (Both in mm)						
	(i) Bottom (Hot dip galvanized)	114.3 x 3.65	139.7 x 5.4	165.1 x 4.85	165.1 x 5.40	193.7 x 4.85	219.1 x 5.90mm
	(ii) Middle	88.9 x 3.25	114.3 x 4.50	139.7 x 4.50	139.7 x 4.50	165.1 x 4.50	193.7x4.85mm
	(iii) Top	76.1x 3.25	88.9x 3.25	114.3x 3.65	114.3x 3.65	139.7x 4.50	165.1x4.50mm
4	Bottom Portion of the pole shall be galvanized as per IS 4736/1986 and latest amendments thereof. Minimum zinc coating shall be 360gms per. Sq.mtr. Zinc thickness shall be minimum 51 microns.						
5	Length of section						
	(i) Bottom (Hot dip galvanized)	4.50 Meter	5.0 Meter	5.0 Meter	5.0 Meter	5.60 Meter	5.8 Meter
	(ii) Middle	1.75 Meter	1.75 Meter	1.75 Meter	2.0 Meter	2.70 Meter	3.6 Meter
	(iii) Top	1.75 Meter	1.75 Meter	1.75 Meter	2.0 Meter	2.70 Meter	3.6 Meter
6	Minimum weight of pole (without top cover)	70 Kg.	129 Kg.	148 Kg.	164 Kg.	227 Kg.	343 Kg.

Sl. No.	Technical Particulars	8Meter Long Steel Tubular Pole (SP – 10)	8.5Meter Long Steel Tubular Pole (SP – 21)	8.5Meter Long Steel Tubular Pole (SP – 23)	9Meter Long Steel Tubular Pole (SP – 33)	11Meter Long Steel Tubular Pole (SP –55)	13Meter Long Steel Tubular Pole (SP –72)
7	Breaking load	≥ 230 Kg. f	≥ 462Kg. f	≥ 596 Kg. f	≥ 612 Kg. f	≥ 650 Kg. f	≥ 828Kg. f
8	Crippling load	≥ 163 Kg. f	≥ 328 Kg. f	≥ 423 Kg. f	≥ 435 Kg. f	≥ 462 Kg. f	≥ 288 Kg. f
9	Max. Permissible working Load with F.O.S. of 1.5 on Crippling load with point of application of load at 0.6 Mtr. from top of pole	≥ 109 Kg. f	≥ 219 Kg. f	≥ 282 Kg. f	≥ 290 Kg. f	≥ 308 Kg. f	≥ 392Kg. f
10	Minimum tensile strength of steel used in manufacturing of poles	≥42 Kg. f/ mm^2	≥42 Kg. f/ mm^2	≥42 Kg. f/ mm^2	≥42 Kg. f/ mm^2	≥42 Kg. f/ mm^2	≥42 Kg. f/ mm^2

10. Technical Specification for Pre-Stressed Concrete Poles 9 M // 450 kg

10.1. Scope

This specification covers solid Rectangular poles and Vierendeel type PSC Poles of 9.0 m suitable for use in overhead 11 kV and LT power lines.

10.2. Service Conditions

The material to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

Table 10-1: Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

10.3. Applicable standards

Except when they conflict with specific requirements in this Specification, the poles shall comply with the relevant provisions made in the following Indian Standards or the latest versions thereof.

a) IS: 1678-1978, Specification for pre stressed concrete poles for overhead power, traction and telecommunication lines.
b) IS: 2905-1966. Methodsof test for concrete poles for overhead power and telecommunication lines.
c) IS: 7321-1974. Code of Practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.

10.4. Terminology

For the purpose of this standard, the following definitions shall apply.

10.4.1. Average Permanent Load

That fraction of the working load which may be considered of long duration over a period of one year.

10.4.2. Load Factor

The ratio of ultimate transverse load to the transverse load at first crack.

10.4.3. Transverse

The direction of the line bisecting the angle contained by the conductor at the pole. In the case of a straight run, this will be normal to the run of the line.

10.4.4. Transverse Load at First Crack

For design, the transverse load at first crack shall be taken as not less than the value of the Working load

10.4.5. Working Load

The maximum load in the transverse direction, that is ever likely to occur, including the wind pressure on the pole. This load is assumed to act at a point 600mm below the top with the butt end of the pole planted to the required depth as intended in the design.

10.4.6. Ultimate Failure

The condition existing when the pole ceases to sustain a load increment owing to either crushing of concrete, or snapping of the pre-stressing tendon or permanent stretching of the steel in any part of the pole.

10.4.7. Ultimate Transverse Load

The load at which failure occurs, when it is applied at a point 600 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

10.5. Application

These poles shall be used for 11 kV and LT overhead lines using conductor formation and clearances as per REC Construction Standard M-3. The requirement of working loads of the poles in different wind pressure zones would be as per REC Construction Standard M-2, which is reproduced below.

Table 10-2Requirement of Working load of poles for different wind pressures

Working load of Pole	Zone
400 kg	100 kg/ m2

The maximum permissible spans shall be as per REC Construction Standard.

10.6. Material

10.6.1. Cement

The cement used in the manufacture of pre-stressed concrete poles shall be ordinary or rapid hardening portland cement conforming to IS : 269-1976 (Specification for ordinary and low heat portland cement) or IS : 8041 E-1978 (Specification for rapid hardening portland cement), or high strength ordinary portland cement conforming to IS : 8112-1976 (Specification for high strength ordinary portland cement).

10.6.2. Aggregates

Aggregates used for the manufacture of pre stressed concrete poles shall confirm to IS: 383-1970 (Specification for coarse and fine aggregates from natural sources for concrete).The nominal maximum size of aggregates shall in no case exceed 10 mm.

10.6.3. Water

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

10.6.4. Admixture

Admixtures should notcontain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel.

10.6.5. Pre-stressing steel

The pre-stressing steel wires, including those used as un-tensioned wires, should conform to IS : 1785(Part-I)-1983 (Specification for plain hard-drawn steel wire for pre stressed concrete, Part- I cold drawn stress relieved wire) IS:6003-1983 (Specification for indented wire for pre stressed concrete) or the latest versions thereof.

10.6.6. Concrete Mix

The concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS: 1343-1980 (Code of practice for pre-stressed concrete) and IS: 456-1978 (Code of practice for plain and reinforced concrete), subject to the following special conditions:

a) Maximum works cube strength at 28 days should be at least 420 kg/cm2.
b) The concrete strength at transfer should be at least 210 kg/cm2.
c) The mix should contain at least 380 kg of cement per cubic meter of concrete.
d) The mix should contain as low water content as is consistent with adequate workability. If it becomes necessary to add water to increase the workability, the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

10.7. Design requirements

The poles shall be designed for the following requirements:

a) The poles shall be planted directly in the ground with a planting depth as per IS: 1678-19.
b) The working load on the poles should correspond to those that are likely to come on the pole during their service life.
c) The factor of safety for all these poles shall not be less than 2.5.
d) The average permanent load shall be 40% of the working load.
e) The F.O.S. against first crack load shall be 1.0.

f) At average permanent load, permissible tensile stress in concrete shall be 30 kg/cm2.
g) At the design value of first crack load, the modulus of rupture shall not exceed 53.0 kg/cm2 for M-40 concrete.
h) The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.
i) The maximum compressive stress in concrete at the time of transfer of pre stress should not exceed 0.8 times the cube strength.
j) The concrete strength at transfer shall not be less than half the 28 days strength ensured in the design, i.e. 400 x 0.5 = 200 kg/cm2.

10.7.1. Dimensions and Reinforcements

The cross-sectional dimensions and the details of pre stressing wires should conform to REC standards. The provisions of holes for fixing cross-arms and other fixtures also should conform to the REC standards and in accordance with the construction practices adopted by the State Electricity Boards.

10.8. Manufacture

All prestressing wires and reinforcements shall be accurately fixed as shown in drawings and maintained in position during manufacture. The untensioned reinforcement, as indicated in the drawings, should be held in position by the use of stirrups which should go round all the wires.
All wires shall be accurately stretched with uniform prestress in each wire. Each wire or a group of wires shall be anchored positively during casing. Care should be taken to see that the anchorages do not yield before the concrete attains the necessary strength.

10.8.1. Cover

The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

10.8.2. Welding and Lapping of Steel

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, jointing or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

10.8.3. Compacting

Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compaction shall not be permitted.

10.8.4. Curing

a) The concrete shall be covered with a layer of sacking, canvass, hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of prestress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit, the interval should depend on the atmospheric humidity and temperature.
b) The prestressing wires shall be detensioned only after the concrete has attained the specified strength at transfer (i.e. 200 kg/cm2). The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible, under conditions similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as

detailed in IS: 1343-1980 (Code of practice for pre-stressed concrete). The manufacturer shall supply, when required by the employer or his representative, result of compressive test conducted in accordance with IS: 456-1978 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the employer so desires, the manufacturer shall supply cubes for test purposes and such cubes shall be tested in accordance with IS: 456-1978 (Code of practice for plain and reinforced concrete).

c) The detensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of detensioning may be controlled by any suitable means either mechanical (screw type) or hydraulic. The poles shall not be detensioned or released by cutting the pre-stressing wires using flames or bar croppers while the wires are still under tension.
d) Separate eye-hooks or holes shall be provided for handling the transport, one each at a distance of 0.15 times the overall length, from either end of the pole. Eye-hooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section. Holes, if provided for lifting purposes, should be perpendicular to the broad face of the pole.
e) Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleepers located as 0.15 times the overall length, measured from the end. The timber supported in the stack should be aligned in a vertical line.
f) Poles should be transported with their broad faces placed vertically and in such a manner that shocks are avoided. Supports should be so arranged that they are located approximately at a distance equal to 0.15 times the overall length from the ends. The erection of the pole should be carried out in such a way that the erection loads are applied so as to cause moment with respect to the major axis, i.e. the rope used for hoisting the pole should be parallel to the broader face of the pole.

10.8.5. Earthing

Earthing shall be provided by having length of 8 SWG GI wire embedded in concrete during manufacture and the ends of the wires left projecting from the pole to a length of 100mm at 250 mm from top and 150 mm below ground level.
Earth wire shall not be allowed to come in contact with the pre stressing wires. The possible location of earth wire for different varieties of poles has been shown in Drawing Nos. 1 to 8.

10.9. Tests

10.9.1. Transverse Strength Test

Poles made from ordinary portland cement shall be tested only on the completion of 28 days and poles made from rapid hardening cement only on the completion of 14 days, after the day of manufacture.

The poles may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole, for this purpose, the overhanging portion of the pole may be supported on a movable trolley or similar device.

The pole shall be rigidly supported at the butt end for a distance equal to the agreed depth of planting. Load shall be applied at a point 600 mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load at first crack. The deflection at this load shall be measured.

A pre-stressed concrete pole shall be deemed not to have passed the test if visible cracks appear at a stage prior to the application of the design transverse load for the first crack. The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load, and

held up for 2 minutes. This procedure shall be repeated until the load reaches the value of 80 per cent of the minimum ultimate transverse load and thereafter increased by 5 per cent of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to pre-stressed concrete pole at the point of failure shall be measured to the nearest five Kilograms. The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.

10.9.2. Measurement of Cover

After completion of the transverse strength test, the sample pole shall be taken and checked for cover. The cover of the pole shall be measured at 3 points, one within 1.8 meter from the butt end of the pole, the second within 0.6 meters from the top and the third at an intermediate point and the mean value compared with the specified value.

The mean value of the measured cover should not differ by more than (±) 1mm from the specified cover. The individual values should not differ by more than (±) 3mm from the specified value. If these requirements are not met, the workmanship with reference to aligning of the end plates and prestressing wires and assembly of moulds should be improved and inspection at pre-production stage tightened suitably.

10.10. Sampling and inspection

10.10.1. Scale of Sampling

Lot: In any batch, all poles of the same class and same dimensions shall be grouped together to constitute a lot.

Sub-lot:If the number of poles in a lot exceeds 500, the lot shall be divided into a suitable number of sub lots such that the number of poles in any sub-lot shall not exceed 500. The acceptance or otherwise of sub-lot shall be determined on the basis of performance of samples selected from it.

The number of poles to be selected from a lot or a sublot shall depend upon its size and shall be in accordance with Col. 1 and 2 of the following table.

Table 10-3No of poles to be selected

SAMPLE SIZE AND CRITERION FOR CONFORMITY Clause 3.9.1.2, 3.9.2.2 & 3.9.3.2			
Size of lot or sub-lot	**Dimensional Requirement**		**No. of poles for transverse strength test**
	Sample size	Permissible No. of defective samples	
Upto 100	10	1	*
101-200	15	1	3
201-300	20	2	4
301-400	30	3	5

*The no. of poles to be tested shall be subject to the agreement between employer & manufacture.

These poles shall be selected at random. In order to ensure randomness, all the poles in the lot or the sub-lot may be arranged in a serial order and starting from any random pole, every r^{th} pole may be included in the sample, r being the integral part of N/n where N is size of the lot or the sub-lot and n is the sample size

10.10.2. Number of Tests

All the poles as selected in 3.9.2 shall be tested for overall length, cross-section and uprightness. The tolerance shall (±) 3 mm on cross sectional dimensions and 0.5 percent on uprightness.

The number of poles to be tested for transverse strength test shall be in accordance with Col. 4 of the above table. These poles may be selected from these already tested in 3.9.2.1

10.10.3. Criteria for Conformity

A lot or sub-lot shall be considered as conforming to this specification if the conditions under 3.9.3.2 and 3.9.3.3 are satisfied.

The number of poles which does not satisfy the requirements of overall length, cross-section and uprightness shall not exceed the corresponding number given in Col. 3 of Table above. If the number of such poles exceeds the corresponding number, all poles in the lot or sub-lot shall be tested for these requirements and those not satisfying the requirements shall be rejected.

All the poles tested for transverse strength test shall satisfy the requirements of the test. If one or more poles fail, twice the number of poles originally tested shall be selected from those already selected and subjected to the test. If there is no failure among these poles, the lot or the sub-lot shall be considered to have satisfied the requirements of this test.

10.11. Marking

The pole shall be clearly and indelibly marked with the following particulars either during or after manufacture but before testing at a position so as to be easily read after erection in position:

a) Month and year of manufacture
b) Transverse strength of pole in Kg.

11. Technical Specification for Pre-Stressed Concrete Poles 8.5 M // 425 kg

11.1. Scope

This specification covers solid Rectangular poles and Vierendeel type PSC Poles of 8.5 m suitable for use in overhead 11 kV and LT power lines.

11.2. Service Conditions

The material to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

Table 11-1Tropical conditions for continuous operation

S.No.	Particulars	Value
1	Maximum ambient temperature (Deg. Celsius)	50
2	Minimum temperature (Deg. Celsius)	-5
3	Relative humidity range (%)	10 to 100
4	Maximum annual rainfall (mm)	1500
5	Maximum wind pressure (kg/sq m)	195
6	Wind Speed Zones (m/s)	47 & 39
7	Maximum altitude above mean sea level (m)	3000
8	Isoceraunic level (days/year)	50
9	Seismic level (Horizontal acceleration) (g)	0.13

11.3. Applicable standards

Except when they conflict with specific requirements in this Specification, the poles shall comply with the relevant provisions made in the following Indian Standards or the latest versions thereof.

a) IS: 1678-1998, Specification for pre stressed concrete poles for overhead power, traction and telecommunication lines.
b) IS: 2905-1966. Methods of testfor concrete poles for overhead power and telecommunication lines.
c) IS: 7321-1974. Code of Practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.

11.4. Terminology

For the purpose of this standard, the following definitions shall apply.

11.4.1. Average Permanent Load

That fraction of the working load which may be considered of long duration over a period of one year.

11.4.2. Load Factor

The ratio of ultimate transverse load to the transverse load at first crack.

11.4.3. Transverse

The direction of the line bisecting the angle contained by the conductor at the pole. In the case of a straight run, this will be normal to the run of the line.

11.4.4. Transverse Load at First Crack

For design, the transverse load at first crack shall be taken as not less than the value of the
Working load

11.4.5. Working Load

The maximum load in the transverse direction, that is ever likely to occur, including the wind pressure on the pole. This load is assumed to act at a point 600mm below the top with the butt end of the pole planted to the required depth as intended in the design.

11.4.6. Ultimate Failure

The condition existing when the pole ceases to sustain a load increment owing to either crushing of concrete, or snapping of the pre-stressing tendon or permanent stretching of the steel in any part of the pole.

11.4.7. Ultimate Transverse Load

The load at which failure occurs, when it is applied at a point 300 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

11.5. Application

These poles shall be used for 11 kV and LT overhead lines using conductor formation and clearances as per REC Construction Standard M-3. The requirement of working loads of the poles in different wind pressure zones would be as per REC Construction Standard M-2, which is reproduced below.

Table 11-2Requirement of Working load of poles for different wind pressures

Working load of Pole	Zone
180 kg	100 kg/ m2

11.6. Material

11.6.1. Cement

The cement used in the manufacture of pre-stressed concrete poles shall be ordinary or rapid hardening portland cement conforming to IS:455 but with not more than 50% slag or IS : 8041 E-1978 (Specification for rapid hardening portland cement), or high strength ordinary portland cement conforming to IS : 8112-1976

(Specification for high strength ordinary portland cement) or 53 Grade ordinary Portland cement conforming to IS:12269.

11.6.2. Aggregates

Aggregates used for the manufacture of pre stressed concrete poles shall confirm to IS:383-1970 (Specification for coarse and fine aggregates from natural sources for concrete).The nominal maximum size of aggregates shall in no case exceed 10 mm.

11.6.3. Water

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

11.6.4. Admixture

Admixtures should notcontain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel.

11.6.5. Pre-stressing steel

The pre-stressing steel wires, including those used as un-tensioned wires, should conform to IS : 1785(Part-I)-1983 (Specification for plain hard-drawn steel wire for pre stressed concrete, Part- I cold drawn stress relieved wire) IS:6003-1983 (Specification for indented wire for pre stressed concrete) or the latest versions thereof.

11.6.6. Concrete Mix

The concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS: 1343-1980 (Code of practice for pre-stressed concrete) and IS: 456-1978 (Code of practice for plain and reinforced concrete), subject to the following special conditions:

(a) Minimum work cube strength at 28 days shall not be less than 440 kg/cm^2 in accordance with acceptability criteria given in Table V clause 5.2.2.1 and 5.4.2 of IS:456;1960.

(b) The mix shall contain as low a water –cement ratio as is consistent with adequate workability.

(c) The concrete shall be compacted thoroughly by vibration, pressure, shock, or other means and shall have a density of not less than 2.4 MT/cm^3 .

(d) The cube strength of concrete at transfer of prestress shall not be less than 245 Kg/cm^2.

(e) The supplier shall be required to maintain a register showing the test results of cubes at the age of 28 days and at the transfer of prestress. For strength test, the cubes shall be taken for each days casting. The register will show the serial number and the pole cast that day for which the test will apply. The acceptability criteria will be as per columns II of table V, Para 5.2.2.1 and 5.4.2 of IS:456. The register shall be opened for inspection with the authorized representative of the Corporation.

11.7. Design requirements

The poles shall be designed for the following requirements:

a) The poles shall be so designed that they do not fail owing to failure initiated by Compression in concrete. Maximum wind pressure to be assumed may be determined as specified in IS: 875(Part-3).
b) The pole shall be 8.5 M long and should be designed for an ultimate load of 450 Kg. acting at 300 mm below top. The dimensions, reinforcement etc. required to be provided may be shown in drawing.
c) The strength of the pole in longitudinal direction of the line will be at least one quarter of the strength in transverse direction.
d) The G.I. Wire, no. 8 SWG, which shall be in one continuous length shall be embedded in the pole for earthing purpose. No joint of any kind in this wire shall be permitted. The position and details of connection to be provided at the end of earth wire have been shown in the enclosed drawing. Two nos. galvanized bolts with two nuts and 3 washers with each bolt are to be supplied by the manufacturer. The details of bolts, nut and washers are shown in the drawing.
e) The position and diameter of the holes to be provided in the poles are also shown in the enclosed drawing and shall be centrally located and will be perpendicular to the face of the pole.
f) The load factor on transverse strength shall not be less than 2.5.
g) The poles shall be designed to be suitable for fitting stays and clamps.
h) Eye hooks shall be provided for lifting of poles. The poles should be strong for lifting and erection in any direction during handling and transport. During erection of poles, poles are laid on the ground and lifted at some point near the end, similarly while loading and unloading the poles from carriers they are lifted at one end resting on the ground and pushed on to the truck's trailers. The poles should be able to withstand all such manual handlings.

11.7.1. Transverse strength and Failure

The poles shall be so designed that the strength in transverse direction shall be sufficient to take the load due to wind on wires and poles, multiplied by load factor.

11.8. Manufacture

The tensioning of prestressing tendons shall be carried out in a manner that will induce a smooth and even rate of increase of stress in the tendons.

a) The force induced in the prestressing tendon shall be determined by suitable means attached to the tensioning apparatus. It is essential that the method used to determine the initial prestress in the wire gives accurate result. Each wire shall be uniform. Care must be taken to ensure that anchorage do not yield before concrete attains the desired strength.
b) The cover of concrete measured from the outside of the prestressing tendon shall be at least 30 mm. or the size of the cable or bar whichever is bigger.
c) When measuring the prestressing force, any slip which may occur in the gripping device shall be taken into consideration.
d) The transfer of prestress shall be carried out gradually by a proper device so that the entire set of wires are released simultaneously.
e) In long line method, where the transfer is made on several moulds at a time, care shall be taken to ensure that prestressing force is evenly applied on all moulds and that the transfer of prestress to

concrete is uniform along with entire length of tension line by ensuring correct alignment of mould on guide plates.

f) The high tensile wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case.

11.8.1. Cover

The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

11.8.2. Welding and Lapping of Steel

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, jointing or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

11.8.3. Compacting

Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compaction shall not be permitted.

11.8.4. Curing

a) The concrete shall be covered with a layer of sacking, canvass, hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of prestress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit, the interval should depend on the atmospheric humidity and temperature.

b) The prestressing wires shall be detensioned only after the concrete has attained the specified strength at transfer (i.e. 245 kg/cm2). The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible, under conditions similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS: 1343-1980 (Code of practice for pre-stressed concrete). The manufacturer shall supply, when required by the employer or his representative, result of compressive test conducted in accordance with IS: 456-1978 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the employer so desires, the manufacturer shall supply cubes for test purposes and such cubes shall be tested in accordance with IS: 456-1978 (Code of practice for plain and reinforced concrete).

c) The detensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of detensioning may be controlled by any suitable means either mechanical (screw type) or hydraulic. The poles shall not be detensioned or released by cutting the pre-stressing wires using flames or bar croppers while the wires are still under tension.

d) Separate eye-hooks or holes shall be provided for handling the transport, one each at a distance of 0.15 times the overall length, from either end of the pole. Eye-hooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section. Holes, if provided for lifting purposes, should be perpendicular to the broad face of the pole.

e) Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleepers located as 0.15 times the overall length, measured from the end. The timber supported in the stack should be aligned in a vertical line.

f) Poles should be transported with their broad faces placed vertically and in such a manner that shocks are avoided. Supports should be so arranged that they are located approximately at a distance equal to 0.15 times the overall length from the ends. The erection of the pole should be carried out in such a way that the erection loads are applied so as to cause moment with respect to the major axis, i.e. the rope used for hoisting the pole should be parallel to the broader face of the pole.

g) Earthing

Earthing shall be provided by having length of 8 SWG GI wire embedded in concrete during manufacture and the ends of the wires left projecting from the pole to a length of 100mm at 250 mm from top and 150 mm below ground level.

Earth wire shall not be allowed to come in contact with the pre-stressing wires. The possible location of earth wire for different varieties of poles has been shown in Drawing Nos. 1 to 8.

11.9. Tests

11.9.1. Transverse Strength Test

Poles made from ordinary portland cement shall be tested only on the completion of 28 days and poles made from rapid hardening cement only on the completion of 14 days, after the day of manufacture.

The poles may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole, for this purpose, the overhanging portion of the pole may be supported on a movable trolley or similar device.

The pole shall be rigidly supported at the butt end for a distance equal to the agreed depth of planting. Load shall be applied at a point 300 mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load at first crack. The deflection at this load shall be measured.

A pre-stressed concrete pole shall be deemed not to have passed the test if visible cracks appear at a stage prior to the application of the design transverse load for the first crack. The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load, and held up for 2 minutes. This procedure shall be repeated until the load reaches the value of 80 per cent of the minimum ultimate transverse load and thereafter increased by 5 per cent of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to pre-stressed concrete pole at the point of failure shall be measured to the nearest five Kilograms. The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.

11.9.2. Measurement of Cover

After completion of the transverse strength test, the sample pole shall be taken and checked for cover. The cover of the pole shall be measured at 3 points, one within 1.8 meter from the butt end of the pole, the second within 0.6 meters from the top and the third at an intermediate point and the mean value compared with the specified value.

The mean value of the measured cover should not differ by more than (±) 1mm from the specified cover. The individual values should not differ by more than (±) 3mm from the specified value. If these requirements are not met, the workmanship with reference to aligning of the end plates and prestressing wires and assembly of moulds should be improved and inspection at pre-production stage tightened suitably.

11.10. Sampling and inspection

11.10.1. Scale of Sampling

Lot: In any batch, all poles of the same class and same dimensions shall be grouped together to constitute a lot.

Sub-lot: If the number of poles in a lot exceeds 500, the lot shall be divided into a suitable number of sub lots such that the number of poles in any sub-lot shall not exceed 500. The acceptance or otherwise of sub-lot shall be determined on the basis of performance of samples selected from it.

The number of poles to be selected from a lot or a sublot shall depend upon its size and shall be in accordance with Col. 1 and 2 of the following table.

Table 11-3No of poles to be selected

SAMPLE SIZE AND CRITERION			
Size of lot or sub-lot	Dimensional Requirement		No. of poles for transverse strength test
	Sample size	Permissible No. of defective samples	
1	2	3	4
Upto 100	10	1	*
101-200	15	1	3
201-300	20	2	4
301-400	30	3	5

*The no. of poles to be tested shall be subject to the agreement between employer & manufacture.

These poles shall be selected at random. In order to ensure randomness, all the poles in the lot or the sub-lot may be arranged in a serial order and starting from any random pole, every r^{th} pole may be included in the sample, r being the integral part of N/n where N is size of the lot or the sub-lot and n is the sample size

11.10.2. Number of Tests

All the poles as selected shall be tested for overall length, cross-section and uprightness. The tolerance shall (±) 5 mm on cross sectional 0.5 percent on uprightness and (±)15 mm on length.

The number of poles to be tested for transverse strength test shall be in accordance with Col. 4 of the above table.

11.10.3. Criteria for Conformity

A lot or sub-lot shall be considered as conforming to this specification if the conditions under 3.9.3.2 and 3.9.3.3 are satisfied.

The number of poles which does not satisfy the requirements of overall length, cross-section and uprightness shall not exceed the corresponding number given in Col. 3 of Table above. If the number of such poles exceeds the corresponding number, all poles in the lot or sub-lot shall be tested for these requirements and those not satisfying the requirements shall be rejected.

All the poles tested for transverse strength test shall satisfy the requirements of the test. If one or more poles fail, twice the number of poles originally tested shall be selected from those already selected and subjected to the test. If there is no failure among these poles, the lot or the sub-lot shall be considered to have satisfied the requirements of this test.

11.11. Marking

The pole shall be clearly and indelibly marked with the following particulars either during or after manufacture but before testing at a position so as to be easily read after erection in position:

(a) **Code No.** *****(Sl. No. of Pole) at two positions:
  (i) 400 mm below top
  (ii) 3.0 M from the bottom

(b) UPCL, date, month and year of manufacture at a place in between code numbers as given in (a).

11.12. Schedules

11.12.1. Schedule – I [Guaranteed Technical Particulars of 8.5 Meters Long PCC Poles]

Table 11-4Guaranteed technical particulars of 8.5 meters long PCC poles

Sl. No.	Particular	Specifications
1	Name of Manufacturer	
2	Overall length of the pole	**8.5 Meter**
3	Depth of plantation	**1.52 Meter**
4	Min Ultimate transverse load at 300 mm from Top	**450 Kg**
5	Weight of pole in Kg.	**425 Kg**
6	Factor of safety	**2.5**
7	Working load applied at 300 mm from Top	**180 Kg**
8	Volume of Pole in Cubic Mtr.	**0.174 M³**
9	Dimension of Pole	
(a)	Top dimension	**145 mm x 92 mm**
(b)	Bottom dimension	**300 mm x 92 mm**
10	Quantity of material used in manufacture of each PCC Pole	
(I)	Cement	**105 Kg**
(II)	Aggregate	**By weight**
(III)	Sand	**Good Quality**
(IV)	Stone Chips	**12 mm**
(V)	H.T. Steel	
(a)	Dia of wire	**4 mm**
(b)	No. of wire	**12 Nos. Tensioned & 2 Nos. Full length (Untensioned)**
(c)	Weight of wire	**12.50 Kg**
(VI)	Other M.S. Reinforcement	

Sl. No.	Particular	Specifications
(a)	H.T. Wire Rings	**12 Nos. of 4 mm Dia**
(b)	H.T. Wire Hooks	**2 Nos. 4 mm Dia**
(c)	Weight of Steel	**1.00 Kg**
11.	Process adopted for compacting & curing	**Compacting by Shutter Vibrator and Curing by Curing Tanks**
12.	Earthing arrangement in each pole	
(I)	Length of G.I. Wire & SWG	**7.5 Meter of 4 mm Dia**
(II)	Weight of G.I. Wire	**0.80 Kg**
(III)	No. of Galvanized bolts with 2 nuts & 3 washers	
13.	Method of pre-stressing	**Tensioning of HT Wire through Tensioning Tower**
14.	Concrete Mix and cube strength after	
(I)	72 Hours	**245 Kg/cm²**
(II)	28 days	**450 Kg/cm²**
15.	Are these supports suitable for use at angle points where stays are needed.	
16	Marking on pole	**"UPCL" (engraved), Name of Manufacturer, Month & year of manufacturing as per SBD.**

12. Technical Specifications of Fabricated Items

The materials shall be inspected by the Board's authorized representative prior to issue of dispatch instruction with reference of below mentioned details:

The structures are to be fabricated as per specification of REC/ the drawing of this department, by cutting, bending, welding and drilling holes in the steel sections conforming to IS/1977/75 having weight per meter as given below:

Table 12-1 Specifications for Fabrications

S. No	Name of Items	Unit	Approx. weight in Kg
1	L.T. 3 Pin Cross Arm 50x50x6 mm	No.	7.27
2	L.T. 4 Pin Cross Arm 50x50x6 mm	No.	8.65
3	L.T. 5 Pin Cross Arm 50x50x6 mm	No.	10.03
4	L.T. 2 Pin Cross Arm 50x50x5 mm	No.	6.40
5	L.T. 3 Pin Cross Arm 50x50x5 mm	No.	7.00
6	L.T. 4 Pin Cross Arm 50x50x5 mm	No.	8.28
7	L.T. 5 Pin Cross Arm 50x50x5 mm	No.	9.65
8	L.T. 3 Pin Cross Arm 65x65x5 mm	No.	7.37
9	L.T. 5 Pin Cross Arm 50x50x5 mm	No.	9.65
10	L.T. 5 Pin Cross Arm for tangent location	No.	16.00
11	11 kV Cross Arm angle type 65x65x6 mm	No.	11.48
12	11 kV "V" Cross Arm Channel type 75x40 mm	No.	14.60
13	11 kV Cross Arm Cleat type	No.	14.16
14	11 kV Top Clamp Angle type 65x65x6 mm	No.	3.08
15	11 kV Top Clamp Channel type 75x40 mm	No.	3.50
16	11 kV Top Clamp Cleat type	No.	3.54
17	33 kV Cross Arm 75x75x6 mm	No.	25.70
18	33 kV Top Channel 75x75x6 mm	No.	4.08
19	D.C.Cross Arm 5.2 Mtr. Channel	No.	49.56
20	D.C.Cross Arm 4.8 Mtr. Channel 100x50 mm	Set	98.00
21	D.C.Cross Arm 3.8 Mtr. Channel 100x50 mm	Set	79.00
22	Lightning Arrestor Structure	No.	143.00
23	11 kV Bridling Cross Arm 65x65x6 mm	No.	19.00

S. No	Name of Items	Unit	Approx. weight in Kg
24	11 kV Bridling Top Clamps 65x65x6 mm	No.	6.00
25	33 kV Bridling Cross Arm 75x75x6 mm	No.	19.30
26	33 kV Bridling Top Clamps 75x75x6 mm	No.	6.18
27	L.T. "U" Clamp 50x6 mm Flat	No.	0.65
28	Fencing Post 4 Feet Centre 75x75x6 mm	No.	6.17
29	Fencing Post 8 Feet Centre 75x75x6 mm	No.	12.34
30	Fencing Post 10 Feet Centre 75x75x6 mm	No.	18.52
31	11 kV Bird Guard Stool	No.	2.70
32	33 kV Bird Guard Stool	No.	3.10
33	D.O.Mounting Channel 75x40 mm	No.	19.37
34	D.O.Mounting Angle 75x75x6 mm	No.	19.20
35	Earthing Rod 25 mm 1.2 Mtr.	No.	4.56
36	Back Clamp for FRC type Cross Arm	No.	1.60
37	Back Clamp for Rail Pole Plate 65x8 mm 1 No.	No.	3.00
38	D.C.Cross arm 4' Centre 100x50 mm Channel 2 Nos.	Set	46.00
39	D.C.Cross arm 4' Centre 75x40 mm Channel	Set	39.13
40	D.C.Cross arm 4' Centre Angle 100x100x6 mm	Set	38.03
41	D.C.Cross arm 5' Centre 100x50 mm M.S.Channel	Set	62.00
42	D.C.Cross arm 5' Centre Angle type 100x100x8 mm	Set	69.00
43	D.C.Cross arm 8' Centre 100x50 mm Channel	Set	53.00
44	D.C.Cross arm 8' Centre 75x40 mm Channel	Set	41.30
45	D.C.Cross arm 8' Centre Angle type 100x100x6 mm	Set	47.50
46	D Transformer Mounting 100x50 mm Channel	Set	52.63
47	Transformer Mounting 75x40 mm Channel	Set	38.75
48	Bracing Set 4' Centre D.P.	Set	45.02
49	Bracing Set 5' Centre D.P.	Set	51.67
50	Bracing Set 8' Centre D.P.	Set	64.29
51	Bracing Cross Arm for 4 Pole Structures	Set	381.70
52	11 kV Guarding Channel 100x50 mm	Set	39.22
53	11 kV Guarding Angle 100x100x6 mm	Set	7.48
54	Upper & Lower Cross Arm for special structures	Set	154.23

S. No	Name of Items	Unit	Approx. weight in Kg
55	33 kV Guarding Channel 100x50 mm	Set	52.77
56	Railway Cross Structures	Set	233.92
57	D.C Cross arm 4' Centre for special structures	Set	132.90
58	Railway Pole Jointing Channel	Set	22.40
59	Single Pole Cut Point Fitting 100x50 mm	Set	28.18
60	Single Pole Cut Point Fitting 75x40 mm	Set	24.62
61	Side Cross Arm for 11 kV 50x50x6 mm	No.	35.36
62	--do-- 75x40 Channel	No.	41.96
63	L.T. Side Bracket 4 Pin 50x50x6 mm	No.	22.12
64	L.T. Side Bracket 5 Pin 50x50x6 mm	No.	23.72
65	Through Bolt - 12 mm	No.	0.32
66	Bolt Big size	No.	0.86
67	I-Bolt - 16 mm	No.	0.65
68	Stay Clamp for 140 kg PCC Pole	Pair	1.54
69	Stay Clamp H.T. Per Pair	Pair	3.00
70	Stay Clamp for 280 kG. PCC Pole	Pair	3.12
71	Stay Clamp for R.S.Joist "A" type	Pair	3.00
72	Stay Clamp for R.S.Joist "B" type	Pair	3.04
73	Stay Clamp Rail "A" type	Pair	3.04
74	Stay Clamp Rail "B" type	Pair	3.04
75	Stay Clamp Rail for H-Beam	Pair	3.28
76	Stay Clamp L.T. Rail for H-Beam	Pair	1.98
77	Back Clamp Rail for H-Beam	Pair	1.98
78	Transformer Mounting with Belting for Addl. X-Arm	No.	31.00
79	L.T. Robust Fuse Unit	No.	9.60
80	Rack 50x50x6 mm Angle	No.	37.03
81	Foundation bolt 25x12 mm	No.	4.56
82	Strain Plate	Set	0.65

The cutting shall be vertical, free from sharp edges, cracks. The holes shall be machine drilled and smooth. Bends shall be smooth preferably done by die. In case of heat-bent the curves shall be smooth on 6mm radius.

The item should not be made of more than one piece of steel section by jointing or welding unless or otherwise specified in the drawing.

The fabricated iron materials are to be cleaned of rust and scales and given two coatings of primer red-oxide paints conforming to IS 123/1962 and as amended from time to time.

Variation in dimensions of different sizes of clamps arising out of change in designs of PSC Poles of REC standards, must be incorporated.

The drawing and the technical specification may be modified as and when required but no claim for compensation shall be entertained as the rates are on tonnage basis.