

# **STANDARD BIDDING DOCUMENT**

## **FOR**

### **Full Turnkey Contract**

### **(Design Supply and Installation)**

**PVVNL**

## **Part – 4**

## **Technical Specifications**

**FOR**

**IMPLEMENTATION OF MSCL PROJECT NETWORK ,  
STRENGTHENING, CAPACITY ENHANCEMENT, IMPLEMENTATION OF  
SCADA FOR POWER SUPPLY UNDER SMART CITY MISSION (SCM) IN  
MORADABAD CITY.**

### **Key Dates**

<b>Date of Release of RFB/ NIT</b>	<b><i>07<sup>th</sup> November 2022</i></b>
<b>Date &amp; Time of receiving Pre-bid queries via mail</b>	<b><i>19<sup>th</sup> November 2022 till 16:00 Hrs</i></b> <b>E-mail Id: <a href="mailto:semmpvvnl@gmail.com">semmpvvnl@gmail.com</a></b>
<b>Deadline for Submission of Bid</b>	<b><i>29<sup>th</sup> November 2022 at 16:00 Hrs</i></b>
<b>Date &amp; Time of Opening of Technical Part of Bid</b>	<b><i>30<sup>th</sup> November 2022 at 16:00 Hrs</i></b>

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### Technical Specifications for Equipment

All materials required to complete the work as per given specifications & drawings etc. must be manufactured and supplied using fresh raw material. Re-moulded, re-circulated materials are not acceptable. The procurement of materials must be made by the contractor directly from manufacturer or through authorized dealer/distributors. Documentary evidence to this effect is to be made available to Employer for necessary checks/verification of source of supply of materials. Secondhand materials/ partial used materials/ used materials would not be acceptable.

Climatic condition details are given with various materials specifications however, bidder shall note that materials covered under project specific works shall be utilized in that particular project only. Hence, the geographical location of that particular project site and its associated climatic condition shall be applicable for all the materials of that particular project.

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**1. 3-Phase Distribution Transformers 11kV /433-250V (Outdoor Type)****1. SCOPE:**

- i) This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3-phase 11 kV/433 - 250 V distribution transformers for outdoor use.
- ii) The equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.
- iii) The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.
- iv) All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

**2 STANDARDS:**

- 2.1 The major materials used in the transformer shall conform in all respects to the relevant/specified Indian Standards and international Standards with latest amendments thereof as on bid opening date, unless otherwise specified herein. Some of the applicable Indian Standards are listed as hereunder:

**3.2**

Indian Standards	Title	International Standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers upto and including 2500kVA, 33kV-Specification	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	IEC Pub 296
IS-5	Specification for colors for ready mixed paints	
IS -104	Ready mixed paint, brushing zinc chromate, priming	
IS-2099	Specification for high voltage porcelain bushing	

IS-649	Testing for steel sheets and strips and magnetic circuits	
IS- 3024	Cold rolled grain oriented electrical sheets and strips	
IS - 4257	Dimensions for clamping arrangements for bushings	
IS - 7421	Specification for Low Voltage bushings	
IS - 3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS - 5484	Specification for Al Wire rods	ASTM B - 233
IS - 9335	Specification for Insulating Kraft Paper	IEC 554
IS - 1576	Specification for Insulating Press Board	IEC 641
IS - 6600	Guide for loading of oil Immersed Transformers	IEC 76
IS - 2362	Determination of water content in oil for porcelain bushing of transformer	
IS - 6162	Paper covered Aluminium conductor	
IS - 6160	Rectangular Electrical conductor for electrical machines	
IS - 5561	Electrical power connector	
IS - 6103	Testing of specific resistance of electrical insulating Liquids	
IS - 6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS - 6792	Determination of electrical strength of insulating oil	
IS - 10028	Installation and maintenance of transformers.	

### 3 STANDARD RATINGS:

The standard ratings shall be 16, 25, 63, 100,160, 200, 250, 315, 400, 500, 630, 1000, 1250, 1600, 2000 and 2500 kVA for 11 kV distribution transformers and 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600,2000, 2500 kVA for 33 kV distribution transformers.

### 4 SERVICE CONDITIONS:

4.1 The Distribution Transformers to be supplied against this Specification shall be suitable for satisfactory continuous operation under the following climatic conditions as per IS 2026 (Part - I).

i) Location : At various locations in the country

- ii) Maximum ambient air temperature ( $^{\circ}\text{C}$ ) : 50
- iii) Minimum ambient air temperature ( $^{\circ}\text{C}$ ) : -5
- iv) Maximum average daily ambient air temperature ( $^{\circ}\text{C}$ ):40
- v) Maximum yearly weighted average : 32  
ambient temperature( $^{\circ}\text{C}$ )
  
- vi) Maximum altitude above Altitude of 5000 meters mean sea level (meters) :  
for HP, J&K, Uttarakhand, Sikkim , Assam, Meghalaya, Manipur, Nagaland, Tripura,  
Arunachal Pradesh and Mizoram

(i) Note:

1. The climatic conditions specified above are indicative and can be changed by the user as per requirements.
2. The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth unless otherwise specified.

## 5 PRINCIPAL PARAMETERS:

- 5.1 The transformers shall be suitable for outdoor installation with three phase, 50 Hz, 11 kV in which the neutral is effectively earthed and they should be suitable for service with fluctuations in supply voltage upto plus 12.5% to minus 12.5%.

(i) The transformers shall conform to the following specific parameters :

Sl. No.	Item	11 kV Distribution Transformers
1	System voltage (Max.)	12 kV
2	Rated Voltage (HV)	11 kV
3	Rated Voltage (LV)	433 - 250 V*
4	Frequency	50 Hz +/- 5%*
5	No. of Phases	Three
6	Connection HV	Delta
7	Connection LV	Star (Neutral brought out)
8	Vector group	Dyn-11
9	Type of cooling	ONAN

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed distribution transformers shall be as below (NEMA Standards):

<b>kVA rating</b>	<b>Audible sound levels (decibels)</b>
0-50	48
51-100	51
101-300	55
301-500	56
750	57
1000	58
1500	60
2000	61
2500	62

## **6. TECHNICAL REQUIREMENTS:**

### **6.1.1 CORE MATERIAL**

- 6.1.2.1 The core shall be stack / wound type of high grade Cold Rolled Grain Oriented or Amorphous Core annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.
- 6.1.2.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at <http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>.
- 6.1.2.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall furnish necessary design data in support of this situation.
- 6.1.2.4 No-load current up to 200kVA shall not exceed 3% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.

or

No-load current above 200kVA and upto 2500kVA shall not exceed 2% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 5% of full load current.

- 6.1.2.5 Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

## **7 WINDINGS:**

### **(i) Material:**

- 7.1.1 HV and LV windings shall be wound from Super Enamel covered /Double Paper covered Aluminum conductor.
- 7.1.2 LV winding shall be such that neutral formation will be at top.
- 7.1.3 The winding construction of single HV coil wound over LV coil is preferable.
- 7.1.4 Inter layer insulation shall be Nomex /Epoxy dotted Kraft Paper.
- 7.1.5 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted.
- 7.1.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars (GTP Schedule I).
- 7.1.7 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 7.1.8 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

## **8 TAPPING RANGES AND METHODS:**

- 8.1.1 No tapping shall be provided for distribution transformers up to 100 kVA rating.
- 8.1.2 The tapping shall be as per provisions of IS: 1180 Part-I (2014).
- 8.1.3 Tap changing shall be carried out by means of an externally operated self-position switch

and when the transformer is in de-energised condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Arrangement for pad locking shall be provided. Suitable aluminum anodized plate shall be fixed for tap changing switch to know the position number of tap.

## 9 OIL:

- 9.1 The insulating oil shall comply with the requirements of IS 335. Use of recycled oil is not acceptable. The specific resistance of the oil shall be as per IS 335.
- 9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.
- 9.3 The oil shall be filled under vacuum.
- 9.4 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

## 10 INSULATION LEVELS:

Sl. No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage(kV)
1	0.433	-	3
2	11	75	28
3	33	170	70

## 11 LOSSES:

- 11.1 The transformer of HV voltage up to 11kV, the total losses(no-load + load losses at 75 °C) at 50% of rated load and total losses at 100% of rated load shall not exceed the maximum total loss values given in Table-3 upto 200kVA & Table-6 for ratings above 200kVA of IS 1180(Part-1):2014.
- 11.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75 °C for 11/0.433 kV transformers can be chosen by the utility as per **Table-3 upto 200kVA and Table-6 for ratings above 200kVA** as per **Energy Efficiency Level-2 specified in IS 1180 (Part-1):2014** for all kVA ratings of distribution transformers.
- 11.3 The above losses are maximum allowable and there would not be any positive tolerance.

Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. The utility can evaluate offers with losses lower than the maximum allowable losses on total owning cost basis in accordance with methodology given in Annex-I.

**12 TOLERANCES:**

- 12.1 No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

**13 PERCENTAGE IMPEDANCE:**

The percentage impedance of transformers at 75 °C for different ratings upto 200 kVA shall be as per Table 3 and for ratings beyond 200 kVA shall be as per Table 6 of IS 1180(Part-1):2014.

- 14 Temperature rise:** The temperature rise over ambient shall not exceed the limits given below:

- 14.1 The permissible temperature rise shall be as per IS: 1180 (Part-I):2014.
- 14.2 The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

**15 PENALTY FOR NON PERFORMANCE:**

- 15.1 During testing at supplier's works if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.
- 15.2 Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.
- 15.3 Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance.

**16 INSULATION MATERIAL:**

- 16.1 Electrical grade insulation epoxy dotted Kraft Paper/Nomex and pressboard of standard make or any other superior material subject to approval of the purchaser shall be used.



- 16.2 All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations.

17.1 **TANK:**

- Transformer tank construction shall conform in all respect to clause 15 of IS 1180(Part-1):2014.
- The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.
- All joints of tank and fittings shall be oil tight and no bulging should occur during service.
- Inside of tank shall be painted with varnish/hot oil resistant paint.
- The top cover of the tank shall be slightly sloping to drain rain water.
- The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle/Hook Type.
- Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

i) **PLAIN TANK:**

- 17.2.1 The transformer tank shall be of robust construction rectangular/octagonal/round/ elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 3.15 mm for the bottom and top and not less than 2.5 mm for the sides for distribution transformers upto and including 25 kVA, 5.0 mm and 3.15 mm respectively for transformers of more than 25 kVA and up to and including 100 kVA and 6 mm and 4 mm respectively above 100 kVA. Tolerances as per IS1852 shall be applicable.
- 17.2.2 In case of rectangular tanks above 100 kVA the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of  $0.8 \text{ kg/cm}^2$  for 30 minutes. In case of transformers of 100 kVA and below, there shall be no joints at corners and there shall not be more than 2 joints in total.
- 17.2.3 Under operating conditions the pressure generated inside the tank should not exceed  $0.4 \text{ kg/sq. cm}$  positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747 for DT up to 63 KVA. For DT of 63 KVA and above rating, conservator shall be provided.

- (i) The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.
- (ii) Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below:

(All figures are in mm)

Horizontal length of flat plate	Permanent deflection
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.0

17.2.4 The tank shall further be capable of withstanding a pressure of 0.8kg/sq.cm and a vacuum of 0.7 kg/sq.cm (g) without any deformation.

17.2.5 The radiators can be tube type or fin type or pressed steel type to achieve the desired cooling to limit the specified temperature rise.

### 17.3 CORRUGATED TANK:

17.3.1 The bidder may offer corrugated tanks for transformers of all ratings.

17.3.2 The transformer tank shall be of robust construction corrugated in shape and shall be built up of tested sheets.

17.3.3 Corrugation panel shall be used for cooling. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

17.3.4 Tanks with corrugations shall be tested for leakage test at a pressure of 0.25kg/ sq cm measured at the top of the tank.

17.3.5 The transformers with corrugation should be provided with a pallet for transportation, the dimensions of which should be more than the length and width of the transformer tank with corrugations.

**18 CONSERVATOR:**

- (i) Transformers of rating 63 kVA and above with plain tank construction, the provision of conservator is mandatory. For corrugated tank and sealed type transformers with or without inert gas cushion, conservator is not required.
- (ii) When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug.
- (iii) The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 500g of silica gel conforming to IS 3401 for transformers upto 200 kVA and 1 kg for transformers above 200 kVA .
- (iv) The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- (v) The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- (vi) The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to -5 °C) should be above the sump level.

**19 SURFACE PREPARATION AND PAINTING:****(i) GENERAL**

- 19.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 19.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The

paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used with prior approval of purchaser.

## **19.2 CLEANING AND SURFACE PREPARATION:**

- a) After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
- b) Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).
- c) Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer to clearly explain such areas in his technical offer.

## **19.3 PROTECTIVE COATING:**

- 19.3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

## **19.4 PAINT MATERIAL:**

- i) Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site: Heat resistant paint (Hot oil proof) for inside surface
- ii) For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel/polyurethane base paint. These paints can be either air drying or stoving.
- iii) For highly polluted areas, chemical atmosphere or for places very near to the sea coast, paint as above with one coat of high build Micaceous iron oxide (MIO) as an intermediate coat may be used.

## **19.5 PAINTING PROCEDURE:**

- i) All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.

- ii) Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%.

#### **19.6 DAMAGED PAINTWORK:**

- (i) Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.

- (ii) Any damaged paint work shall be made good as follows:

19.6.2.1 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.

19.6.2.2 A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.

19.6.2.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

19.6.2.4 The paint shade shall be as per Annexure-Paint which is attached herewith.

#### **19.7 DRY FILM THICKNESS:**

19.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour.

19.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.

19.7.3 Particular attention must be paid to full film thickness at the edges.

19.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl. No.	Paint type	Area to be painted	No. of coats	Total dry film thickness (min.) (microns)

1.	Thermo setting powder paint	inside outside	01	30
			01	60
2.	Liquid paint			
	a) Epoxy (primer)	outside outside	01	30
	b) P.U. Paint (Finish coat)	inside	02	25 each
	c) Hot oil paint/ Varnish		01	35/10

#### 19.8 TESTS FOR PAINTED SURFACE:

19.8.1 The painted surface shall be tested for paint thickness.

19.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and Salt spray test and Hardness test as type test as per the relevant ASTM standards.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

#### 20 BUSHINGS:

20.1 The bushings arrangement shall be decided by utility during detailed engineering.

20.2 For 33 kV-36 kV class-1 bushings shall be used for transformers of ratings 500 kVA and above. And for transformers below 500 KVA, 33 kV class bushings, for 11 kV -12 kV class bushings and for 0.433 kV- 11 kV class bushings shall be used.

20.3 Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.

20.4 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257

20.5 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Voltage	Clearance
---------	-----------

	<b>Phase to phase</b>	<b>Phase to earth</b>
33 kV	350mm	320mm
11 kV	255mm	140mm
LV	75mm	40mm

For DTs of 200 KVA and above, the clearances of cable box shall be as below:

<b>Voltage</b>	<b>Clearance</b>	
	<b>Phase to phase</b>	<b>Phase to earth</b>
33 kV	350mm	220mm
11 kV	130mm	80mm
LV	25mm	20mm

- 20.6 Arcing horns shall be provided on HV bushings.
- 20.7 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section – IX.
- 20.8 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.
- 20.9 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.
- 21 TERMINAL CONNECTORS:**
- 21.1 The LV and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561.
- 22 LIGHTNING ARRESTORS:**
- 22.1 9 kV, 5 kA metal oxide lightning arrestors of reputed make conforming to IS 3070 Part-III, one number per phase shall be provided.( To be mounted on pole or to be fitted under the HV bushing with GI earth strip 25x4 mm connected to the body of the transformer with necessary clamping arrangement as per requirement of purchaser.) Lightning arrestors with polymer insulators in conformance with relevant IEC can also be used. 1 clamp for LA shall also be provided for each HT bushing. Supply of LA is not included in DT supplier's scope.

**23 CABLE BOXES:**

No cable box shall be provided in transformer below 200 kVA. Above 200kVA, Cable Boxes shall be provided on both HV & LV side.

- 23.1 In case HV/LV terminations are to be made through cables the transformer shall be fitted with suitable cable box on 11 kV side to terminate one 11kV/ 3 core aluminium conductor cable up to 240 sq. mm. (Size as per requirement).

The bidder shall ensure the arrangement of HT Cable box so as to prevent the ingress of moisture into the box due to rain water directly falling on the box. The cable box on HT side shall be of the split type with faces plain and machined and fitted with Neo-k-Tex or similar quality gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut-bolt arrangement and MS earthing clamp. The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the connecting rods shall be stated and shall be adequate for carrying the rated currents. On the HV side the terminal rod shall have a diameter of not less than 12 mm. The material of connecting rod shall be copper. HT Cable support clamp should be provided to avoid tension due to cable weight.

- 23.2 The transformer shall be fitted with suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression brass glands on LV side to terminate 1.1 kV/single core XLPE armoured cable (Size as per requirement)

**24 TERMINAL MARKINGS:**

High voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2U, 2V, 2W. The neutral point terminal shall be indicated by the letter 2N. Neutral terminal is to be brought out and connected to local grounding terminal by an earthing strip.

- 26.1 The following standard fittings shall be provided :

- i. Rating and terminal marking plates, non-detachable.
- ii. Earthing terminals with lugs - 2 Nos.
- iii. Lifting lugs for main tank and top cover
- iv. Terminal connectors on the HV/LV bushings (For bare terminations only).
- v. Thermometer pocket with cap - 1 No.
- vi. Air release device (for non-sealed transformer)



- vii. HV bushings - 3 Nos.
- viii. LV bushings - 4 Nos.
- ix. Pulling lugs
- x. Stiffener
- xi. Radiators - No. and length may be mentioned (as per heat dissipation calculations)/ corrugations.
- xii. Arcing horns on HT side - 3 No . Only clamps for lightning arrestor shall be provided.
- xiii. Prismatic oil level gauge.
- xiv. Drain cum sampling valve.
- xv. One filter valve on upper side of the transformer (For transformers above 200 kVA)
- xvi. Oil filling hole having p. 1- ¼ ‘’ thread with plug and drain plug on the conservator.
- xvii. Silica gel breather (for non-sealed type transformer)
- xviii. Base channel 75x40 mm for up to 100 kVA and 100 mmx50 mm above 100 kVA, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- xix. 4 No. rollers for transformers of 200 kVA and above.
- xx. Pressure relief device or explosion vent (above 200 kVA)
- xxi. Oil level gauge
  - A. -5 °C and 90°C marking for non-sealed type Transformers
  - B.- 30°C marking for sealed type transformers
- xxii. Nitrogen / air filling device/ pipe with welded cover Capable of reuse (for sealed type transformers)
- xxiii. Inspection hole for transformers above 200 kVA
- xxiii. Pressure gauge for sealed type transformers above 200 kVA.
- xxiv. Buchholz relay for transformers above 1000 KVA.

## 27 FASTENERS:

- 27.1 All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the

appropriate Indian Standards for metric threads, or the technical equivalent.

- 27.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.
- 27.3 All nuts and pins shall be adequately locked.
- 27.4 Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.
- 27.5 All bolts/nuts/washers exposed to atmosphere should be as follows.
- a) Size 12 mm or below – Stainless steel
  - b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.
- 27.6 Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.
- 27.7 The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- 27.8 Taper washers shall be provided where necessary.
- 27.9 Protective washers of suitable material shall be provided front and back of the securing screws.

## **28 OVERLOAD CAPACITY:**

- 28.1 The transformers shall be suitable for loading as per IS 6600.

## **29 TESTS:**

- 29.1 All the equipment offered shall be fully type tested by the bidder or his collaborator as per the relevant standards including the additional type tests. The type test must have been conducted on a transformer of same design **during the last five years** at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. **In case, the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.**

- 29.2 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards.
- 29.3 The requirements of site tests are also given in this clause.
- 29.4 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted with the bid.
- 29.5 The procedure for testing shall be in accordance with IS1180 (Part-1) :2014 /2026 as the case may be except for temperature rise test.
- 29.6 Before dispatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

**30 ROUTINE TESTS:**

- 30.1 Ratio, polarity, phase sequence and vector group.
- 30.2 No Load current and losses at service voltage and normal frequency.
- 30.3 Load losses at rated current and normal frequency.
- 30.4 The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted after the receipt of order.
- 30.5 Impedance voltage test.
- 30.6 Resistance of windings at each tap, cold (at or near the test bed temperature).
- 30.7 Insulation resistance.
- 30.8 Induced over voltage withstand test.
- 30.9 Separate source voltage withstand test.
- 30.10 Neutral current measurement-The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.
- 30.11 Oil samples (one sample per lot) to comply with IS 1866.

- 30.12 Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
- 30.13 Pressure and vacuum test for checking the deflection on one transformer of each type in every inspection.

### **31 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:**

In addition to the tests mentioned in clause 30 and 31 following tests shall be conducted:

- 31.1 Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.
- 31.2 Impulse voltage test: with chopped wave of IS 2026 part-III. BIL for 11 kV shall be 75 kV peak.
- 31.3 Short circuit withstand test: Thermal and dynamic ability.
- 31.4 Air Pressure Test: As per IS – 1180 (Part-1):2014.
- 31.5 Magnetic Balance Test.
- 31.6 Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.
- 31.7 Noise-level measurement.
- 31.8 Measurement of zero-phase sequence impedance.
- 31.9 Measurement of Harmonics of no-load current.
- 31.10 “Vacuum Type Test on Transformer Tank” shall be carried out as per IS 1180 (Part-1): 2014 i.e. The transformer tank shall be subjected to air pressure 80 kPa for 30 minutes and vacuum of 250 mm of mercury for 30 minutes. \* The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

\*Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18/D.No. 3091 dated 25.08.2017

<b>Horizontal length of flat plate (in mm)</b>	<b>Permanent deflection (in mm)</b>
Upto and including 750	5.0

751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.0

- 31.11 Transformer tank together with its radiator and other fittings shall be subjected to pressure corresponding to twice the normal pressure or 0.35 kg / sq.cm whichever is lower, measured at the base of the tank and maintained for an hour. The permanent deflection of the flat plates after the excess pressure has been released, shall not exceed the figures for vacuum test.
- 31.12 Pressure relief device test: The pressure relief device shall be subject to increasing fluid pressure. It shall operate before reaching the test pressure as specified in the above class. The operating pressure shall be recorded. The device shall seal-off after the excess pressure has been released.
- 31.13 **Short Circuit Test and Impulse Voltage Withstand Tests:** The purchaser intends to procure transformers designed and successfully tested for short circuit and impulse test. In case the transformers proposed for supply against the order are not exactly as per the tested design, the supplier shall be required to carry out the short circuit test and impulse voltage withstand test at their own cost in the presence of the representative of the purchaser.
- 31.13.1 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.
- 31.13.2 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.
- 31.13.3 It may also be noted that the purchaser reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating at purchaser cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the supplier.

**32 ACCEPTANCE TESTS:**

- 32.1 **At least 10% transformers of the offered lot (minimum of one)** shall be subjected to the following routine/ acceptance test in presence of purchaser's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:1180 (Part-1): 2014 and IS:2026.
- 32.2 Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings on one transformer of each type in every inspection.
- 32.3 Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report.
- 32.4 Temperature rise test on one unit of the total ordered quantity.

**33 TESTS AT SITE:**

The purchaser will conduct the following test on receipt of transformers in their store. The utility shall arrange all equipment, tools & tackle and manpower for the testing. The bidder will depute his representative to witness the same. All such test shall be conducted by utility not later than 10 days from receipt of transformers.

- i. Megger Test
- ii. Ratio test
- iii. Magnetisation test
- iv. Oil test
- v. Core balancing test

**34 INSPECTION:**

- 34.1 In respect of raw material such as core stampings, winding conductors, insulating paper and oil, supplier shall use materials manufactured/supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect of the raw materials:
- i. Invoice of supplier.
  - ii. Mill's certificate.

- iii. Packing list.
- iv. Bill of landing.
- v. Bill of entry certificate by custom.

Please refer to “**Check-list for Inspection of Prime quality CRGO for Transformers**” attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.

### **35 INSPECTION AND TESTING OF TRANSFORMER OIL:**

- 35.1 To ascertain the quality of the transformer oil, the original manufacturer’s tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil as per IS: 335 , after taking out the sample from the manufactured transformers and tested in the presence of purchaser’s representative.
- 35.2 To ensure about the quality of transformers, the inspection shall be carried out by the purchaser’s representative at following two stages:-
  - 35.2.1 Anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.
  - 35.2.2 At finished stage i.e. transformers are fully assembled and are ready for dispatch.
- 35.3 The stage inspection shall be carried out in accordance with **Annexure-II**.
- 35.4 After the main raw-material i.e. core and coil material and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, as far as possible within seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled to ensure that the laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating about the readiness of transformers, for final inspection for carrying out tests as per relevant IS shall be sent by the firm along with Routine Test Certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection. The proforma for pre delivery inspection of Distribution transformers is placed at **Annex- III**.
- 35.5 In case of any defect/defective workmanship observed at any stage by the purchaser’s Inspecting Officer, the same shall be pointed out to the firm in writing for taking remedial measures. Further processing should only be done after clearance from the Inspecting Officer/ purchaser.

- 35.6 All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the Inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as Active Part Inspection during Acceptance Tests.
- 35.7 The manufacturer shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical /electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.
- 35.8 Purchaser shall have every right to appoint a third party inspection to carry out the inspection process.
- 35.9 The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser have every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.
- 36 QUALITY ASSURANCE PLAN:**
- 36.1 The bidder shall invariably furnish following information along with his bid, failing which his bid shall be liable for rejection. Information shall be separately given for individual type of equipment offered.
- 36.2 Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of bidder's representative, copies of test certificates.
- 36.3 Information and copies of test certificates as above in respect of bought out accessories.
- 36.4 List of manufacturing facilities available.
- 36.5 Level of automation achieved and list of areas where manual processing exists.
- 36.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.



- 36.7 List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports. These shall be furnished with the bid. Manufacturer shall possess 0.1 accuracy class instruments for measurement of losses.
- 36.8 Quality Assurance Plan (QAP) withhold points for purchaser's inspection.
- 36.9 The successful bidder shall within 30 days of placement of order, submit following information to the purchaser :
- 36.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- 36.9.2 Type test certificates of the raw materials and bought out accessories.
- 36.9.3 The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing.
- 36.9.4 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Department of Heavy Industries, Government of India, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).
- 37 DOCUMENTATION:**
- 37.1 The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.
- 37.2 Dimensional tolerances.
- 37.3 Weight of individual components and total weight.
- 37.4 An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.
- 37.5 Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.
- 37.6 Typical general arrangement drawing showing both primary and secondary sides and end- elevation and plan of the transformer.

**38 PACKING AND FORWARDING:**

- 38.1 The packing shall be done as per the manufacturer's standard practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.
- 38.2 The marking on each package shall be as per the relevant IS.

**39 GUARANTEE**

- 39.1 The manufacturers of the transformer shall provide a guarantee of 60 months from the date of receipt of transformer at the stores of the Utility. In case the transformer fails within the guarantee period, the supplier will depute his representative within 15 days from date of intimation by utility for joint inspection. In case, the failure is due to the reasons attributed to supplier, the transformer will be replaced/repared by the supplier within 2 months from date of joint inspection.
- 39.2 The outage period i.e. period from the date of failure till unit is repaired/ replaced shall not be counted for arriving at the guarantee period.
- 39.3 In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

**40 SCHEDULES:**

- 40.1 The bidder shall fill in the following schedule which will be part of the offer. If the schedule are not submitted duly filled in with the offer, the offer shall be liable for rejection.

**Schedule-A : Guaranteed Technical Particulars**

**Schedule-B : Schedule of Deviations**

**41 DEVIATIONS :**

- 41.1 The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit with his bid in the relevant schedule a detailed list of all deviations without any ambiguity. In the absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specifications and no post-bid negotiations shall take place in this regard.

- 41.2 The discrepancies, if any, between the specification and the catalogues and / or literatures submitted as part of the offer by the bidders, shall not be considered and representations in this regard shall not be entertained.
- 41.3 If it is observed that there are deviations in the offer in guaranteed technical particulars other than those specified in the deviation schedules then such deviations shall be treated as deviations.
- 41.4 All the schedules shall be prepared by vendor and are to be enclosed with the bid.

#### 42. Other requirements:

42.1 Marshaling box with WTI shall be provided. For functioning of WTI, CT (primary) at any Phase on LV side of suitable current rating for transformer shall be provided. Secondary side of CT shall be compatible with WTI CT ratio.

Annex-I

### METHODOLOGY FOR COMPUTING TOTAL OWNING COST\*

TOC = IC + (A x Wi) + (B x Wc) ; Losses in KW		
Where,		
TOC	=	Total Owing Cost
IC	=	Initial cost including taxes of transformer as quoted by the manufacturer
A factor	=	Cost of no load losses in Rs/KW (A = 288239)
B factor	=	Cost of load losses in Rs/KW (B = 93678)
Wi	=	No load losses quoted by the manufacturer in KW
Wc	=	Load losses quoted by the manufacturer in KW

**Note:** No (+)ve tolerance shall be allowed at any point of time on the quoted losses after the award. In case, the losses during type testing, routine testing etc are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

\* Amendment issued vide letter No. REC/DDUGJY/SBD/DTR-TS/969 Dated 29.09.2016

**Annexure-Paint****Painting-Transformer Main tank, pipes, Conservator Tank, Radiator etc.-**

	Surface Preparation	primer coat	intermediate under coat	finish coat	total DFT	Colour shade
Main tank, pipes, conservator tank, etc. (External surfaces)	Blast cleaning Sa2½	Epoxy base Zinc primer 30-40 micron	Epoxy base Zinc primer 30-40 micron	Aliphatic Polyurethane (PU Paint) (min 50 micron	Min 110 micron	541 shade of IS:5
Main tank, pipes (above 80 NB), conservator tank, etc (Internal surfaces)	Blast cleaning Sa2½	Hot oil resistant, non-corrosive varnish or paint	--	--	Min 30 micron	Glossy white for paint
Radiator (External surfaces)	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer 30-40 micron	Epoxy base Zinc primer Min 30-40 micron	Aliphatic Polyurethane (PU Paint) (min)50 micron	Min 110 micron	541 shade of IS:5
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning if required	Hot oil proof low viscosity varnish or hot oil resistant non corrosive paint	--	--	--	Glossy white for paint

**PROFORMA FOR STAGE INSPECTION OF DISTRIBUTION TRANSFORMERS****(A) GENERAL INFORMATION:**

1. Name of firm : M/s.
2. Order No. and Date :
3. Rating-wise quantity offered :
4. Details of offer
  - a) Rating
  - b) Quantity
  - c) Serial Numbers
5. Details of last stage inspected lot:
  - a) Total quantity inspected
  - b) Serial Numbers
  - c) Date of stage inspection
  - d) Quantity offered for final inspection of  
(a) above with date

**(B) Availability of material for offered quantity :**

Details to be filled in

**(C) Position of manufacturing stage of the offered quantity :**

- a) Complete tanked assembly
- b) Core and coil assembly ready
- c) Core assembled
- d) Coils ready for assembly
  - (i) HV Coils
  - (ii) LV Coils

**Note:** (i) A quantity of less than 100 Nos. shall not be entertained for stage inspection. If the awarded quantity is less than 100 Nos., then whole lot shall be offered in single lot.

- (ii) The stage inspection shall be carried out in case :-
- (a) At least 25% quantity offered has been tanked and
  - (b) core coil assembly of further at least 30% of the quantity offered has been completed.
- (iii) Quantity offered for stage inspection should be offered for final Inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

Sl No	Particulars	As offered	As observed	Deviation and Remarks
(D)	<u>Inspection of Core:</u>			
	(I) Core Material (1) Manufacturer's Characteristic Certificate in respect of grade of lamination used. (Please furnish test certificate)			
	(2) Remarks regarding Rust ting and smoothness of core.			
	(3) Whether laminations used for top and bottom yoke are in one piece.			
	(II) Core Construction :			
	(1) No. of Steps			
	(2) Dimension of Steps			
	Step No. 1 2 3 4 5 6 7 8 9 10 11 12			
	As offered:			
	W mm			
	T mm			

	As found:									
	W mm									
	T mm									
	(3) Core Dia (mm)									
	(4) Total cross Section area of core									
	(5) Effective cross Sectional area of core									
	(6) Clamping arrangement									
	(i) Channel Size									
	(ii) Bolt size and No.									
	(iii) Tie Rods size and No.									
	(iv) Painting									
	(a) Channels									
	(b) Tie Rods									
	(c) Bolts									
	(7) Whether top yoke is cut for LV connection.									
	(8) If yes, at 7 above, whether Reinforcement is done.									
	(9) Size of Support Channels provided for Core base and bottom yoke (Single piece of channels are only acceptable) This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided.  This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be									

	provided.		
	(10) Thickness of insulation provided between core base and support channel.		
	(11) core length (leg center to leg center)		
	(12) Window height		
	(13) Core height		
	(14) Core weight only (without channels etc.)		
(E)	INSPECTION OF WINDING		
	(I) Winding material		
	(1) Material used for		
	(a) HV winding		
	(b) LV winding		
	(2) Grade of material for		
	(a) HV winding		
	(b) LV winding		
	3) Test certificate of manufacturer (enclose copy) for winding material of:		
	(a) HV		
	(b) LV		
	(II) CONSTRUCTIONAL DETAILS		
	(1) Size of Cross Sectional area of conductor for :		
	(a) HV winding		

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	(b) LV winding			
	(2) Type of insulation for conductor of :			
	a) HV winding			
	(b) LV winding			
	(3) Diameter of wire used for delta formation (mm)			
	(4) Diameter of coils in:			
	a) LV winding			
	i) Internal dia (mm)			
	ii) Outer dia (mm)			
	b) HV winding			
	i) Internal dia (mm)			
	ii) Outer dia (mm)			
	(5) Current Density of winding material used for :			
	(a) HV			
	(b) LV			
	(6) Whether neutral formation on top.			
	(7) HV Coils/ Phase			
	a) Number			
	b) Turns / coil			
	c) Total turns			
	(8) LV Coils/ Phase			
	a) Number			
	b) Turns / coil			
	c) Total turns			
	(9) Method of HV Coil Joints			
	(10) Total weight of coils of			

	a) LV winding (kg)			
	b) HV winding (kg)			
(F)	INSULATION MATERIALS :			
	(I) MATERIAL :			
	1) Craft paper			
	a) Make			
	b) Thickness (mm)			
	c) Test Certificate of manufacturer (enclose copy).			
	2) Press Board			
	a) Make			
	b) Thickness (mm)			
	c) Test Certificate of manufacturer (enclose copy).			
	3) Material used for top and bottom yoke and insulation			
	(II) Type and thickness of material used : (mm)			
	a) Between core and LV			
	b) Spacers			
	c) Inter layer			
	d) Between HV and LV winding			
	e) Between phases			
	f) End insulation			
(G)	CLEARANCES : (mm)			
	(I) Related to core and Windings			
	1) LV to Core (Radial)			
	2) Between HV and LV			

	(Radial)			
	3) (i) Phase to phase between HV Conductor			
	(ii) Whether two Nos. Press Board each of minimum 1 mm thick provided to cover the tie rods.			
	4) Thickness of locking spacers between LV coils (mm)			
	5) Axial wedges between HV and LV coils / phase (Nos.)			
	6) No. of radial spacers per phase between HV coils			
	7) Size of duct between LV and HV winding (mm)			
	(II) Between core - coil assembly and tank : (mm)			
	1) Between winding and body:			
	a) Tank lengthwise			
	b) Tank Breadth wise			
	2) Clearance between top cover and top yoke upto 100 kVA and between top cover and top most live part of tap changing switch for 200 kVA and above.			
(H)	TANK : (I) Constructional details : 1) Rectangular shape 2) Thickness of side wall (mm) 3) Thickness of top and			

	bottom plate (mm)			
	4) Provision of slopping top cover towards HV bushing.			
	5) Tank internal dimensions (mm)			
	a) Length			
	b) Breadth			
	c) Height			
	(i) On LV side			
	(ii) On LV side			
	(II) General details :			
	1) Inside painted by varnish/ oil corrosion resistant paint (please specify which type of coating done).			
	2) Gasket between top cover and tank			
	i) Material			
	ii) Thickness (mm)			
	iii) Jointing over laps (mm)			
	3) Reinforcement of welded angle (specify size and No. of angle provided ) on side walls of tank.			
	4) Provision of lifting lugs:			
	b) Whether lugs of 8 mm thick MS Plate provided			
	c) Whether reinforced by welded plates edge wise below the lug upto re- enforcing angle of the tank done.			
	5) Pulling lug of MS Plate			
	a) Nos.			
	b) Thickness (mm)			
	c) Whether provided on breadth side or length side			

	6) Provision of air release plug			
	7) Provision of galvanized GI Nuts Bolts with 1 No. Plain and 1 No. spring washer.			
	8) Deformation of length wise side wall of tank when subject to:			
	a) Vacuum of (-) 0.7 kg/sq cm for 30 minutes			
	b) Pressure of 0.8 kg/sq cm for 30 minutes.			
<b>(I)</b>	<b>RAIDATORS :</b>			
	1. Fin Radiators of 1.25 mm thick sheet			
	a) Dimension of each fin (LxBxT)			
	b) Fins per radiator			
	c) Total No. of radiators			
	2. Verification of manufacturer's test certificate regarding Heat dissipation (excluding Top and Bottom) in w/sq m			
	3. Verification of position of radiator with respect to bushing.			
<b>(J)</b>	<b>CONSERVATOR :</b>			
	1. Dimensions ( L x D) (in mm)			
	2. Volume (m3)			
	3. Inside dia of Conservator tank pipe (mm)			
	4. Whether conservator outlet pipe is projected approx. 20 mm inside the conservator tank.			
	5. Whether arrangement made so that oil does not fall on the active parts.			

	6. Whether die cast metal oil level gauge indicator having three positions at ( - 5o C, 30 o C and 98 oC) is provided .			
	7. Whether drain plug and filling hole with cover is provided.			
	8. Inner side of the conservator Tank painted with-			
<b>(K)</b>	<b>BREATHER :</b>			
	1. Whether Die cast aluminium body breather for silica gel provided.			
	2. Make			
	3. Capacity			
<b>(L)</b>	<b>TERMINALS :</b>			
	1. Material whether of Brass Rods/ Tinned Copper.			
	a) HV			
	b) LV			
	2. Size (dia in mm)			
	a) HV			
	b) LV			
	3. Method of Star connection formed on LV side of 6mm thick (Should use Al./Cu. Flat bolted/ brazed with crimped lugs on winding alternatively for 63 and 100 kVA ratings brazing is done covered with tubular sleeve duly crimped). - Please state dimensions of Al/ Cu flat or tubular sleeve used.			

	4. Method of Connection of LV winding to LV Bushing (end of winding should be crimped with lugs (Al/Cu) and bolted with bushing stud).			
	5. Method of Connection of HV winding to HV bushing (Copper joint should be done by using silver brazing alloy and for Aluminium, brazing rod or with tubular connector crimped at three spots).			
	6. Whether SRB Ptube/insulated paper used for formation of Delta on HV.			
	7. Whether Empire sleeves used on the portion of HV winding joining to HV bushing.			
	8. Whether neutral formation is covered with cotton tape			
	Whether arrangement for studs for fitting of HV Bushing are in diamond shape (so that Arcing Horns are placed vertically).			
	4. Position of mounting of LV bushings.			
	5. Bushing Clearance: (mm)			
	a) LV to Earth			
	b) HV to Earth			
	c) Between LV Bushings			
	d) Between HV Bushings			
(N)	TANK BASE CHANNEL / ROLLERS :			
	1. Size of channel (mm)			

	2. Whether channels welded across the length of the tank			
	3. Size and type of roller (mm)			
(O)	OIL :			
	1. Name of supplier			
	2. Break down voltage of oil: (kV)			
	i) Filled in tanked transformer			
	ii) In storage tank (to be tested by Inspecting Officer).			
	3. Supplier's test certificate(enclose copy)			
(P)	ENGRAVING :			
	1. Engraving / punching Sl. No. and name of firm on top channel / clamp or on separate plate which is firmly welded to the top channel/ clamp.			
	i) On bottom of clamping channel of core-coil assembly.			
	ii) Engraving of Sl. No. and name of firm on side wall and top cover of tank along with date of dispatch.			
(Q)	i) MS plate of size 125x125 mm welded on width side of stiffner			
	ii) Following details engraved (as per approved GTP):			
	(a) Serial Number			
	(b) Name of firm			
	(c) Order No. and Date			
	(d) Rating			
	(e) Name of Inspecting Officer			
	(f) Designation			
	(g) Date of dispatch			
(R)	NAME PLATE DETAILS :			
	Whether Name Plate is as per approved drawing			
(S)	Colour of Transformer			



	1. Tank body colour shall be as per Annexure-Paint which is attached herewith			
	2. Conservator colour shall be as per Annexure- Paint which is attached herewith .			
(T)	CHECKING OF TESTING FACILITIES:			
	(Calibration certificate also to be checked for its validity)			

	<b>TESTS :</b>			
	1. No Load Current			
	2. No Load Loss			
	3. % Impedance			
	4. Load Losses			
	5. Insulation Resistance Test			
	6. Vector Group Test (phase relationship)			
	7. Ratio and Polarity test relationship			
	8. Transformer Oil Test (Break Down Voltage)			
	9. Magnetic Balance			
	10. Measurement of winding resistance (HV and LV both)			
	11. Induced over voltage withstand test			
	12. Separate source power frequency withstand test at 28 kV for HV and 3 kV for LV (one minute).			
	13. Air pressure/ Oil leakage Test			
	14. Vacuum test			
	15. Unbalanced current test			
	16. Temperature rise (Heat Run) test.			
(U)	We have specifically checked the following and found the same as per G.T.P./deviations observed as mentioned against each:			
	i) Rustlessness of CRGO laminations			
	ii) Core steps			
	iii) Core area			
	iv) Core weight			
	v) Winding cross sectional area			
	a) LV			
	b) HV			
	vi) Weight of windings			

	vii) Clearance between winding and wall of tank (mm)			
	a) Length-wise			
	b) Breadth-wise			
	viii) Clearance between top of yoke/ top most live part of tap changer to tank cover.			
	ix) Details of Neutral formation			
	x) Connections to bushings:			
	a) LV			
	b) HV			
	xi) Slope of tank top			
	xii) Position of mounting of bushings			

**GUARANTEED TECHNICAL PARTICULARS**

<b>Sr. No.</b>	<b>Particulars</b>	<b>Unit / Type</b>	<b>As per Firm's Offer</b>
<b>1</b>	<b>Name of manufacturer</b>		
<b>2</b>	<b>Place of Manufacturing</b>		
<b>3</b>	<b>Transformer capacity</b>	KVA	
<b>4</b>	<b>Voltage</b>	11/0.433-0.250 KV	
<b>5</b>	<b>No. of Phases</b>	3 No./1 No.	
<b>6</b>	<b>Vector Group</b>	DY-11	
<b>7</b>	<b>Type of Cooling</b>	ONAN	
<b>8</b>	<b>Type of Transformer</b>	Sealed/Unsealed	
<b>9</b>	<b>For 250 KVA/400 KVA/630 KVA</b>		
	a) No. of tap positions in HV winding		
	b) Voltage variation		
<b>10</b>	<b>Energy Efficiency Level</b>	Level-1	
<b>11</b>	<b>Losses</b>		
<b>i</b>	Core loss	Watts	
	a) at Normal Voltage	Watts	
	b) at Maximum Voltage	Watts	
<b>ii</b>	Full Load losses at 75 deg.C.	Watts	
<b>iii</b>	Total losses at 50 % loading at 75 deg.C.	Watts	
<b>iv</b>	Total losses at 100 % loading at 75 deg.C.	Watts	
<b>12</b>	<b>Percentage Impedance at 75 deg.C.</b>	%	
<b>13</b>	<b>Maximum temperature rise of</b>		
	a) Windings by resistance method	40 deg C (35 deg C for 5KVA)	
	b) Oil by Thermometer	35 deg C (30 deg C for 5KVA)	
<b>14</b>	<b>Clearances</b>		
	a) Core & LV	Mm	
	b) LV & HV	Mm	
	c) HV Phase to Phase	Mm	
	d) End insulation clearance to Earth	Mm	
	e) Any point of winding to tank	Mm	
	f) HV to earth creepage distance	Mm	

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	g) LV to earth creepage distance	Mm	
<b>15</b>	<b>Efficiency at 75 deg.C.</b>		
	<b>a) Unity P.F.</b>		
	1) 125% load	%	
	2) 100% load	%	
	3) 75% load	%	
	4) 50% load	%	
	5) 25% load	%	
	<b>b) 0.8 P.F.</b>		
	1) 125% load	%	
	2) 100% load	%	
	3) 75% load	%	
	4) 50% load	%	
	5) 25% load	%	
<b>16</b>	<b>Regulation at</b>		
	a) Unity P.F.		
	b) 0.8 P.F. at 75 deg.C.		
<b>17</b>	<b>CORE</b>	<b>CRGO/ Amorphous</b>	
<b>i</b>	Core Grade		
<b>ii</b>	Core diameter	Mm	
<b>iii</b>	Gross Core area	Mtr <sup>2</sup>	
<b>iv</b>	Net Core area	Mtr <sup>2</sup>	
<b>v</b>	Flux density	Wb/Mtr <sup>2</sup>	
<b>vii</b>	Wt. of Core	Kg	
<b>viii</b>	Loss per kg. of Core at the specified Flux Density	Watts	
<b>ix</b>	Core window height	Mm	
<b>x</b>	Centre to centre distance of the core	Mm	
<b>xi</b>	The nominal flux density at		
	a) 100% rated voltage	$\leq 1.69 \text{ Wb/Mtr}^2$	
	b) 110% of rated voltage	$\leq 1.9 \text{ Wb/Mtr}^2$	
<b>xii</b>	% No load current of full load current at rated voltage and frequency on the secondary and Increase of voltage by 112.5%		
	(i) CRGO Core: at 100% and 112.5% of rated		

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	Voltage		
	a) Up to 200 KVA Transformer	$\leq 3\%$ and $\leq 6\%$	
	b) Above 200 KVA Transformer	$\leq 2\%$ and $\leq 5\%$	
	(ii) Amorphous Core: at 100% and 112.5% of rated Voltage		
	a) All Ratings	$\leq 2\%$ and $\leq 5\%$	
<b>18</b>	<b>WINDINGS</b>	<b>Aluminium</b>	
<b>i</b>	No. of L.V. Turns	No.	
<b>ii</b>	No. of H V turns	No.	
<b>iii</b>	Size of LV Conductor bare/ covered	Mm	
<b>iv</b>	Size of HV conductor bare/covered	Mm	
<b>v</b>	No. of parallels	No.	
<b>vii</b>	Resistance of HV winding at 20 deg.C	Ohm	
<b>viii</b>	Resistance of LV winding at 20 deg.C	Ohm	
<b>ix</b>	Current density of LV winding	Amps/ <a href="#">sq.mm.</a>	
<b>x</b>	Current density of HV winding	Amps/ <a href="#">sq.mm.</a>	
<b>xi</b>	Wt. of the LV winding for Transformer	kg.	
<b>xii</b>	Wt. of the HV winding for Transformer	kg.	
<b>xiii</b>	No. of LV Coils/phase	No.	
<b>xiv</b>	No. of HV coils / phase	No.	
<b>xv</b>	Height of LV Windings	Mm	
<b>xvi</b>	Height of HV winding	Mm	
<b>xvii</b>	ID/OD of LV winding	Mm	
<b>xviii</b>	ID/OD of HV winding	Mm	
<b>xix</b>	Size of the duct in LV winding	Mm	
<b>xx</b>	Size of the duct in HV winding	Mm	
<b>xxi</b>	Size of the duct between HV & LV	Mm	
<b>xxii</b>	Inter layer insulation provided in design for		
	1) Top & bottom layer		
	2) In between all layer		
	3) Details of end insulation		
	4) Whether wedges are provided at 50% turns of the HV coil		
<b>xxiii</b>	Insulation materials provided		
	a) For Conductors		

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	(1) HV		
	(2) LV		
	B) For Core		
<b>xxiv</b>	Material and Size of the wire used		
	1) HV a) SWG	No.	
	b) Dia	Mm	
	2) LV a) Strip size	mm X mm	
	b) No. of Conductors in parallel	No	
	c) Total area of cross section	<a href="#">sq.mm.</a>	
<b>19</b>	<b>Weight content of</b>		
	a) Core lamination (min)	KG	
	b) Windings (min) Aluminium	KG	
	c) Tank & Fittings	KG	
	d) Oil	KG	
	e) Oil qty (min)	Litre	
	f) Total Weight	KG	
<b>20</b>	<b>Oil Data</b>		
	1. Qty for first filling (min)	Litre	
	2. Grade of oil used		
	3. Maker's name		
	4. BDV at the time of filling	KV	
<b>21</b>	<b>Transformer</b>		
	1) Overall length x breadth x height	mm X mm X mm	
	2) Shape of Tank		
	2) Tank length x breadth x height	mm X mm X mm	
	3) Thickness of plates for		
	a) Side plate (min)	Mm	
	b) Top & Bottom plate (min)	Mm	
	4) Conservator Dimensions	mm X mm	
	5) Tank base channel dimensions	mm X mm X mm	
<b>22</b>	<b>HV Bushings &amp; Terminals</b>		
	1) Make of HV bushing		
	2) Rating in KV	KV	
	3) Turret Height	Mm	
	4) Material of HV terminal	Brass/Copper	

Sr. No.	Particulars	Unit / Type	As per Firm's Offer
	5) Current Density of HV terminal	Amps/ <a href="#">sq.mm.</a>	
<b>23</b>	<b>LV Bushings &amp; Terminals</b>		
	1) Make of LV bushing		
	2) Rating in KV	KV	
	3) Turret Height	Mm	
	4) Material of LV terminal	Brass/Copper	
	5) Current Density of LV terminal	Amps/ <a href="#">sq.mm.</a>	
<b>24</b>	<b>Details of MCCB (for transformers having rating upto 25 KVA)</b>		
	Make		
	Rated thermal current	Amp.	
	Current setting	Amp.	
	Minimum short circuit breaking current	KA	
<b>25</b>	<b>Radiation</b>		
	1) Heat dissipation by tank walls exclusive top & bottom		
	2)Heat dissipation by cooling tube		
	3)Dia & thickness of cooling tube		
	4) Whether calculation sheet for selecting cooling area to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise is enclosed.	Yes/No	
<b>26</b>	Whether the name plate gives all particulars as required in Tender	Yes/No	
<b>27</b>	Whether the transformer offered is already type tested for the design and test reports enclosed	Yes/No	



**Name Plate Details**

Digit/letter No.	Details	TIN	Remark
1	Name of Company	M	First letter of DISCOM name
2	KVA rating	5	for 5/10/16/25/63/100/200/500 KVA ratings digits will be respectively 1/2/3/4/5/6/7/8
3	Type of Core Material	1	CRGO-1, Amorphous-2
4	Core construction	1	Stack-1, Wound-2
5	Supplier Name Code	1	each supplier will be given 2 digit code no. e.g. M/s XYZ given code no.15
6		5	
7	Month of	0	2 digits for Month of manufacturing
8	manufacturing	2	
9	Year of	1	2 digits for Year of manufacturing
10	manufacturing	7	
11	CPP Tender No.	9	4 digits for CPP tender no.
12		0	
13		3	
14		2	
15	Sr. No. of transformer given by Supplier	0	5 digits for transformer sr. no. given by supplier (e.g. M/s XYZ will give transformer sr. no. from 00001 to 00260 for P.O. of 260 no. transformers issued to them vide CPP tender no.9032 )
16		0	
17		0	
18		0	
19		1	

## 2. ACSR Conductor

### 1. SCOPE

This section covers design, manufacture, testing before dispatch, packing, supply and delivery for destination of Kms of ACSR , Dog Conductor.

### 2. STANDARDS

The Conductor shall also comply in all respects with the IS: 398(Part-II)-1996 with latest amendments unless otherwise stipulated in this specification or any other International Standards which ensure equal or higher quality material.

The ACSR Conductor shall also conform to the following standards.

Sl . N o.	Indian Standards	Title	International
1	IS:209-1979	Specification for Zinc	BS-3436-1961
2	IS:398-1996	Specification for aluminum conductors for overhead transmission purposes.	
	Part-II	Aluminum conductors	IEC-209-1966
		Galvanized steel reinforced	BS-215(Part-II)
3	IS:1521-1972	Method of Tensile Testing of Steel wire	ISO/R89-1959
4	IS:1778-1980	Reels and Drums for Bare conductors	BS-1559-1949
5	IS:1841-1978	E.C. Grade Aluminum rod produced by rolling	
6	IS:2629-1966	Recommended practice for Hot Dip Galvanizing of iron and steel	
7	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles.	
8	IS:4826-1968	Galvanized coatings on round steel wires.	ASTM A472-729
9	IS:5484-1978	E.C. Grade Aluminium rod produced by continuous casting and rolling.	

10	IS:6745-1972	Methods of determination of weight of zinc-coating of zinc coated iron and steel articles	BS-443-1969
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Offers conforming to standards other than IS-398 shall be accompanied by the English version of relevant standards in support of the guaranteed technical particulars to be furnished as per format enclosed.

### **3. GENERAL TECHNICAL REQUIREMENTS**

The General Technical Requirements are given in Section-II. The Conductor shall conform to these technical requirements.

The Bidder shall furnish guaranteed technical particulars in Section-III.

#### **3.1. MATERIALS/WORKMANSHIP**

3.1.1. The material offered shall be of best quality and workmanship. The steel cored aluminum conductor strands shall consist of hard drawn aluminium wire manufactured from not less than 99.5% pure electrolytic aluminium rods of E.C. grade and copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889- 1987. The steel wire shall be made from material produced either by the acid or basic open hearth process or by electric furnace process or basic oxygen process. Steel wire drawn from Bessemer process shall not be used.

3.1.2. The steel wires shall be evenly and uniformly coated with electrolytic high grade, 99.95% purity zinc complying with the latest issue of IS-209 for zinc. The uniformity of zinc coating and the weight of coating shall be in accordance with Section-II and shall be tested and determined according to the latest IS-2633 or any other authoritative standard.

3.1.3. The steel strands shall be hot dip galvanized as per IS: 4826. The coating shall be smooth, continuous, and of uniform thickness, free from imperfections and shall withstand minimum three dips after stranding in standard preece test. The steel strands shall be preformed and postformed in order to prevent spreading of strands in the event of cutting of composite core wire. The properties and characteristics of finished strands and individual wires shall be as prescribed in IEC: 888- 1987. If tested after stranding, reference shall also be made to cl. 4.1.1 and cl. 4.2.3 of IS : 4826.

### **4. CONDUCTOR PARAMETERS**

The Parameters of individual strands and composite steel cored aluminum conductor, shall be in accordance with the values given in Section-II.

Creep in a conductor is attributed partly due to settlement of strands and partly due to non-elastic elongation of metal when subjected to load. The manufacturer of conductor shall furnish the amount of creep which will take place in 10, 20, 30, 40 and 50 years along with the supporting calculations. The calculations should be based on everyday temperature of 32 °C and everyday tension of 25% of UTS of conductor of 11/33 KV Lines.

## **5. TOLERANCES**

The tolerances on standard diameter of Aluminum and Steel wires shall be as detailed in specific technical requirements.

The cross-section of any wire shall not depart from circularity by more than an amount corresponding to the tolerance on the standard diameter.

The details of diameters, lay ratios of Aluminum and steel wires shall be in accordance with the Section-II "Technical Requirements".

## **6. SURFACE CONDITIONS**

All aluminum and steel strands shall be smooth, and free from all imperfections, spills/and splits. The finished conductor shall be smooth, compact, uniform and free from all imperfections including spills and splits, die marks, scratches, abrasions, scuff marks, kinks (protrusion of wires), dents, pressmarks, cut marks, wire cross-over, over-riding looseness, pressure and/or unusual bangle noise on tapping, material inclusions, white rust, powder formation or black spots (on account of reaction with trapped rain water etc.), dirt, grit, etc. The surface of conductor shall be free from points, sharp edges, abrasions or other departures from smoothness or uniformity of surface contour that would increase radio interference and corona losses. When subjected to tension upto 50% of the ultimate strength of the conductor, the surface shall not depart from the cylindrical form nor any part of the component parts or strands move relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

## **7. JOINTS IN WIRES**

### **7.1. Aluminum wires**

During stranding, no aluminum wire welds shall be made for the purpose of achieving the required conductor length.

No joint shall be permitted in the individual aluminum wires in the outer most layer of the finished Conductor. However, joints in the 12 wire & 18 wire inner layer of the conductor are permitted but these joints shall be made by the cold pressure butt welding and shall be such that no two such joints shall be within 15 meters of each other in the complete stranded conductor.

**7.2. Steel wires**

There shall be no joints in finished steel wires forming the core of the steel reinforced aluminum conductor.

**8. STRANDING**

The wires used in construction of the stranded conductor, shall, before stranding, satisfy all requirements of IS-398 (Part-II) 1996.

In all constructions, the successive layers shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The outer most layer of wires shall have a right hand lay. The lay ratio of the different layers shall be within the limits given under Section-II.

**9. PACKING**

9.1. The conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS-1778-1980 and latest version except as otherwise specified hereinafter. The conductor drums shall be adequate to wind one or more standard length of 2500 meters of SQUIRREL/WEASEL/RABIT/RACOON/DOG/ PANTHER ACSR conductor.

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

9.3. The bidders should submit their drawings of the conductor drums along with the bid. After placement of letter of intent the Manufacturer shall submit four copies of fully dimensioned drawing of the drum for Employer's approval. After getting approval from the Employer, Manufacturer shall submit 30 more copies of the approved drawings for further distribution and field use.

9.4. All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti fungus shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.

9.5. All flanges shall be 2-ply construction with 64 mm thickness. Each ply shall be nailed and clenched together at approximately 90 degrees. Nails shall be driven from the inside face of the flange, punched and then clenched on the outer face. Flange boards shall not be less than the nominal thickness by more than 2 mm.

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There shall not be less than 2 nails per board in each circle.

- 9.6. The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.
- 9.7. Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.
- 9.8. Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be countersunk. The ends of the barrel shall generally be flushed with the top of the nuts.
- 9.9. The inner cheek of the flanges and drum barrel surface shall be painted with bitumen based paint.
- 9.10. Before reeling, card board or double corrugated or thick bituminized waterproof bamboo paper or HDPE sheet shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the conductor the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.
- 9.11. A minimum space of 75 mm shall be provided between the inner surface of the external protective lagging and outer layer of the conductor. Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanised steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 9.12. Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nail shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.
- 9.13. The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges.
- 9.14. Only standard lengths of conductor shall be wound on each drum. The method of lagging to be employed shall be clearly stated in the tender.

- 9.15. As an alternative to wooden drum Bidder may also supply the conductors in non-returnable painted steel drums. The painting shall conform to IS:9954-1981, reaffirmed in 1992. Wooden/ steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote the package.

## **10. LABELLING AND MARKING**

The drum number shall be branded or gauged or stencilled into the flange. An arrow shall be marked on the sides of the drum, together with the words "Roll this way". Each drum shall have the following information provided on the outside of the flange stencilled with indelible ink.

- i) Manufacturer's name and address.
- ii) Contract/Specification number.
- iii) Size and type of conductor.
- iv) Net weight of the conductor.
- v) Gross weight of the conductor and drum.
- vi) Length of the conductor.
- vii) Position of the conductor end.
- viii) Drum and lot number.
- ix) Name and address of the consignee.
- x) Month and year of manufacture.
- xi) The drum may also be marked with standard specification as per which the conductor is manufactured.

## **11. STANDARD LENGTHS**

- 11.1. The standard length of the conductor shall be 2500 metres. A tolerance of plus or minus 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.
- 11.2. Random lengths will be accepted provided no length is less than 70% of the standard length and total quantity of such random length shall not be more than 10% of the total quantity order. When one number random length has been manufactured at any time, five (5) more individual lengths, each equivalent to the above random length with a tolerance of +/-5% shall also be manufactured and all above six random lengths shall be dispatched in the same shipment. At any point, the cumulative quantity supplied including such random lengths shall not be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard length as specified.
- 11.3. Bidder shall also indicate the maximum single length, above the standard length,

he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Employer reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

## **12. QUALITY ASSURANCE PLAN**

A Quality Assurance Plan including customer hold points covering the manufacturing activities of the material shall be required to be submitted by the tenderer to the Employer along with the tender. The Quality Assurance Plan after the same is found acceptable, will be approved by the Employer.

The contractor shall follow the approved Quality Assurance Plan in true spirit. If desired by the Employer, he shall give access to all the documents and materials to satisfy the Employer that the Quality Assurance Plan is being properly followed.

## **13. TESTING**

### **13.1. SELECTION OF TEST SAMPLES FOR TYPE TESTS**

13.1.1. The samples shall be taken from a continuous length of conductor and subjected to all the tests specified in clause 14.

### **13.2. SELECTION OF TEST SAMPLES FOR ACCEPTANCE TESTS**

13.2.1. Before dispatch from the works individual wire and finished steel cored aluminum conductor shall be subjected to the tests as specified in IS:398 or any other authoritative standard.

13.2.2. Sample for individual wires for test shall be taken before stranding from outer ends of not less than ten per cent of the spools in the case of aluminum wire and ten per cent of the wire coils in the case of steel wires. If samples are taken after stranding, they shall be obtained by cutting 1.2 meters from the outer ends of the finished conductor from not more than 10 per cent of the finished reels.

13.2.3. The routine tests shall be same as acceptance test. The manufacturer will draw samples for routine tests as per Cl. 13.1.1 or 13.1.2 of IS: 398 (Part 2) and will maintain the record of routine tests for buyer's review. For acceptance tests, the sample shall be taken as per Cl. shall be as per Cl.13.1.2 of IS: 398 (Part 2).

## **14. TESTS**

The following tests shall be carried out on sample/samples of conductor.



#### 14.1 Type Tests

- (i) Visual examination
- (ii) Measurement of diameters of individual aluminum and steel wires.
- (iii) Measurement of lay ratio of each layer
- (iv) Breaking load test
- (v) Ductility test
- (vi) Wrapping test
- (vii) Resistance test on aluminum wires.
- (viii) DC resistance Test on aluminum wires.
- (ix) Galvanizing test
- (x) Surface condition test
- (xi) Stress Strain test
- (xii) Procedure qualification test on welded joint of Aluminum Strands.

**NOTE:-**The type test reports shall not be older than FIVE years and shall be valid up to expiry of validity of offer.

The above additional lists if not conducted earlier, shall be done under the subject project package at no extra cost.

#### 14.2 Acceptance tests and Routine tests

- (ii) Visual and dimensional check on drum.
- (iii) Visual examination
- (iv) Measurement of diameters of individual aluminum and steel wires.
- (v) Measurement of lay ratio of each layer
- (vi) Breaking load test
- (vii) Ductility test
- (viii) Wrapping test
- (ix) Resistance test on aluminum wires.
- (x) DC resistance Test on Composite Conductor.
- (xi) Galvanizing test

#### 14.3 Tests During Manufacture

The following tests during manufacture shall be carried out.

- (i) Chemical analysis of zinc used for galvanising,
- (ii) Chemical analysis of aluminum used for making aluminum strands,
- (iii) Chemical analysis of steel used for making steel strands,

#### 14.4 Visual examination

The conductor shall be examined visually for good workmanship and general surface finish of the conductor. The conductor drums shall be rewound in the presence of Inspecting Officer. The Inspector will initially check for Scratches, Joints etc., and that the conductor shall generally conform to the requirements of the specifications/IS 398(Part- II)-1996.

14.5 Measurement of diameters of individual Aluminum and Steel Wires.

The diameters of individual Aluminum and Steel Wires shall be checked to ensure that they conform to the requirements of this specification.

14.6 Measurement of lay-ratios

The lay-ratios of each layer of the conductor shall be measured and checked to ensure that they conform to the requirements of this specification and IS:398 (Part-II)-1996.

14.7 Breaking load test

a) **Breaking load test on complete conductor.**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

b) **Breaking load test on individual aluminum and galvanized steel wires.**

This test shall be conducted on both Aluminum and Galvanized steel wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm. / min. The ultimate breaking load of the specimens shall be not less than the values specified in the Section-II.

14.8 Ductility Test

For the purpose of this test both torsion and elongation tests shall be carried out on galvanized steel wires only.

#### 14.9 Torsion Test

One specimen cut from each of the samples taken shall be gripped in two vices exactly 15 cms. apart. One of the vices shall be made to revolve at a speed not exceeding one revolution per second and the other shall be capable of moving longitudinally to allow for contraction or expansion during testing. A small tensile load not exceeding 2 (two) percent of the breaking load of the wire shall be applied to the samples during testing. The test shall be continued until fracture occurs and the fracture shall show a smooth surface at right angles to the axis of the wire. After fracture, the specimen shall be free from helical splits. The sample shall withstand a number of twists equivalent to not less than 18 on length equal to 100 times the diameter. When twisted after stranding the number of complete twists before fracture occurs shall be not less than 16 on a length equal to 100 times the diameter of the wire. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to the next higher whole number. The fracture shall show a smooth surface at right angles to the axis of the wire.

#### 14.10 Elongation Test

The elongation of one specimen cut from each of the samples taken shall be determined. The specimen shall be straightened by hand and an original gauge length of 200 mm. shall be marked on the wire. A tensile load shall be applied as described in 1.1.4.6.2.1 and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm. of either mark and the required elongation is not obtained, the test shall be disregarded and another test conducted. When tested before stranding, the elongation shall be not less than 4 percent and when tested after stranding, the elongation shall be not less than 3.5 percent.

#### 14.11 Wrapping Test

This test shall be conducted on both Aluminum and Galvanized steel wires.

##### 14.11.1 Aluminum wires

One specimen cut from each of the samples of aluminum wires shall be wrapped round a wire of its own diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and closely wrapped in the same direction as before. The wire shall not break or show any crack.

##### 14.11.2 Galvanized steel wires

One specimen cut from each of the samples of galvanized steel wire taken shall be wrapped round a mandrel of diameter equal to 4 times the wire diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

#### 14.12 Resistance Test

This test shall be conducted on aluminum wires only, conforming to procedure as per IEC:889. The electrical resistance of one specimen of aluminum wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degrees C. by means of following formula.

1

$$R_{20} = R_T \frac{1 + \alpha (T - 20)}{1 + \alpha (20 - T)}$$

1+ alpha x  
(T-20)

Where

R<sub>20</sub> = Resistance corrected at 20 degrees C.

R<sub>T</sub> = Resistance measured at T degrees C.

alpha = Constant mass temperature coefficient  
of resistance 0.004. T = Ambient temperature during  
measurement

This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in section-II.

#### 14.13 Galvanizing Test

This test shall be conducted on galvanized steel wires only. The uniformity of Zinc coating and the weight of coating shall be in accordance with IS 4826-1979.

#### 14.14 Surface Condition Test

A sample of the finished conductor for use in 11/33 KV system having a minimum length of 5 meters with compression type dead end clamps compressed on both ends in such manner as to permit the conductor to take its normal straight line shape, shall be subjected to a tension of 50 percent of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place or disturb

the longitudinal smoothness of conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminum and steel strands as indicated in Section-II.

**14.15 Stress-Strain Test**

The test is contemplated only to collect the creep data of the conductor from the manufacturer. A sample of conductor of minimum 10 meters length shall be suitably compressed with dead end clamps. (applicable only for conductors of nominal aluminium area 100 sq. mm and above)

**15. TEST SET-UP**

15.1. The test sample shall be supported in a trough over its full length and the trough adjusted so that the conductor will not be lifted by more than 10mm under tension. This shall be ascertained by actual measurement.

15.2. The distance between the clamp and the sleeve mouth shall be monitored with callipers during the test to ensure that, after the test, it does not change by more than 1mm + 0.1mm from the value before the test.

15.3. The conductor strain shall be evaluated from the measured displacements at the two ends of the gauge length of the sample. The gauge reference targets shall be attached to the clamps which lock the steel and aluminum wires together. Target plates may be used with dial gauges or displacement transducers and care shall be taken to position the plates perpendicular to the conductor. Twisting the conductor, lifting it and moving it from side- to-side by the maximum amounts expected during the test should introduce no more than 0.3mm error in the reading.

**16. TEST LOADS FOR COMPLETE CONDUCTOR**

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows:

16.1. 1KN load shall be applied initially to straighten the conductor. The load shall be removed after straightening and then the strain gauges are to be set At zero tension.

16.2. For non-continuous stress-strain data, the strain readings at 1KN intervals at lower tensions and 5 KN intervals above 30% of UTS shall be recorded.

16.3. The sample shall be reloaded to 30% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released then after the hold period.

- 16.4. The sample shall be reloaded to 50% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released then after the hold period.
- 16.5. Reloading upto 70% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes. The load shall be released.
- 16.6. Reloading upto 85% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes and the load shall be released then.
- 16.7. Tension shall be applied again and shall be increased uniformly until the actual breaking strength is reached. Simultaneous readings of tension and elongation shall be recorded upto 90% of UTS at the intervals described under Clause 16.6.

**17. TEST LOADS FOR STEEL CORE ONLY (applicable only for conductors of nominal aluminum area 100 sq. mm and above)**

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows:

- 17.1. The test shall consist of successive applications of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.
- 17.2. The steel core shall be loaded until the elongation at the beginning of each hold period corresponds to that obtained on the complete conductor at 30%, 50%, 70% and 85% of UTS respectively.

**18. STRESS-STRAIN CURVES**

The design stress-strain curve shall be obtained by drawing a smooth curve through the 0.5 and 1 hour points at 30%, 50% and 70% of UTS loadings. The presence of any aluminum slack that can be related to any observed extrusion entering the span from the compression dead ends shall be removed from the lower ends of the design curves. Both the laboratory and standard stress-strain curves shall be submitted to the Employer along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 deg.C.

**19. DC RESISTANCE TEST ON COMPOSITE CONDUCTOR**

On a conductor sample of minimum 5m length, two contact clamps shall be fixed with a pre-determined bolt torque. The resistance of the sample shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20

deg C as per clause no. 12.8 of IS:398 (Part-II)-1982/1996. The corrected resistance value at 20 deg.C shall conform to the requirements of this specification.

**20. PROCEDURE QUALIFICATION TEST ON WELDED ALUMINUM STRANDS.**

Two Aluminum wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

**21. CHEMICAL ANALYSIS OF ALUMINUM AND STEEL**

Samples taken from the Aluminum and Steel ingots / coils/ strands shall be chemically/ spectrographically analyzed. The same shall be in conformity with the requirements stated in this specification.

**22. CHEMICAL ANALYSIS OF ZINC**

Samples taken from the zinc ingots shall be chemically / spectrographically analysed. The same shall be in conformity with the requirements stated in this specification.

**23. VISUAL AND DIMENSIONAL CHECK ON DRUMS**

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification.

**24. REJECTION AND RETEST**

24.1. In case of failure in any type test, the Manufacturer is either required to manufacture fresh sample lot and repeat all the tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

24.2. If samples are taken for test after stranding and if any selected reel fails in the retest, the manufacturer may test each and every reel and submit them for further inspection. All rejected material shall be suitably marked and segregated.

**25. CHECKING AND VERIFICATION OF LENGTH OF CONDUCTOR**

The contractor should arrange for inspection by the representative of the Employer specially authorised for this purpose. At least 50% of the total number of drums of conductor subject to minimum of two taken at random should be checked to ascertain the length of conductor. Arrangements should be

made available in the works of the manufacturer for transferring the conductor from one reel to another at the same time measuring the length of the conductor so transferred by means of a meter.

**26. ADDITIONAL TESTS**

The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Bidder's premises, at site, or in any other standard Laboratory in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the specifications.

**27. TESTING EXPENSES**

27.1. The breakup of the testing charges for the type tests specified shall be indicated separately.

27.2. Bidder shall indicate the laboratories in which they propose to conduct the type test. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.

27.3. The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of the conductor, except for the expenses of the inspector/Employer's representative.

27.4. In case of failure in any type test, if repeat type tests are required to be conducted then all the expenses for deputation of Inspector/Employer's representative shall be deducted from the contract price. Also if on receipt of the Manufacturer's notice of testing, the Employer's representative does not find 'plant' to be ready for testing, the expenses incurred by the Employer for re - deputation shall be deducted from contract price.

**28. TEST REPORTS**

28.1. Copies of type test reports shall be furnished in at least six copies alongwith one original. One copy will be returned duly certified by the Employer only after which the commercial production of the material shall start.

28.2. Record of Routine test reports shall be maintained by the Manufacturer at his works for periodic inspection by the Employer's representative.

28.3. Test certificates of Tests during manufacture shall be maintained by the



Manufacturer. These shall be produced for verification as and when desired by the Employer.

## **29. TEST FACILITIES**

The following additional test facilities shall be available at the Manufacturer's works:

- (i) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer, etc.
- (ii) Standard resistance for calibration of resistance bridges.
- (iii) Finished Conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and be free of vibrations, jerks etc. with traverse laying facilities.

## **30. INSPECTION**

- 30.1. The Employer's representative shall, at all times, be entitled to have access to the works and all places of manufacture where conductor shall be manufactured and the representative shall have full facilities for unrestricted inspection of the Bidder's works, raw materials and process of manufacture and conducting necessary tests as detailed herein.
- 30.2. The Bidder shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.
- 30.3. The contractor will intimate the Employer about carrying out of the tests at least 45 days in advance of the scheduled date of tests during which the Employer will arrange to depute his representative/s to be present at the time of carrying out of the tests. Six (6) copies of the test reports shall be submitted.
- 30.4. No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, Unless the inspection is waived off by the employer in writing. In the later case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein has been completed and approved by the employer.
- 30.5. The acceptance of any quantity of material shall in no way relieve the Bidder of

any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

- 30.6. At least 50% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by the following method:

"At the works of the manufacturer of the conductor, the conductor shall be transferred from one drum to another at the same time measuring its length with the help of a graduated pulley and Cyclometer. The difference in the average length thus obtained and as declared by the Bidder in the packing list shall be applied to all the drums if the conductor is found short during checking".

### 31. SCHEDULE OF DEVIATIONS/VARIATIONS

If the tenderer has any exceptions to any of the clause/s laid down in this specification, these should be clearly stated in the schedule of deviations / variations.

## SECTION - II SPECIFIC TECHNICAL REQUIREMENTS SCOPE

This section of the specification covers climatic and isoceraunic conditions, specific technical particulars, schedule of requirements & desired deliveries, for conductor for 11/33 kV lines.

### 1. CLIMATIC & ISOCERAUNIC CONDITIONS TO BE SPECIFIED BY EMPLOYER

#### 1.1 Maximum Temperature

- a) Conductor °C.

#### 1.2 Minimum Temperature °C.

#### 1.3 i)Max. ambient temperature °C

#### ii) Mean annual / every day temperature °C

#### 2.4 Basic wind speed m/s

#### 2.5 Relative humidity

i) Maximum %

ii) Minimum %

2.6 Average Rainfall (Max.) mm per annum

2.7a) Rainy months May to Sept.

15 Rainy days in a year (days)

2.8 Average number of thunder storm

2.9 Altitude varying from sea level

2.10 Basic horizontal Seismic Co-efficient(horizontal) Basic vertical Seismic Co-efficient

2.11 System Particulars

a) Line Voltage (kV)

b) Highest System Voltage (kV)

c) Number of Circuits

d) Frequency HZ

e) Neutral

f) Short circuit level (KA)

## 2. SPECIFIC TECHNICAL REQUIREMENTS

CONDUCTOR:					
1. Conductor:	Rabbit/Raccoon/Dog/Weasel/Panther ACSR				
2. IS applicable:	IS-398 (part-II) 1996 latest revision				
3. Wire Diameter	Rabbit	Raccoon	Dog	Weasel	Panther
Aluminium (mm)	6/3.35	6/4.06	6/4.72	6/2.59	30/3.00
Steel(mm)	1/3.35	1/4.09	7/1.57	1/2.59	7/3.00
4. Number of strands:					
Steel centre		1	1	1	1

1st steel layer	-		6		6
1st Aluminium layer	6	6	6	6	12
2nd Aluminium layer					18
5. Sectional Area of Aluminium (sq. mm.)	52.88	78.83	105	31.61	212.1
6. Total Sectional Area(sq.mm.)	61.7	91.97	118.5	36.88	261.5
7. Overall diameter(mm)	10.05	12.27	14.15	7.77	21
8. Approximate weight(Kg./Km.)	10.05	12.27	14.15	7.77	21
9. Calculated D.C resistance at 20 degrees C., maximum. (Ohms/Km)	0.552	4.371	2.2792	0.9289	0.139
10. Ultimate tensile strength (KN)	18.25	26.91	32.41	11.12	89.67
11. Final modulus of elasticity (GN/sq.m)	79	79	75	79	80
12. Coefficient of linear expansion x 10-6 per°C	19.1	19.1	19.8	19.1	17.8
13. Lay ratio	Max Min	Max Min	Max Min	Max Min	Max Min
Steel core 6 wire layer			28 13		28 13
Aluminium Ist layer	14 10	14 10	14 10	14 10	14 10
2nd layer					16 10

## 14. Technical Particulars

a. Diameter-mm		Rabbit		Raccon		Dog		Weasel		Panther
	Al	Steel	Al	Steel	Al	Steel	Al	Steel	Al	Steel
Standard(mm)	3.35	3.35	4.09	4.09	1.57	4.72	2.5	2.59	3.00	3.00

								9			
	Maximum (mm)	3.42	3.38	4.17	4.13	1.60	4.77	2.64	2.62	3.06	3.03
	Minimum (mm)	3.28	3.32	4.01	4.05	1.54	4.67	2.54	2.56	2.94	2.97
b.	Cross-sectional area of nominal diameter wire (mm <sup>2</sup> )	8.814		8.814	13.14	13.14		1.936	17.50	5.269	5.269 7.069
c	Weight (Kg./Km)	68.75	23.82	102.48	35.51	15.10	47.30	41.09	14.24	55.13	19.1
d	Min. breaking load (KN)										
	Before stranding	11.58	1.43	17.27	2.08	2.70	2.78	6.92	0.89	9.29	1.17
	After Stranding	11.00	1.36	16.48	1.98	2.57	2.64	6.57	0.85	8.83	1.11
e.	D.C resistance at 20°C min. (Ohm/Km)		-3.265		-2.194		1.65		-5.49		
					-4.079						

**15. Zinc coating of steel core:**

- (i) The steel strands shall be hot dip galvanized as per IS: 4826.
- (ii) Process of Galvanizing: Hot dip.
- (iii) Quality of Zinc : IS-209/1979 or latest edition.

**16. Joints in strands****16.1 Steel : Not permitted****16.2 Aluminium:** No joint shall be permitted in the Aluminum wires in the outer most layer of the ACSR conductor. But permitted in the inner layers such that no two such joints are within 15 meters of each other in the complete stranded conductor.**15. Chemical composition of high carbon steel wire:**

Element	%Composition
i) Carbon	0.5 to 0.85
ii) Manganese	0.5 to 1.10
iii) Phosphorus	Not more than 0.035
iv) Sulphur	Not more than 0.045
v) Silicon	0.10 to 0.35

**Guaranteed Technical Particulars of Conductor (To be filled in by the Tenderer)**

1. Code Word
2. Maker's name and address
  - a. Aluminium Rods
  - b. Steel Rods
  - c. Complete Conductor
3. Stranding and Wire diameter
  - a. Aluminium
    - i) Nominal
    - ii) Minimum
    - iii) Maximum
  - b. Steel
    - i) Nominal
    - ii) Minimum
    - iii) Maximum
4. Nominal Aluminium Area in [sq. mm](#)
5. Sectional Area of Aluminium in Sq. mm.
6. Total Sectional Area in Sq.mm.
7. Cross Sectional area of Nominal Diameter wire in [sq.mm](#).

- |     | a) Aluminium   | b) Steel                | c) Overall diameter of conductor in mm. |
|-----|--|-------------------------|---|
| 8.  | Breaking load of conductor in KN.  |                         |   |
| 9   | Minimum breaking load for  |                         |   |
|     | a. Aluminium Wire  | --- i) Before stranding | ii) After stranding                     |
|     | b. Steel Wire  | --- i) Before stranding | ii) After stranding                     |
| 10. | Zinc Coating of steel wire   |                         |   |
|     | a. Uniformity of coating, number & duration of dips process test, withstood                                    |                         |   |
|     | i) Before stranding ii) After stranding  |                         | 1 Min x nos.                            |
|     |  |                         | 1/2 Min x nos                           |
|     | b. Minimum Weight of coating gm/sq.m   |                         |   |
|     | i) Before stranding ii) After stranding  |                         |   |
| 11. | Mass in kg. per Km.  |                         |   |
|     | a. Aluminium   |                         |   |
|     | b. Steel   |                         |   |
|     | c. Conductor   |                         |   |
| 12. | Resistance in ohm per Km at 20 <sup>0</sup> C  |                         | i) Aluminium ii) Conductor              |
| 13. | Continuous maximum current rating of conductor (Amps. in still air at 45 <sup>0</sup> C ambient temperatures). |                         |   |
| 14. | Modulus of elasticity of conductor   |                         |   |
| 15. | Co-efficient of linear expansion per degree centigrade of :  |                         |   |
|     | a. Aluminum wire   |                         |   |
|     | b. Steel Wire  |                         |   |
|     | c. Conductor   |                         |   |
| 16. | Standard length of each piece in Km.   |                         |   |
| 17. | Approximate dimensions of the drum in mm.  |                         |   |
| 18  | Weight of the conductor in one drum in Kg.   |                         |   |
| 19  | Weight of the drum in Kg.  |                         |   |
| 20. | Gross weight of the drum including weight of the conductor.  |                         |   |
| 21. | Standard according to which the conductor will be manufactured and tested.                                     |                         |   |
| 22. | Other particulars if any.  |                         |   |

### **3. Tubular Steel Poles for Overhead Lines**

#### **1 SCOPE:**

This specification covers the general requirements towards design, manufacture, testing at manufacturers works, supply and delivery for tubular steel poles of circular cross section ( swaged type ) for overhead lines.

#### **2 STANDARD:**

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.

#### **3 Topography and Climatic Condition:**

The materials offered, shall be suitable for operation in tropical climate and will be subjected to the sun and inclement weather and shall be able to withstand wide range of temperature variation. For the purpose of design, average atmospheric temperature may be considered to be 50°C with humidity nearing saturation.

#### **4 Materials:**

**4.1** The materials used in construction of tubular steel poles shall be of the tested quality of steels of minimum tensile strength 410 MPa ( 42 Kgf/mm<sup>2</sup>).

**4.2** The materials, when analysed 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.



## **5 Types, Size and construction:**

### **5.1 Tubular Steel Poles shall be swaged type.**

The poles required under this specification are as below: -

- |                                   |                     |
|-----------------------------------|---------------------|
| 1. Steel Tubular Poles (410SP-33) | 9.00 Meter Length.  |
| 2. Steel Tubular Poles (410SP-55) | 11.00 Meter Length. |
| 3. Steel Tubular Poles (410SP-72) | 13.00 Meter Length. |

**5.2** 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.

**5.3** 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.

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

**5.5.** 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 cylindrical. The weld joints, if any, shall be of good quality, free from scale, surface defects, cracks, etc.

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

**5.7.** 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.

## **Earthing Arrangements:**

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

## **1 Tests and Test Certificates:**

**7.1** 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, and
- D. Drop test.

**7.2** In addition to above verification of dimensions as per IS: 2713 (Part-III) : 1980 shall be carried out during acceptance lots.

**7.3** Number of poles selected for conducting different tests shall be in accordance to clause No. 10.1.1 and No. 10.1.12: of IS: 2713 (Part-I) 1980.

**7.4** 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.

**7.5** Re-tests, if any, shall be made in accordance with IS: 2713 (Part-I) 1980.

**7.6** Purchaser reserves the right to inspect during manufacturing and depute his representative to inspect/test at the works.

**7.7** If any extra cost is required for carrying out the above specified tests, the same shall be borne by the manufacturer.

## **2 Marking:**

**8.1** The poles shall be marked with designation, manufacturer's identification, year of manufacture and name of the purchaser: Employer Name;

**8.2** The poles may also be marked with the ISI certification mark.

## **3 Guaranteed technical particulars:**

**9.1** The manufacturer shall furnish all necessary guaranteed technical particulars in the prescribed Performa enclosed hereinafter.

## **10 Performance:-**

**10.1** The manufacturer shall furnish a list of the major supplies effected during the last 3 (three) years indicating the volume of supply and actual delivery dates.

**10.2** Manufacturer may not be considered if the past manufacturing experience is found to be less that 3 (three) years.

## **11 Deviation:-**

Any deviation in technical specification shall be clearly indicated with sufficient reasons thereof. Purchaser shall however reserve the right to accept and/or reject the same without assigning any reasons what-so-ever.

**ANNEXURE –‘A’****SPECIFIC TECHNICAL REQUIREMENTS FOR TUBULAR STEEL  
POLES : SWAGED TYPE**

	<b>9 meters long</b>	<b>11 meters long</b>	<b>13 meters long</b>
1) Standard	IS: 2713 ( Pat-I and III): 1980 as amended upto date		
2) Type of Pole	Swaged Type		
3) Designation	410 SP 33	410 SP 55	410 SP 72
4) Overall Length	9 meters	11 meters	13 meters
5) Planting depth	1.5 meters	1.8 meters	2.0 meters
6) Height above ground	7.5 meters	9.2 meters	11.0 meters
7) Effective length of Each section.			
a) Bottom	5.0 meters	5.6 meters	5.80 meters
b) Middle	2.0 meters	2.7 meters	3.60 meters
c) Top	2.0 meters	2.7 meters	3.60 meters

8) Outside diameter and Thickness of each Section.			
a) Bottom	165.1x5.40 mm	193.7x4.85 mm	219.1x5.90 mm
b) Middle	139.7x4.50 mm	165.1x4.50 mm	193.7x4.85 mm
c) Top	114.3x3.65 mm	139.7x4.50 mm	165.1x4.50 mm
9) Joint Length ( in cm.):			
a) Bottom (J2)	30 cm.	35 cm.	45 cm.
b) Top (J1)	23 cm.	30 cm.	40 cm.
10) Approximate weight of Pole	164 Kg.	227 Kg.	343 Kg.
11) Point of application of load below/top (mtr.)	0.3 mtr.	0.6 mtr.	0.6 mtr
12) Breaking load (inKgf )	612	650	828
13) Working load with factor of Safety : 2.5 ( in Kgf )	290	308	331
14) Crippling load ( inKgf )	435	462	588
15) Load for permanent set Not exceeding 13mm (in Kgf)	232	276	527
16) Load for Temporary Deflection of 157.5 mm (in Kgf)	76	74	121
17) Minimum tensile strength of steel used in manufacturing of poles(kg.f mm <sup>2</sup> )	42	42	42
18) Tolerance	As per IS : 2713 ( Part-I & Part-III): 1980		
19) Finish	-do-		
20) Manufacturing clause	-do-		

#### **4 Mild Steel Channel, Angle And Flat**

##### **1) APPLICABLE STANDARDS:**

The mild steel shall conform to IS: 2062 grade 'a' modified upto date or equivalent international standard for steel materials, documents for which shall be made available at the time of inspection to the owner's representative.

##### **2) GENERAL REQUIREMENTS:**

Material shall be supplied as per the following sizes:

100x50 ISMC channel conforming to IS: 2062 grade 'a' modified upto date or its equivalent International Standard having length ranging from 5.5 to 13.5 meters. 75x40 ISMC channel conforming to IS: 2062 grade 'a' modified upto date or its equivalent International Standard having length ranging from 5.5 to 13.5 meters.

50x50x8 mm or 6 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.

45X45X5 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.

60x65x6 mm ISA angles conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 13.5 meters.

25X3mm, 50X6mm, 50x8mm, 75X8mm and 80X8 flats conforming to IS: 2062 grade 'a' modified upto date or its equivalent international standard having length ranging from 5.5 to 9.5 meters.

##### **3) GALVANISATION:**

All above steel members shall be fabricated as per approved drawing having smooth edge, drilled circular/elliptical holes of suitable measurements.

All structural steel members and bolts shall be galvanized as per IS:4759 and zinc coating shall not be less than 610gm/sq. meter for all structural steel members. All weld shall be 6mm filled weld unless specified otherwise. All nuts and bolt shall be of property class 5.6 of IS 1367. Plain washers shall be as per IS 2016 and spring washers shall be IS:3063

##### **4) INSPECTION:**

All inspection/test will be carried out by representative of owner.

All tests and inspection shall be made at the place of manufacturer unless otherwise specially agreed upon by the manufacturer and the owner. The manufacturer shall provide all reasonable facilities, without charge to satisfy him that the material is being supplied in accordance with the specification.

## 5 11 & 33 KV Outdoor Type Current Transformer

### 4.1 INTRODUCTION

This section covers the specification of 33 kV and 11kV Current Transformer suitable for outdoor service. Any other parts not specifically mentioned in this specification but otherwise required for proper functioning of the equipment should be included by the tender in the offer. The CTs should normally be installed above VCB. The VCB & CT should be installed on common mounting structure. In places, where VCB are not provided in the Substation separate CT mounting structure shall be provided with CTs.

### 4.2 APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Current Transformer shall comply with the latest version of relevant standards (IS 2165, IS 2705(I-IV), IS 2099, IS 5621, IS 2071, IS 335, IS 13947(part I), IEC 185, IEC 270, IEC 44(4), IEC 171, IEC 60, IEC 8263, IEC 815, Indian electricity Rules 2003) or better international standards. This list of standards is for guidance only. The contractor shall be solely responsible to design & manufacture the CT suitable for 33kV & /11 kV systems.

### 4.3 AMBIENT CONDITIONS

The CT supplied against these specifications shall be suitable for satisfactory continuous operation under the tropical conditions. The detail condition is mentioned in General Technical requirement.

### 4.4 SYSTEM PARTICULARS

a)	Nominal System Voltage	33kV & 11kV
b)	Highest system Voltage	36kV & 12kV
c)	Rated Frequency	50Hz & 50Hz
d)	No of phases	Three & Three
e)	System neutral earthing	-Solidly Earthed-
f)	One minute Power Freq. withstand voltage (rms)	70kV & 28kV
g)	Lighting Impulse withstand Voltage	170kVp & 75kVp

- |    |                    |                 |
|----|--------------------|-----------------|
| i) | System fault level | -25kA for 3sec- |
|----|--------------------|-----------------|

#### 4.5 TECHNICAL PARAMETERS OF CT

- |    |  |  |
|----|--|--|
| a) | Type<br>outdoor,oil  | Single phase, dead tank,<br><br>filled & hermetically sealed |
| b) | Type of mounting   | Pedestal type  |
| c) | Rated primary current  | As per BPS   |
| d) | Rated Continuous thermal current<br>Primary current                                | 120 % of rated   |
| e) | Rated short time withstand<br>Requirement for sec. Winding                         | As per IS 2705 Pt. I   |
| f) | Rated short time withstand<br>Current  | 25kA(RMS)  |
|    | i) Duration (for primary current<br>of 150amps and above)                          | 3Sec   |
|    | ii) Duration (for primary current<br>below 150amps)                                | 1Sec   |
| g) | Rated dynamic withstand<br>Current (KA rms)  | 62.5   |
| h) | Max temp rise  | As per IEC-185/ IS 2705                                      |
| i) | Minimum creepage distance<br>of porcelain housing(mm)                              | 25 mm /KV  |
| j) | One minute power frequency<br>Withstand voltage between Secondary terminal & earth | 3 kV   |
| k) | Detail of Secondary Cores  | Metering Protn.  |
|    | Current ratio  | (As per BPS)   |
|    | Accuracy class   | 0.5 5P10   |

Burden (VA)	30	30
Instrument security Factor	$\leq 5$	-
Accuracy Limit Factor	-	$\geq 10$

**Note:** The ratings indicated for instrument transformer are tentative only and may be changed to meet the requirements.

#### 4.6 PORCELAIN HOUSING

It shall be single piece of homogeneous, vitreous porcelain of high mechanical & dielectric strength. It will be glazed with uniform Brown or Dark brown colour with smooth surface finish. The creepage distance for the porcelain housing shall be at least 25 mm per kV.

#### 4.7 WINDING

##### 1 PRIMARY WINDING

It shall be made of high conductivity rigid copper wire. The primary winding current density shall not exceed the limit of 1.6 Amp per sq. mm for normal rating.

The design current density for short circuit current as well as conductivity of metal used for primary winding shall be as per IS 2705. The calculation for the selection of winding cross section shall be furnished by contractor.

The primary terminal shall be of maximum\* size of 30 mm dia x 80 mm length of heavily tinned (min. thickness 15 micron) electrolytic copper of 99.9 % conductivity. Manufacturer shall design the diameter of primary terminal keeping current density 1.6A per sq. mm for the given capacity of CT.\*

\*Amendment issued vide letter No. REC/DDUGJY/SBD/2017/2148 Dated 21.07.2017.

##### 2 SECONDARY WINDING

shall be made of insulated copper wire of electrolytic grade. Type of insulation used shall be described in the offer. For multi ratio design, the multi ratio will be achieved by reconnection of the primary winding or secondary winding. The excitation current of the CT shall be as low as possible. The contractor shall furnish the magnetization curves for all the cores.



The terminal box shall be dust free & vermin proof. The size of the terminal box shall be big enough to enable easy access and working space with the use of normal tools.

The secondary terminals studs shall be provided with at least 3 nuts and two plain washers, these shall be made of brass duly nickel plated. The min. stud outer dia shall be 6 mm & length 15 mm. The min spacing between the centres of the adjacent studs shall be 1.5 time the outer dia of the stud.

### **3 POLARITY**

The polarity shall be marked on each CT at the primary and secondary terminals.

#### **4.8 TANK & HARDWARES**

The CT will be dead tank type. The tank shall be fabricated of MS steel sheet of min. 3.15 mm for sides & 5 mm for top & bottom. The tank will be finished with min. 2 coats of zinc rich epoxy paint externally. The inner surface shall be painted with oil resistance white enamel paint.

All ferrous hardware, exposed to atmosphere shall be hot dipped galvanized.

#### **4.9 INSULATION OIL**

The first filling of oil in CT shall be in contractor's scope. The oil shall be as per IS 335.

**To ensure prevention of oil leakage, the manufacturer will give following details supported by drawings:**

- i) Location of emergence of Primary & Secondary terminals
- ii) Interface between porcelain & metal tanks
- iii) Cover of the secondary terminal box

Any nut & bolt and screw used for fixation of the interfacing porcelain bushing for taking out the terminals shall be provided on flanges cemented to the bushings & not on the porcelain.

If gasket joints are used, Nitrite Butyl Rubber gasket shall be used. The grooves shall be machined with adequate space for accommodating gasket under pressure.

The CT shall be vacuum filled with oil after processing. It will be properly sealed to eliminate breathing & to prevent air & moisture from entering the tank. The sealing methods/arrangement shall be described by the contractor & be approved by the owner.

#### **4.10 OIL LEVEL INDICATOR**

The CT shall be fitted with prismatic type oil sight window at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.

To compensate oil volume variation due to temperature variation, Nitrogen cushion or the stainless steel bellows shall be used. Rubber diaphragms are not permitted for this purpose.

#### **4.11 EARTHING**

Two earthing terminals shall be provided on the metallic tank of size 16 mm dia & 30 mm length each with one plain washer & one nut for connection to the station earth mat

#### **4.12 Junction Box**

The junction box shall be of MS sheet having thickness of 2mm, synthetic enamel painted as per procedure mentioned in General Technical Requirement (Min. thickness 55 micron). The shade of junction box shall be 697 of IS: 5. Disconnecting type terminal blocks for CT secondary lead shall be provided. The junction boxes shall be weather proof type with gaskets, as per section-I (Introduction and general technical requirements) conforming to IP-55 as per IS-13947 (Part-I).

#### **4.13 LIFTING & MOUNTING ARRANGEMENT**

The CT shall be provided with two lifting eyes to lift the CT. This shall be so positioned so as to avoid any damage to the CT during lifting for installation or transportation purpose. This shall be detailed in General Arrangement drawing.

The CT shall be of pedestal mounting type suitable for outdoor installation on steel/cement concrete structures. All the clamps, bolts, nut and washers etc. required for mounting the CT on the structure shall be supplied along with the CT and shall be galvanized. The contractor shall supply all the terminal connectors etc. required for connection to the CT.

#### **4.14 TESTING**

All Type and Routine Tests shall be as per relevant IS and/or IEC.

### GUARANTEED TECHNICAL PARTICULARS OF CURRENT TRANSFORMER

Sl.No.	Particular of GTP Parameter	Bidders Confirmation	
		33kV CT	11kV CT
1	Manufacturer's Name & address		
2	Type of equipment		
3	Type of Mounting		
4	Equipment Conforming to Standards		
5	Rated Voltage / Highest System Voltage in KV		
6	Rated Primary Current (Amp)		
7	Rated Secondary Current (Amp)		
8	Frequency (HZ)		
9	Ratio of Current Transformer		
10	Details of Cores		
i)	Number of Cores		
ii)	Purpose		
iii)	Burden (VA)		
iv)	Class of Accuracy		
11	Rated Short Time Withstand Current for 1 Sec. duration		
12	Rated Dynamic Withstand Current (KAp)		
13	Method of Earthing system to be connected to		
14	One-minute Dry Power Frequency Withstand Voltage (KV rms) of Primary Winding		
15	One-minute Wet Power Frequency Withstand Voltage (KV rms) of Primary Winding		
16	1.2/50 micro-second Impulse Withstand Voltage (KVP)		
17	The die-electric Withstand values (KVp)of external & internal insulation		
18	One minute Power Frequency Withstand Voltage (KV rms) of Secondary Winding		
19	Minimum Creepage Distance (mm)		
20	Weight of oil (kg/Ltrs.)		
21	Total Weight (kg)		
22	Mounting details		
23	Overall dimension		
24	Type of Winding		
25	Material of Winding		
26	Size & Cross Section of Primary Winding		
27	Size & Cross Section of Secondary Winding		
28	No. of Primary Turns		
29	No. of Secondary Turns		

Sl.No.	Particular of GTP Parameter	Bidders Confirmation	
		33kV CT	11kV CT
30	Current Density of Primary & Secondary Winding (max. – 1.6A/sq.mm)		
31	Primary Terminal		
32	Type of Insulation		
33	Whether Current Transformer confirms to Temperature Rise		

## 6 LT upto (1100 V) XLPE Insulated Cable

### 1.0 SCOPE:

- 1.1 The scope of this specification covers the design, manufacture inspection and testing the finished ISI marked LT (1100 volts, 31/2 x25 Sq.mm to 400 Sq.mm stranded, compact aluminum conductor, with XLPE insulated, PVC inner sheathed, galvanized steel strip armored/unarmored and overall PVC sheathed Black colour cable conforming to IS:7098 /88 with latest amendments and as per specification detailed.

### 2.0 RATED VOLTAGE:

- 2.1 The rated voltage of the cable shall be 1100 Volts AC with the highest system voltage of 1100 Volts between phases of the effectively earthed three-phase transmission system.
- 2.2 The cables shall be capable of operating continuously under the system frequency variation of  $\pm 3$  Hz, voltage variation of  $\pm 10\%$  and a combined frequency – voltage variation of  $\pm 10\%$ .

### 3.0 APPLICABLE STANDARDS:

- i) Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:

IS 7098 (Part 2)-Cross-linked Polyethylene insulation for Cables.

IS 8130-Conductors for insulated electrical cables and flexible cords.

IS 10810(series)-Methods of tests for cables.

IS 10418-Drums for electric cables.

IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables.

IS 5831-Specification for PVC insulation sheath for electric cables.

IS 10462-Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables.

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

#### 4.0 CONSTRUCTION:

4.1 **Conductor:** - The cable conductor shall be made from stranded aluminum to form compact sector shaped conductor having resistance within the limits specified in IS:8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay. Stranded Class 2 – as per the IS:8 130 / IEC 60228/ BS 6360 standards.

4.2 **Insulation:** - The insulation shall be cross linked polyethylene applied by extrusion and shall be steam (wet) cured as per IS:7098(1)1988 and curing in hot water tank/bath is not accepted.:

<u>Sl.No.</u>	<u>Properties</u>	<u>Requirements</u>
1.	Tensile Strength	12.5N/mm <sup>2</sup> , Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: a) Treatment: Temperature: Duration: b) Tensile Strength variation: c) Elongation variation:	135±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set:	

	a) Treatment: Temperature: Time under load Mechanical stress	200±3°C 15 min 20N/cm <sup>2</sup>
	b) Elongation under load Permanent elongation (set) after	175 percent, Max
	c) cooling	15 percent, Max
5.	Shrinkage: a) Treatment: Temperature Duration b) Shrinkage	130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): a) Treatment: Temperature: Duration b) Water absorbed	85±2°C 14 days 1 mg/cm <sup>2</sup> , Max
7.	Volume Resistivity a) at 27°C b) at 70°C	1×10 <sup>14</sup> ohm-cm, Min 1×10 <sup>13</sup> ohm-cm, Min
8	Thermal Resistivity	350 degrees C cm/W
9	Power factor at maximum conductor temperature	0.008
10	Dielectric strength	22 kV/mm

**4.3.1** The XLPE insulation should be suitable for specified 1.1 KV system voltage.

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

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

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

- 4.3.5** The cables can operate even at conductor temperature of 130 deg C continuously and 250 deg C during a Short Circuit condition

**4.4 SHEATH :**

The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all defects. The PVC sheath shall be extruded as per IS:7098 (Part – I/1988). IEC:60502 Part– I, BS:6622, LSOH to BS:7835.

**4.5 ARMOUR :**

Armoring shall be applied over the inner sheath with single galvanized steel complying with the requirements of IS:3975/1979. The dimensions of the galvanized strip shall be as specified in table 4 of the IS:7098/Part-I/1988. The armour wire shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire shall be atleast 300mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS:7098 Part 1, IS: 3975.

The cable without armouring shall also be accepted of type detailed in price schedule.

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

Part 1, IEC:60502 Part – 1, BS:6622, LSOH to BS:78 35. shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the PVC sheathing material used.

- 4.7** The cables should be suitable for use in solidly earthed system.
- 4.8** The power cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The Manufacturer shall furnish the quality plan, giving in detail the quality control procedure / management system.
- 4.9** The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

4.10 The parameters of the LT power cables to be supplied shall be as specified below

Nom. cross sectional area (Sq.mm)	Nom. Thickness of XLPE Insulation mm main core	Armoured			Max.DC Conductor Resistance at 20°C (ohm/km)	AC current rating	
		Nom. Steel Armour size (mm)	Approx. Overall dia. (mm)	Approx. Weight (kg/km)		In air (amps)	In Grpund (amps)
25	0.90	4 X 0.8	22.8	821.0	1.200	95	97
35	0.90	4 X 0.8	24.9	961.0	0.868	117	116
50	1.00	4 X 0.8	28.1	1195.0	0.641	140	134
70	1.10	4 X 0.8	33.0	1569.0	0.443	176	167
95	1.10	4 X 0.8	35.8	1903.0	0.320	221	199
120	1.20	4 X 0.8	39.0	2303.0	0.253	258	227
150	1.40	4 X 0.8	42.9	2720.0	0.206	294	255
185	1.60	4 X 0.8	47.5	3276.0	0.164	339	287
240	1.70	4 X 0.8	52.7	4048.0	0.125	402	333
300	1.80	4 X 0.8	58.4	4872.0	0.100	461	375
400	2.00	4 X 0.8	65.6	6101.0	0.0778	542	426

4.11 The short circuit current of the LT cable to be as specified below

Sq.mm of LT Cable	Short Circuit Current(KA)
25	2.420
35	3.370
50	4.790
70	6.680
95	9.030
120	11.400
150	14.200
185	17.500
240	22.600



300	28.200
400	37.600

## 5.0 **SYSTEM DETAILS:**

### **General Technical particulars**

Nominal system voltage (rms) (U)	0.44KV
Highest system voltage (rms) ( $U_m$ )	1.1 KV
Number of Phase	3
Frequency	50Hz
Variation in Frequency	+/- 3%
Type of Earthing	Solidly Earthed
Total relay & circuit breaker Operating time	15 – 20 cycles

## 6.0 **CLIMATIC CONDITIONS:**

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

## 7.0 **DESIGN CRITERIA:**

- i. The cables that are covered in these specifications are intended for use outdoor , under the climatic conditions and installation conditions described in the technical specification.
- ii. For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit

conditions.

- iii. The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.
- iv. The materials used for outer sheaths shall be resistant to oils, acids and alkalis.
- v. The cables shall have the mechanical strength required, during handling and laying.
- vi. The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.
- vii. The cables shall be designed to have a minimum useful life span of Thirty-five years.
- viii. The detailed design drawings shall be submitted along with Purchase order.

#### **8.0 MANUFACTURE PROCESS:**

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

#### **9.0 MATERIALS:**

- 9.1 **Conductor:** -The conductor shall be of stranded construction. The material for conductor shall consist of the plain aluminum of H2 or H4 grade as per clause – 3 of IS 8130/ 1984.
- 9.2 The minimum number of wires shall be 53 for circular compacted 400 sq. mm aluminum conductor as per table – 2 of IS 8130/ 1984.

#### **10.0 CORE IDENTIFICATION:**

- 10.1. The core identification for 31/2 core cables shall be provided, by suitable means, like, by application of individual colour or colored stripes, or by numerals or by printing on the cores as per clause 13 of IS: 7098 - Part 2
- 10.2. For identification of different coloring of XLPE Insulation, or by using colored strips, red, yellow and blue colors respectively shall be used to identify the phase conductors.

**11.0 LAYING UP OF CORES:**

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

**12.0 INNER SHEATH (COMMON COVERING):**

**12.1** The laid up cores shall be provided with inner sheath applied either by extrusion. It shall be ensured that the shape is as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

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

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

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

**13.0 ARMOURING:**

**13.1** Armouring shall be single strip steel wire applied over the inner sheath as closely as practicable. The direction of the lay of the armour shall be left hand.

**13.2** The armour shall consist of galvanized strip steel The dimensions of the galvanized steel wires shall be 4 X 0.8 mm (Nominal)

**13.3** The joints in the armour strip shall be made by brazing or welding and the surface irregularities shall be removed. A joint in the wire shall be at least 300-mm from the nearest joint in any other wire in the complete cable.

- 13.4 Manufacturers shall furnish the calculation / data sheet for the short circuit carrying capability of the Armour.

#### **14.0 OUTER SHEATH:**

- 14.1 The outer sheath shall be applied by extrusion. It shall be applied over the armouring shall consist of poly-vinyl chloride (PVC) compound, conforming to the requirements of type ST-2 of IS 5831. Suitable additives shall be added to give anti termite protection.
- 14.2 The minimum thickness of the PVC outer sheath shall be as per IS:10462 and as detailed.

<b>Calculated diameter under the outer sheath [IS 10462 Part 1] – mm</b>		<b>Nominal thickness of the outer sheath (ts) - mm</b>
<b>Over</b>	<b>Up to and including</b>	
—	15	1.24
15	25	1.40
25	35	1.56
35	40	1.72
40	45	1.88
45	50	2.04
50	55	2.20
55	60	2.36
60	65	2.52
65	70	2.68
70	75	2.84
75	—	3.0

#### **14.3 IDENTIFICATION:**

The outer sheath shall have the following information embossed or indented on it; ISI marking, the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters “, Name of Employer” The identification shall repeat every 300/350mm along the length of the cable. Outer sheath of cable shall be black in permanent colour.

#### **15.0 INSPECTION AND QUALITY CONTROL:**

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

#### **16.0 TYPE TESTS:**

Type test certificates from Accredited NABL Testing Laboratories for 1.1 kV XLPE, shall be submitted along with Purchase order. The Type Tests should have been conducted not later than 5 years as on the date of supply.

- 16.1 Stage wise Inspection: The Manufacturer shall offer the stage wise inspection as detailed in the in the quality assurance plan
- 16.2 All acceptance tests shall be conducted in the presence of the Employer's representative.
- 16.3 The supplier shall give 10 days advance notice for inspections, and witnessing of tests by the Employer representative.
- 16.4 The following type tests shall be conducted on the cable.

Sl. No.	Test	Requirement	Test method Ref Part no of IS: 10810
a)	Tests on conductor		
	i) Tensile test	IS:8130	2
	ii) Wrapping test	IS:8130	3
	iii) Resistance test	IS:8130	4
b)	Tests for armoured wires and strips	Clause 15.2 & IS:3975	36 to 42
c)	Test for thickness of insulation and	Clause 4.3, 14.2 &	6

	sheath	16.2	
d)	Physical tests for insulation:	Clause 4.2	
	i) Tensile strength and elongation at break		7
	ii) Aging in air oven		11
	iii) Hot test		30
	iv) Shrinkage test		12
	v) Water absorption (gravimetric)		33
e)	Physical tests for outer sheath	IS: 5831	
	i) Tensile strength and elongation at break		7
	ii) Aging in air oven		11
	iii) Shrinkage test		12
	iv) Hot deformation		15
f)	High voltage test	Clause 22.7	45
g)	Flammability test	Clause 22.8	53

#### 17.0 **ACCEPTANCE TEST:**

17.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix 'A'.

17.2 The following shall constitute the acceptance test.

- a. Tensile test for aluminum.
- b. Wrapping test for aluminum.
- c. Conductor resistance test.
- d. Test for thickness of insulation.
  - (i) Test for thickness of inner and outer sheath.
  - (ii) Hot-set test for insulation.
  - (iii) Tensile strength and elongation at break test for insulation and outer sheath.
  - (iv) High voltage test.
  - (v) Insulation resistance (volume resistivity) test.

**18.0 ROUTINE TEST:**

The following shall constitute routine tests:

- Conductor resistance test.
- High voltage test.

**19.0 DETAILS OF TESTS:**

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

19.2 High Voltage Test at room temperature:

The cables shall withstand a voltage of 3KV AC (rms) at a frequency of 40 to 60 Hz or an AC voltage of 7.2kV , between conductors and between conductors and ECC ( if any) for a period of 5 minutes each test connection.

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

Employer reserves the right to select a random sample of 1.1 kV UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by Employer. If the testing results are found to be not satisfactory Employer reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of Employer in this regard is final.

**20.0 PACKING:**

20.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable wooden drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The cable drums shall conform to IS 10418-1982 or equivalent standard. The dimensional drawings of wooden drums shall be furnished with the Purchase order. The drum shall be provided with circumferential lagging of strong wooden planks. The end of the

cable shall be sealed with good quality heat shrink sealing caps. The sufficiently required additional sealing caps shall be supplied for use of testing during laying and jointing at site and to seal spare lengths of cable. The packing should be able to withstand the rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

- a. Name & Address of the manufacturer, Trade name/Trade mark/Brand
- b. ISI Marking
- c. Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.
- d. Length of cables (Meters)
- e. Direction of rolling
  - i) Net weight (in Kg)
  - ii) Gross weight (in Kg)
  - iii) Owners purchase order reference.

#### **21.0 SEALING OF CABLE ENDS ON DRUMS:**

- 21.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a heat shrinkable or push-on or Tapex or cold shrinkable type cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.
- 21.2 The three cores should have an overall heat shrinkable or push-on or Tapex or cold shrinkable type cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable. The ends of single core cables shall also be sealed on the same lines to prevent entry of moisture.

#### **22.0 CABLE LENGTHS:**



The cables shall be supplied in continuous lengths of 500 m or more with 5% tolerance and cable shall on the wooden drums only.

**23.0 QUANTITY TOLERANCE:**

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

**24.0 MARKING:**

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

- a. The letters ‘, Name of Employer’
- b. Reference to Standard and ISI mark.
- c. Manufacturer’s Name or trade mark.
- d. Type of cable & voltage grade.
- e. Number of cores.
- f. Nominal cross- sectional area of conductor.
- g. Cable code.
- h. Length of cable on the drum.
- i. Direction of rotation.
- j. Gross weight.
- k. Country of Manufacture.
- l. Year of Manufacture.
- m. Purchase order and date.

n. Address of consignee.

24.2. The cable shall be marked with size, “ XLPE PVVNL - 2023” and with sequential marking at every meter.

#### **25.0 GUARANTEED TECHNICAL PARTICULARS:**

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

#### **26.0 DRAWING & LITERATURE:**

(i) The following shall be furnished along with the tender

Cross sectional drawings of the cables, giving dimensional details.

An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, de rating factors for different types of installation, packing date, weights and other relevant information.

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

**28.0** The Manufacturer shall furnish a copy of valid BIS licence for ISI marking without which the cable shall not be accepted.

#### **GUARANTEED TECHNICAL PARTICULARS FOR 1.1 KV**

	<b>Manufacturer's Name</b>		
	<b>Class of Power Cable</b>		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable / cable code		
4	Applicable standard		
	Voltage		
5	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for :		

	a. Earthed system		
7	<b>Conductor</b>		
	a) Nominal cross section (sq.mm)		
	b) Material		
	c) Shape		
	d) Diameter of conductor (mm)		
	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
8	<b>Insulation XLPE</b>		
	a) Curing process (furnish details separately)		
	b) Material/Composition		
	c) Dia over insulation		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
9	<b>Inner sheath</b>		
	a) Type / composition		
	b) Material		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
10	<b>Armouring</b>		
	a) Material		
	b) Dia of wire		
	Nom. (mm)		
11	<b>Outer sheath</b>		
	a) Type / composition		
	b) Material		
	c) Nominal thickness		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
12	<b>Anti-thermite treatment to outer sheath</b>		
	a) Material		

	External overall dia of cable		
	Short circuit rating of conductor 90 deg. C operating temperature for 1 Sec.		
13	Minimum cable bending radius (in terms of cable diameter)		
14	Permissible maximum tension		
15	Continuous current rating under specified insulation conditions at conductor temperature of 65 deg. C and 90 deg. C.		
16	Ground Temperature 30 deg. C		
17	Thermal resistivity of soil 150 deg. C CM/W		
18	Depth of laying 200 mm		
19	Ambient Air temperature 40 deg. C		
20	No. of circuits 1 OR 2		
21	Spacing between two circuits		
22	Formation		
23	Maximum permissible conductor temperature for continuous operation under specified installation conditions (deg. C)		
24	Conductor temperature at rated current (deg. C)		
25	Basic impulse level at conductor temperature of 90 deg. C (KV)		
26	Impulse wave shape		
27	Power frequency with stand voltage (KV)		
28	Tan Delta at 50 Hz (at U.KV and 90 (-5/+10) deg. C		
29	Sheath voltage at max. load		
30	Withstand voltage of sheath on spark test		
31	Permissible short circuit current ratings of conductor		

	i) 0.1 Sec KA		
	ii) 0.2 Sec KA		
	iii) 0.5 Sec KA		
	iv) 1.0 Sec KA		
32	<b>Conductor resistance DC &amp; AC</b>		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 105 deg. C (d.c)/A.C. ohm/KM over load temp) a.c. (ohm)		
33	<b>Equivalent star resistance at 50 Hz of 3 phase current</b>		
	a) at 20 deg. C (d.c)/A.C. ohm/KM		
	b) at 90 deg. C (d.c)/A.C. ohm/KM		
	c) at 10% continuous overload temperature (ohm/KM)		
34	<b>Star reactance at 50 hz (ohm/KM)</b>		
	Approximate impedance at 50 hz per KM		
	a. at 20 deg. C ohm/KM		
	b. at 90 deg. C ohm/KM		
	c. at 10% continuous overload temperature (ohm/KM)		
35	Self-electrostatic capacitance per phase (Micro farad/KM)		
36	Maximum power factor at charging KVA of cables when laid direct in ground at normal voltage & frequency		
	a) at ambient Temperature		
	b) at Maximum conductor Temperature		
37	<b>Impedance</b>		
	a) Positive and negative sequence impedance		

	(ohm/KM)		
	b) Zero sequence impedance (ohm/KM)		
	c) Zero sequence data		
	<b>Series reactance / Resistance</b>		
	a) Series resistance (ohm/KM)		
38	Series reactance (ohm/KM)		
	Shunt capacitive reactance (ohm/KM)		
39	Sheath resistance at 20 deg. C ohm/KM		
40	Surge impedance of cable (ohm/KM)		
	IR value at ambient temperature per KM		
	Maximum magnitude of partial discharge at 1.5 U.o		
	At Ambient Temperature (Po)		
	At High Temperature (Po)		
	Losses per Km.		
	NOTE : (i) Cable Conductor size 400 sq. mm		
41	a) Total 3 phase dielectric loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	b) Total 3 phase resistive loss		
	i. One circuit alive Kw/KM		
	ii. Both circuits alive KW/KM on each circuit		
	c) Total 3 phase sheath / screen loss		
	i. One circuit alive Kw/KM		

	ii. Both circuits alive load KW/KM on each circuit		
42	d) Other losses due to reinforcement		
43	One circuit alive KW/KM		
	Both circuits alive KW/KM on each circuit		
	Total losses		
44	i. One circuit alive KW/KM		
	ii. Both circuits alive KW/KM		
	Charging current at rated voltage per Km (Amps)		
45	Short circuit capacity of conductor for one second at 90 deg. C prior to short circuit and 250 deg. C during short circuit (KA)		
	Screening factor of cable for calculating interference on control and communication cables :		
46	Approximate value of attenuation of carrier current signals operating over a frequency range		
	i. 50 KC/s- dB/KM		
	ii. 100 KC/s- dB/KM		
	iii. 150 KC/s- dB/KM		
	iv. 200 KC/s- dB/KM		
	<b>Shipping weight and size of cable drum</b>		
	a) Size of Drum		
47	i. Dia of Drum (M)		
	ii. Width of Drum (M)		
	iii. Gross Weight (Kgs)		
	iv. Length of cable per Drum(M)		
	v. Weight of Cable (Kg/M)		

### Current Rating Factor

Particulars	Single Point Bonded		Both End Bonded	
	65 deg. C Amps	90 deg C Amps.	65 deg. C Amps	90 deg. C Amps
Current Rating conductor size 400 Sq. mm				

a) In Ground				
i. Of each circuits (when both the circuits alive)				
b) In Duct				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
c) In pipe, one cable per pipe.				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				
d) In Air				
i. Of each circuits (when both the circuits alive)				
ii. Of one circuits (when other circuit is isolated)				

### Derating Factors

<b>1. VARIATION IN GROUND TEMPERATURE :</b>							
Ground Temperature (deg. C) :	15	20	25	30	35	40	45
Rating Factor							
<b>2. VARIATION IN DEPTH OF LAYING :</b>							
Depth of Laying (Meters):	0.7	0.9	1.0	1.2	1.3	1.5	
Rating Factor							
<b>3. VARIATION IN THERMAL RESISTIVITY OF SOIL</b>							



Thermal Resistivity of Soil : (deg. C cm/watt)	100	120	150.0	200	250		
Rating Factor							
<b>4. VARIATION IN AIR TEMPERATURE :</b>							
Air Temperature (deg. C) :	25	30	35	40	45	50	55
Rating Factor							
<b>5. VARIATION DISTANCE (MM) :</b>							
Axial Distance (mm) Between circuits :	100	200	300.0	400	600	800	
Rating Factor							

## **7 AB CABLE**

### **AERIAL BUNCHED CABLES FOR 11kV LINES**

**SCOPE :** This specification covers requirements of XLPE insulated, 11kV Aerial Bunched Cables for overhead lines.

#### **1.0 Qualifying Requirement of AB Cable Manufacturer/Supplier**

The manufacturer should have manufactured, successfully type tested and supplied at least one hundred (100) kms of 11k V or above voltage grade XLPE armoured and/or AB cable in the last five (5) years as on the date of bid opening.

#### **2. COMPOSITION OF THE CABLE**

The composite cable shall compose three single-core cables twisted around a bare aluminium alloy messenger wire, which will carry the weight of the cable.

#### **3. RATED VOLTAGE**

The rated voltage of the cables shall be 6.35 kV/11kV and the maximum operating voltage shall be 12 kV

#### **4. APPLICABLE STANDARDS**

Unless otherwise stipulated in this specification, the following standards shall be applicable:

- i) IS:7098 (part-II) – 1985 – Cross linked Polyethylene Insulated PVC Sheathed Cables
- ii) IS:8130-1984-Conductors for Insulated Cables
- iii) IS:398 (Part-IV) – 1979 – Aluminium Alloy Conductors

#### **5. DETAILS OF SINGLE CORE CABLE**

- 5.1 The cable conductors shall be of round, stranded and compacted aluminium of nominal cross sectional area 35 mm<sup>2</sup> and 70 mm<sup>2</sup>. Corresponding nominal conductor diameter and number of wires in the conductor shall be as given in clause 5.7.

#### **5.2 Conductor Screen**

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

### 5.3 Insulation

The Insulation screen shall be as per IS:7098 (Part II).

### 5.4 Insulation screen

The Insulation screed shall comprise extruded semi-conducting compound and/or semi- conducting tape. Thickness of the screen shall be not less than 0.6 mm.

### 5.5 Outer Sheath

The outer sheath shall be black polyethylene. The nominal thickness of sheath shall be 1.8mm and it shall conform to the technical requirements of ST-3 of EIC-502

### 5.6 Dimensional and Electrical Data

The Dimensional and Electrical Data for single –core cable is given below:

S.No.	Description	Nominal area of conductors	
		35 mm <sup>2</sup>	70mm <sup>2</sup>
I.	Nominal conductor diameter(mm)/No. of wires in conductor	6.8/6	10/12
II.	Approx over dia of cable (mm)	22	25
III.	Max D.C. resistance at 200c Ohm/Km	0868	.443
IV.	Max SC current for 1 Sec. KA	3.4	6.7
V.	Max continuous load (amps)	106	156

Note: Due to limitation of short circuit current rating, it is recommended that 70mm<sup>2</sup> cable is used the base line for the first 4-5kms from the 33/11kV substation and

thereafter the lower size of cable i.e. 35mm<sup>2</sup> can be used depending upon the line loading .Normally the current loading of 70mm<sup>2</sup> cable should not exceed 145amps and that of 35mm<sup>2</sup> cable as 95 amps .For a maximum ambient temperature of 50<sup>0</sup>C.

#### 6. MESSENGER (NEUTRAL CONDUCTOR)

- 6.1 The bare messenger wire shall be of 70 mm<sup>2</sup> (nominal area) aluminium alloy, generally conforming to IS:398 (Part IV) – 1979, comprising of seven(7) strands and 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.
- 6.2 There shall be no joints in any wire of the stranded messenger conductor except those made in the base rod or wire before finally drawing.
- 6.3 The technical characteristics of messenger wire shall be as follows:

i.	Nominal sectional area(mm <sup>2</sup> )	70
ii.	Nos. of wire	7
iii.	Nominal dia of wires /compacted conductor (approx.)mm	3.5/10
iv.	Approx. Mass kg/Km	184
v.	D.C resistance at 20 <sup>0</sup> C Ohm/Km	0.493
vi.	Breaking load(KN)	20
vii.	Modulus of elasticity (approx) KN/mm <sup>2</sup>	59
viii.	Coefficient of linear expansion	23X10 <sup>-6</sup> oC

Note: the value of item v above is to be guaranteed. A tolerance of (-) 5% is permissible on the value in item vi above.

#### 7. DESIGNATION AND PARAMETER OF FINISHED CABLES

The designation and parameter of finished cables are given in the following table:

S.N o.	Designation	Complete bunched cables	
		Overall dia approx mm	Total mass(Approx.)Kg/Km

I.	3 x 35+70	53	1450
II.	3 x 70+70	59	1900

Note: the first part of the designation refers to the number and size of phase conductor and the second to the size of messenger wire .The sizes shown represent the nominal cross sectional area in mm.

## 8. TESTS

8.1 The following tests shall be carried out on the single-core cables as per IS-7098 (Part-II).

### 8.1.1 Type Tests

- a) Tests on conductor:
  - i) Tensile test
  - ii) Wrapping test
  - iii) Resistance test
- b) Tests for thickness of insulation and sheath
- c) Physical tests for insulation:
  - i) Tensile strength and elongation at break
  - ii) Agency in air oven
  - iii) Hot test
  - iv) Shrinkage test
  - v) Water absorption
- d) Tests for outer sheath:
  - i) Tensile strength and elongation at break
  - ii) Ageing in air oven

- iii) Shrinkage test
- vi) Hot deformation
- vii) Bleeding and blooming test.
- e) Partial discharge test
- f) Bending test
- g) Dielectric Power factor test:
  - i) As a function of voltage
  - ii) As a function of temperature
- h) Insulation resistance test
- g) Heating cycle test
- k) High voltage test
- l) Flammability test

#### 8.1.2 Acceptance Test

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

#### 8.1.3 Routine Tests

- a) Conductor resistance test
- b) Partial Discharge Test

- c) High voltage test

**8.2 The following tests shall be carried out on the bare messenger wire in accordance with IS:398 (Part-IV).**

Type Tests/Acceptance Test

- a) Breaking Load Test (on finished wire
- b) Elongation Test
- c) Resistance Test

## **9. PACKING AND MARKING**

### **9.1 Packing**

Cables shall be supplied in returnable wooden drums conforming to IS: 10418. The standard length of the bunched cable in each drum shall be 1000 meters (+/-) 10%. Other lengths may be acceptable subject to the approval of employer/purchaser.

### **9.2 Marking**

The Cable drum shall carry the information as per the requirements of IS: 7098 (Part-II). However, exact details of marking/embossing, color of outer sheath etc. Will be as per the detailed purchase order.

- 9.3 Suitable identification marks shall be given on the outer sheath to clearly distinguish three phases of the bunched cable.

**GUARANTEED TECHNICAL PARTICULARS FOR 1.1 KV**

	<b>Manufacturer's Name</b>		
	<b>Class of Power Cable</b>		
1	Name of the Manufacturer and country of origin		
2	Country of Manufacture		
3	Type of cable / cable code		
4	Applicable standard		
	Voltage		
5	a. Rated Nominal voltage		
	b) Rated Maximum voltage		
6	Suitability for :		
	a. Earthed system		
	<b>Conductor</b>		
	a) Nominal cross section ( <a href="#">sq.mm</a> )		
	b) Material		
7	c) Shape		
	d) Diameter of conductor (mm)		
	e) Number of wires per conductor (Nos.)		
	f) Nominal diameter of wire in conductor (mm)		
	<b>Insulation XLPE</b>		
	a) Curing process (furnish details separately)		
	b) Material/Composition		
8	c) Dia over insulation		
	i. Nominal (mm)		
	ii. Average (mm)		
	iii. Minimum (mm)		
	<b>Inner sheath</b>		
	a) Type / composition		
9	b) Material		
	d) Tolerance on thickness		
	e) Diameter of cable over sheath (mm)		
	<b>Armouring</b>		
	a) Material		
10	b) Dia of wire		
	Nom. (mm)		
	Min. (mm)		
11	<b>Outer sheath</b>		



## **8 XLPE Power Cables (11kV & 33 kV)**

### **STANDARD TECHNICAL REQUIREMENT**

#### **1.0 SCOPE:**

This section covers the standard technical requirements of design, manufacturing, testing, packing and dispatching of 11 kV and 33 kV XLPE HT Power Cable.

#### **2.0 APPLICABLE STANDARDS**

The materials shall conform to the latest editions of the following Indian/International Standards :

IS 7098 Part 2 : 1985 XLPE insulated PVC sheathed cables For working voltages from 3.3 kV up to and including 33 kV

IS 5831 : 1984 PVC Insulation and Sheath of electric Cables

IS 8130:1984 Conductors for insulated electric cables and flexible cords. IS 613:1984 Copper rods and bars for electrical purposes.

IS 3975:1988 Mild steel wires, formed and tapes for armouring of cable. IS 10810:1984 Method of tests for cables.

IEEE-383:1974 Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.

ASTM-D2843,1993 Standard test method for density of smoke from burning or decomposition of plastics.

ASTM-D2863, 1991 Standard test method for measuring minimum oxygen concentration to support candle - like combustion of plastics (oxygen index).

NEMA-WC5,1992 Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.

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.

IEC:332 Test on electric cables under fire conditions

(Part I):1993 Test on a single vertical insulated wire or cable. IS 3961 Recommended current rating for cables -

(Part II):1967 PVC insulated and PVC sheathed heavy duty cables.

IS 10418:1982 Drums for electric cables.

### **3.0 GENERAL REQUIREMENTS**

All cables shall be suitable for high ambient, high humid tropical Indian Climatic conditions. 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.

Conductor shall be of uniform, of good quality, free from defects Aluminium copper. Insulation shall be Cross Linked Polyethylene (XLPE) .

For 33 kV and 11 kV cables, conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 33 kV cable shall be "Dry curing/ gas curing " only, whereas for 11 kV and 3.3 kV cables it shall be "Dry curing/ gas curing / Steam curing".

Extruded Semi-conducting screening and metallic screening of copper tape shall be generally as per IS 7098 (Part-II) with latest amendments. The semi conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

The insulation screen shall be an extruded layer of black semi-conducting compound and continuously covers the whole area of insulation. The semi-conducting screens should be effectively cross linked to achieve 90 ° C cable rating. The contact surface between insulation and insulation screen shall be smooth and free from protrusion and irregularities.

The interface between insulation and insulation screen shall be free of any voids. Insulation screen shall be strippable type.

The metallic screen shall consist of a layer of copper cable applied in helical form.

Inner sheath - All armoured and multi-core un-armoured cables shall have distinct

extruded inner PVC sheath of black colour.

Armouring - Material for armour for Single Core Cable shall be Aluminum wire. For Multicore cable it shall be GS wire / flat. Armouring shall be as per relevant IS and it shall have minimum 90% coverage.

Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath – It shall be of black colour PVC (type ST2 as per IS 5831) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 (one ) Meter distance. Word "FRLS" shall also be embossed on it at every 5 (Five ) meter distance. Word “ XLPE PVVNL - 2023” shall also embossed on it at every 1(one)m distance.

FRLS Properties - All cable shall be Flame Retardant, Low Smoke (FRLS) type. Outer sheath shall have the following properties –

Acid Gas Generation – Max 20% ( as per IEC 754-1)

Smoke density rating: 60% (As per ASTM D 2843)

Flammability test - As per Swedish chimney test F3 as per SEN 4241475

As per IEC 332 part-3 (Category B)

Minimum bending radius shall be 10 D

Repaired cables shall not be acceptable.

#### **4.0 CURRENT RATING OF CABLES**

- 1) Normal current rating shall not be less than that covered by IS 3961. Vendor shall submit data in respect of all cables in the prescribed format.
- 2) Tables given de-rating factors for various conditions of cable installation including the following, for all types of cables shall be furnished.
  - Variation in ambient air temperature. - Variation in ground temperature.
  - Depth of laying.
  - Cables laid in the ground - Cables laid in trench
  - Cables laid in ducts - Soil resistivity.
  - Grouping of cables.

- 3) The value of short circuit withstand current ratings of all cables shall be indicated for a short circuit for 1 second duration and should also specify the maximum temperature during short circuit.
- 4) The following factors shall also be accounted for, while specifying the maximum short circuit withstand of the cables.
- 5) Deformation of the insulation, due to thermo-mechanical forces produced by the short circuit conditions, can reduce the effective thickness of insulation.
- 6) Conductor and core screens can be adversely affected with loss of screening effect. Likewise the thermal properties of the outer sheath material can be the limitation.
- 7) It is essential that the accessories which are used in the cable system with mechanical and/or soldered connections are suitable for the temperature adopted for the cables.
- 8) Formula for calculating short circuit current for different duration or curve showing short time current v/s time for different sizes of cables shall be furnished by vendor.

## **5.0 CABLE DRUMS**

- 5.1 Cables shall be supplied in 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.
- 5.2 All Power Cables shall be supplied in drum length of 200/300/500m as per requirement of utility/Discom.\* Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. The cable length per drum is allowed a tolerance of  $\pm 5\%$ . The tolerance allowed on total quantity of each size is as given below.
  - 3.1 50 meters for cable length upto 10 kms.
  - 3.2 100 meters for cable length more than 10 kms. and up to 20 kms.
  - 3.3 150 meters for cable length more than 20 kms.

Where the ordered quantity is not multiple of 1000 m and the incremental quantity is very small, the same may be included in one of the drums. Otherwise, an additional length for the incremental quantity will be supplied.

\* Amendment issued vide letter No. REC/DDUGJY/SBD/TS/2017-18D. No.3091  
Dated 25.08.2017

- 5.3 A layer of waterproof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 5.4 A clear space of at least 40mm shall be left between the cables and the logging.
- 5.5 Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 5.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

## **6.0 TESTS**

### **6.1 Type Tests**

The following shall constitute type tests:

- i) Tests on conductor
  - a. Annealing test (for copper)
  - b. Tensile tests (for aluminum)
  - c. Wrapping tests (for aluminum)
  - d. Resistance test
- ii) Tests for armouring wires/strips
- iii) Test for thickness of insulation and sheath
- iv) Physical tests for insulation
  - a. Tensile strength and elongation at break
  - b. Ageing in air oven
  - c. Hot test
  - d. Shrinkage test
  - e. Water absorption (gravimetric)
- v) Physical tests for out sheath
  - a. Tensile strength and elongation at break

- b. Ageing in air oven
  - c. Hot test
  - d. Shrinkage test
- vi) Partial discharge test
- vii) Bending test
- viii) Dielectric power factor test
  - a. As a function of voltage
  - b. As a function of temperature
- ix) Insulation resistance (volume receptivity) tests
- x) Heating cycle test
- xi) Impulse withstand test
- xii) High voltage test
- xiii) Flammability test

## 6.2 Acceptance tests

The following shall constitute acceptance tests:

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

## 6.3 Routine test

The following shall constitute routine tests:

- i) Conductor resistance test
- ii) Partial discharge test (for screened cables only) and
- iii) High voltage tests.

#### 6.4 Optional tests

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

### **SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.**

#### **1.0 SCOPE**

This section of the specification covers project information, site condition, desired Technical parameters, and quantity of XLPE Cable.

##### **1.1 Project Information**

- a. Customer: PVVNL
- b. Engineer/Consultant: WAPCOS
- c. Project Location: Moradabad
- d. Transport facilities
  - i) Nearest Railway station: /Gauge : Moradabad Junction.
  - ii) Distance from site:
- e. Access Roads:

##### **1.2 SITE CONDITIONS**

- (i)** Ambient air temp. (max.) °C : 50
- (ii)** Ambient air temp. (min.) °C : -5
- (iii)** Design ambient temp. °C : 50

1.2.1 Relative humidity for design : purposes

1.2.2 Height above mean sea level in : meters

1.2.3 Earth quake data

- i) Seismic zone : IS:1893-84
- ii) Seismic acceleration : As per IS 2.2.4

##### **1.2.4 Wind data**

Site Wind Pressure  $\text{Kgf/m}^2$  : As per IS 2.3

##### **1.3 System Particulars**

a.	Line Voltage (kV)	11/33
b.	Highest System Voltage (kV)	12/36
c.	Number of Circuits	1
d.	Frequency	HZ50
e.	Neutral	effectively earthed
f.	Short circuit level (KA)	22.77 KA, 31.8KA / 22.5KA,45KA

#### 1.4 SPECIFIC TECHNICAL REQUIREMENTS

Technical Parameters of the cable shall be as follows:

S. No.	PARTICULAR	Unit	DATA	DATA
1	Rated Voltage	kV	6.35/11	19.0/33
2	Type of Insulation	-	XLPE	XLPE
3	Single core/ Multi core	-	Single/Three core	Single/Three core
4	Armoured / Unarmoured	-	Armoured	Armoured
5	Material of Conductor	-	Aluminium	Aluminium
6	System	-	11 kV Earthed	33 kV Earthed
7	Highest System Voltage	kV	12	36
8	Conductor size	sq. mm	120, 150, 185, 240, 300	150, 185, 240, 300, 400
9	Material		Stranded Aluminium	Stranded Aluminium
10	Shape of Conductor		Circular	Circular
11	Short Circuit Current	kA	13.12, 18.35 for 3 secs.	13.12, 26.24 for 3 secs
12	Power Frequency Withstand Voltage	KV rms	28	70
13	Lightning Impulse Withstand Voltage	kVp	75	170
14	Continuous Withstand Temperature	Deg C	90	90
15	Short Circuit withstand Temperature	Deg C	250	250
16	Oxygen Index		Min 29 (as per ASTM D 2863)	Min 29 (as per ASTM D 2863)
17	Acid Gas Generation		Max 20% ( as per IEC 754-1)	Max 20% ( as per IEC 754-1)



18.	Smoke Density Generation		60% (As per ASTM D 2843)	60% (As per ASTM D 2843)
19.	Flammability Test		As per Swedish Chimney test	As per Swedish Chimney test

### SECTION-III GUARANTEED TECHNICAL PARTICULARS

Sl. No.	Item Particulars	Unit
1	Manufacturers Name & Address	
2	Country of manufacturer	
3	Type of cable	
4	Applicable standards for manufacturing	
5	Applicable standards for testing	
6	Rated voltage	kV
7	Maximum service voltage	kV
8	Maximum continuous current carrying capacity per cable when lain in air at an ambient air temperature of 50 deg. (single core cables solid bonded)	A
9	Maximum continuous current carrying capacity per cable when lain in ground at a depth of 1.0 m (ground temp. 40 deg. C and soil thermal resistivity of 150 deg.c/watt/cm max. Conductor temp. 90 deg. C) (single core cables solid bonded)	A
10	Maximum continuous current carrying capacity per cable when drawing into duct./pipes (single core cables solid bonded)	A
11	Maximum continuous current carrying capacity per cable when lain in covered RCC trenches at an ambient temperature of 50 Deg. C laying conditions to be specified (Single core cables solid bonded)	A
12	Short circuit withstand capacities for 1 second of (With a conductor temperature of 90 Deg. C at the commencement	
i)	Conductor	KA
ii)	Screen	KA
iii)	Armour	KA
13	Conductor	

Sl. No.	Item Particulars	Unit
i)	Material & Grade	
ii)	Nominal cross – sectional area	sq.mm
iii)	No. of strands	
iv)	Diameter of each strand (Nominal)	mm
v)	Max. DC resistance of conductor at 20 Deg. C	ohm/km
vi)	Max. AC resistance of conductor at 90 Deg. C	ohm/km
14	Reactance of cable at normal frequency (Approx)	ohm/km
15	Electrostatic capacitance at normal frequency	mircorfarads per km
16	Charging current	
17	Loss tangent at normal frequency at Uo	
18	Conductor screen	
i)	Material	
ii)	Nominal thickness	mm
19	XLPE Insulation	
i)	Composition	
ii)	Type of curing	
iii)	Thickness of insulation (nominal)	mm
iv)	Tolerance on thickness	mm
v)	Dielectric constant at normal frequency	
vi)	Specific insulation resistance at 20 deg. C	ohm/km
vii)	Min. Volume resistivity at 20 deg. C	
viii)	Min. volume resistivity at 90 deg. C	
ix)	Min. Tensile strength	kg/sq.cm
x)	Min. Elongation percentage at rapture	%
xi)	Identification of cores	
20	1.2/50 microsecond impulse wave withstand voltage	kVp
21	5 min. power frequency withstand voltage	kV
22	Max. Dielectric stress at the conductor	kV/cm
23	Max. Dielectric stress at the conductor screen	kV/cm
24	Insulation screen	
i)	Material	
ii)	Extruded/wrapped	
iii)	Nominal thickness	mm
iv)	Colour	
25	Metallic screen	
i)	Material / composition	

ii)	Nominal radial thickness / dia	
26	Nominal diameter over metallic screen	mm
27	Nominal radial clearance allowed under metal sheath	mm
28	Type and material of filler	
29	Armour	
i)	Material and type	
ii)	Dia	

## 9 Technical Specifications of High Density Polyethylene (HDPE) pipe and fittings

### 1. Scope:

This specification covers technical requirements of design, Constructional features, Inspection, testing, Supply & transportation of HDPE pipe of 125 mm 160 mm & 200 mm Diameter.

### 2. APPLICABLE STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian, International Standards and shall conform to the regulations of the local Statutory authorities:

IS 4984-1995: Specification for High Density Polyethylene Pipe with latest amendment.

### 3. CLIMATIC CONDITIONS OF THE INSTALLATION:

- a) Max. Ambient Temperature : 50 deg.C
- b) Max. Daily average ambient temp : 40 deg.C
- c) Min. Ambient Temperature : 0 deg.c
- d) Maximum Humidity: 100%
- e) Minimum Humidity : 10%
- f) Average No. of thunderstorm per annum : 40
- g) Average Annual Rainfall: 750 mm
- h) Average No. of rainy days per annum : 50
- i) Rainy months : June to Oct.
- j) Altitude not exceeding : 300 meters.
- k) Wind Pressure : 195 kg/sq. m up an elevation of 30m

Atmosphere is generally laden with mild acid and dust suspended during dry months and subjected to fog in cold months. The design of the equipment and accessories shall be suitable to withstand seismic forces corresponding to an acceleration of 0.1g.

**4. GENERAL TECHNICAL REQUIREMENTS****A) FOR HDPE PIPE 160MM DIA**

Sl No	Item Description	Unit	Requirement
1.	MFR (190°C, 5kg load)	gm/10 mins	0.20 to 1.10
2.	Specified base density	kg/mtr <sup>3</sup>	940 to 958
3.	Material Grade		PE-63
4.	Wall Thickness	Mm	7.7-8.7
5.	Carbon Black	%	2.5+- 0.5
6.	Antioxidant	% by mass	<0.3% by mass
7.	Overall Migration	Mg/dm <sup>2</sup>	10 Max
8.	Reversion	%	<=3%
9.	Hydraulic Characteristics		No sign of localized swelling leakage or weeping (at 80°C for 48 & 165 hrs.)
10.	Continuous Temperature withstand capacity	0C	120

**B) FOR HDPE PIPE 125 MM DIA**

Sl No	Item Description	Unit	Requirement
1.	MFR (190°C, 5kg load)	gm/10 mins	0.20 to 1.10
2.	Specified base density	kg/mtr <sup>3</sup>	940 to 958
3.	Material Grade		PE-80
4.	Wall Thickness	Mm	4.9 -5.6
5.	Carbon Black	%	2.5+- 0.5
6.	Antioxidant	% by mass	<0.3% by mass
7.	Overall Migration	Mg/dm <sup>2</sup>	10 Max
8.	Reversion	%	<=3%
9.	Hydraulic Characteristics		No sign of localized swelling leakage or weeping (at 80°C for 48 & 165 hrs.)
10.	Continuous Temperature withstand capacity	0C	110

**C) FOR HDPE PIPE 200 MM DIA**

Sl No	Item Description	Unit	Requirement	
			PN 4	PN 6

1.	MFR (190°C, 5kg load)	gm/10 mins	0.20 to 1.10	0.20 to 1.10
2.	Specified base density	kg/mtr <sup>3</sup>	940 to 958	940 to 958
3.	Material Grade		PE-63	PE-63
4.	Wall Thickness	Mm	9.6 -10.8	14 -15.6
5.	Carbon Black	%	2.5+- 0.5	2.5+- 0.5
6.	Antioxidant	% by mass	<0.3% by mass	<0.3% by mass
7.	Overall Migration	Mg/dm <sup>2</sup>	10 Max	10 Max
8.	Reversion	%	<=3%	<=3%
9.	Hydraulic Characteristics		No sign of localized swelling leakage or weeping (at 80°C for 48 & 165 hrs.)	No sign of localized swelling leakage or weeping (at 80°C for 48 & 165 hrs.)
10.	Continuous Temperature withstand capacity	0C	110	110

## 5. GENERAL CONSTRUCTIONS FOR HDPE PIPE

High-density polyethylene (HDPE) is apolyethylenethermoplastic made from petroleum. Known for its large strength to density ratio, HDPE is commonly used in the production of corrosion-resistant piping. The HDPE pipes required in size 125mm dia. Of material grade PE-80 and pressure rating is PN4, in size 160mm dia. of material grade PE-63 and pressure rating is PN4 and in size 200mm dia. of material grade PE-63 and pressure rating is PN 4 & PN 6. The HDPE pipe material should be Fire Retardant or non-Flammable. All HDPE pipe Color should be Black.

## 6. MARKING

The body of the device shall be appropriately embossed/marked with “PROPERTY OF PVVNL” such that it is permanent and does not harm the body of the device.

## 7. TESTS

All routine, acceptance & type tests shall be carried out in accordance with the relevant IS. All Routine /acceptance tests shall be witnessed by the purchaser/his authorized representative.

### TYPE TEST:

The following tests shall constitute the type tests and shall be carried out as per relevant IS: 4984-1995.with latest Amendment.

- Avg. Outer Diameter.
- Wall thickness.
- Measurement of Ovality.

- Heat Reversion
- MLF.R. at 190 Degree C.
- Carbon Black Content.
- Carbon Dispersion.
- Density at 27 Degree C.
- Overall Migration.
- Hydraulic Characteristics.

#### ROUTINE/ACCEPTANCE TEST:

The following tests shall be got conducted in presence of purchaser representative as per relevant IS:

4984-1995.with latest Amendment on the samples taken from the offered lot material for the purpose of acceptance of that lot of material.

- Avg. Outer Diameter.
- Wall thickness.
- Measurement of Ovality.
- Heat Reversion.
- M.F.R. at 190 Degree C
- Carbon Black Content.
- Carbon Dispersion
- Density at 27 Degree C.
- Overall Migration
- Hydraulic Characteristics.

#### 8. TYPE TEST CERTIFICATES

The bidder shall furnish the type test certificates of the individual component for the tests as mentioned as above as per the corresponding standards, if asked for by PVVNL. All the tests shall be conducted by NABL accredited Lab as per the relevant standards. Type test should have been conducted in certified Test Laboratories during the period not exceeding 5 years from the date of opening the bid. In the event of any discrepancy in the test reports i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to PVVNL.

#### 9. PRE DISPATCH INSPECTION

The Material shall be subject to inspection by a duly authorized representative of the PVVNL. Inspection may be made at any stage of manufacture at the discretion of the purchaser and the equipment, if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to PVVNL's representatives at all times when the work is in progress. Inspection by the DHBVN or its authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by PVVNL.

Following documents shall be sent along with material

- a) Test reports
- b) MDCC issued by PVVNL
- c) PVVNL Invoice in duplicate
- d) Packing list
- e) Drawings & catalogue
- f) Guarantee / Warrantee card
- g) Delivery Challan
- h) Other Documents (as applicable).

#### **10. INSPECTION AFTER RECEIPT AT STORES**

The material received at PVVNL store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to each MM & PD department.

#### **11. GUARANTEE**

Bidder shall stand guarantee towards design, materials, workmanship & quality of process / manufacturing of items under this contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Purchaser up to a period of 12 months from the date of commissioning or 18 months from the date of last supplies made under the contract whichever is earlier, Bidder shall be liable to undertake to replace/rectify such defects at its own costs, within mutually agreed time frame, and to the entire Satisfaction of the Purchaser, failing which the Purchaser will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@ 20% of expenses incurred), from the Bidder or from the "Security cum Performance Deposit" as the case may be. Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

#### **12. PACKING**

Bidder shall ensure that all the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit.

#### **13. TENDER SAMPLE**

NA

#### **14. QUALITY CONTROL**

The bidder shall have a prove track of not less than 10 years in HDPE Pipe manufacturing and servicing in Indian market. The bidder shall submit with the offer Quality assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall

be furnished, The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub- supplier's works to carry out inspections.

### **15. MINIMUM TESTING FACILITIES**

Bidder shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant Indian standards.

### **16. MANUFACTURING ACTIVITIES**

The successful bidder will have to submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer. This bar chart will have to be submitted within 15 days from the release of the order.

### **17. SPARES, ACCESSORIES AND TOOLS**

Not applicable.

### **18. DRAWINGS AND DOCUMENTS**

Following documents shall be prepared based on PVVNL specifications and statutory requirements with complete BOM and shall be submitted with the bid:

- a) Completely filled in Technical Particulars.
- b) General description of the equipment and all components including brochures.
- c) Bill of Material
- d) Type test Certificates
- e) Experience List.

After the after of the contract, four (4) copies of the drawings, drawn to scale, describing the equipment in detail shall be forwarded for approval and shall subsequently provide four (4) complete sets of final drawings, one of which shall be auto positive suitable for reproduction, before the dispatch of the equipment. Soft copy (Compact Disk CD) of all the drawing, GTP, test certificates shall be submitted after the final approval of the same to the purchaser.

Following Drawings/Documents shall be submitted after the award of the contract:

S. No	Description	For approval	For Review Information	Final Submission
1	Technical Parameters	✓		✓
2	Manual/Catalogues/drawings for all components		✓	
3	Technical details and test certificates of the component		✓	✓
4	Instructions for use		✓	✓
5	Transport/shipping dimension drawing		✓	✓
6	QA & QC Plan	✓	✓	✓
7	Routine Acceptance and	✓	✓	✓



	Type test Certificates			
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All the Documents and Drawings shall be in English Language.

**Instruction Manuals:** Bidder shall furnish two (2) soft copies (CD) and four (4) hard copies of nicely bound manual (in English Language) covering erection and maintenance instructions and all relevant Information pertaining to the main equipment as well as auxiliary device.

## 19. GUARANTEED TECHNICAL PARTICULARS

### A) FOR HDPE PIPE 160MM DIA

Sl No	Item Description	Unit	Requirement
1.	MFR (190°C, 5kg load)	gm/10 mins	To be submitted by Bidder's
2.	Specified base density	kg/mtr <sup>3</sup>	
3.	Material Grade		
4.	Wall Thickness	mm	
5.	Pressure Rating		
6.	Carbon Black	%	
7.	Antioxidant	% by mass	
8.	Overall Migration	Mg/dm <sup>2</sup>	
9.	Reversion	%	
10.	Hydraulic Characteristics		
11.	Continuous Temperature withstand capacity	0C	

### B) FOR HDPE PIPE 125MM DIA

Sl No	Item Description	Unit	Requirement
1.	MFR (190°C, 5kg load)	gm/10 mins	To be submitted by Bidder's
2.	Specified base density	kg/mtr <sup>3</sup>	
3.	Material Grade		
4.	Wall Thickness	mm	
5.	Pressure Rating		
6.	Carbon Black	%	
7.	Antioxidant	% by mass	
8.	Overall Migration	Mg/dm <sup>2</sup>	
9.	Reversion	%	
10.	Hydraulic Characteristics		
11.	Continuous Temperature withstand capacity	0C	

## C) FOR HDPE PIPE 200 MM DIA

Sl No	Item Description	Unit	Requirement
1.	MFR (190°C, 5kg load)	gm/10 mins	To be submitted by Bidder's
2.	Specified base density	kg/mtr <sup>3</sup>	
3.	Material Grade		
4.	Wall Thickness	mm	
5.	Pressure Rating		
6.	Carbon Black	%	
7.	Antioxidant	% by mass	
8.	Overall Migration	Mg/dm <sup>2</sup>	
9.	Reversion	%	
10.	Hydraulic Characteristics		
11.	Continuous Temperature withstand capacity	0C	

## 10 TECHNICAL SPECIFICATION FOR L.T. AERIAL BUNCHEDED CABLE (3x120+1x95+1x16 SQ MM)

**1. SCOPE:** This specification provides for manufacture, testing & supply of Aerial Bunched Cable (3x120+1x95+1x16) mm<sup>2</sup> as per the quantities mentioned.

1.1. It is not the intent to specify completely herein all the details of the design and construction of material. However the material shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith.

### 2. STANDARDS:

This Aerial Bunched Cable shall comply with the following standards with latest amendments unless otherwise stipulated in this specification.

- 1 IS: 7098-Part-I XLPE Cable
- 2 IS: 8130-Conductors for cable
- 3 IS: 398 (Part-IV)-Aluminium Alloy Conductors
- 4 IS: 10810- Test methods
- 5 IS: 5484-E.C. Grade Aluminium Rods
- 6 IS: 9997- Aluminium Alloy Rods

- 7 IS:IEC: 207- Aluminium Alloy Standard Conductor
- 8 IS:IEC: 502: Excluded Solid Di-electric insulated Cable 581
- 9 IS:IEC: 540 Test methods for insulation & sheath of cable
- 10 IS: 14255:1995 for Aerial Bunched Cable
- 11 IS: 10418:1982 Drums of electric Cables

### **3.0 CONSTRUCTION OF L.T. AERIAL BUNCHED CABLE:**

**MAIN FEATURES:** The ABC cables shall be of LT 1.1 kV Grade, stranded compacted, high conductivity, aluminum conductor, XLPE insulated, conforming to relevant standards suitable for LT AC three phase, 50 c/s, effectively earthed distribution system. In the ABC System, the insulated conductors are twisted around the bare Aluminium Alloy messenger conductor.

### **3.1 PHASE CONDUCTOR/STREET LIGHT CONDUCTOR:**

The Phase conductors are made of hard drawn Aluminium wires having tensile strength not less than 90N/mm<sup>2</sup> Stranded circular compacted Aluminium Conductor is Insulated with cross-linked polyethylene (XLPE). Three such phase conductors and street lightconductors are twisted around bare stranded Aluminium Alloy Messenger Conductor of size 95 mm<sup>2</sup>.

The power/outer insulated neutral/street lighting conductors shall be made from stranded Aluminium to form compact circular conductor having resistance within limits as specified in table-2 of IS: 8130/1984 and any amendment there of. The total Minimum Guaranteed weight of Aluminium in phase as well as Street light conductors shall be 1016.3 kgs/ km.

### **3.2 CONSTRUCTION:**

- 1) All materials used in the manufacture of cable shall be new, unused and of finest quality. All materials shall comply with the applicable provisions of the tests of the relevant Standards.
- 2) The XLPE material used in the manufacture of cable shall be of reputed make. The purchaser reserves the right to ask for documentary proof of the purchase of various materials to be used for the manufacture of cable and to check that the conductor is complying with quality control.
- 3) The XLPE insulating material should be UV resistant weather proof. Black carbon content should be minimum 2.5% - 3% as per IS: 14255.
- 4) A sample of the material supplied by the manufacturer may be sent by the purchaser for type testing at the Govt. approved test lab at the cost of the contractor which shall be refunded in case sample passes the type test otherwise no refund shall be made and the supplied material shall be rejected and contractor/ manufacturer shall be debarred from participation in further three consecutive tenders.

### **3.4 CORE IDENTIFICATION:**

For the identification of individual cores longitudinal ridges or number printing over cores shall be used at regular intervals to identify phase conductors.

### **3.5 MESSENGER/NEUTRAL CONDUCTOR:**

Messenger/Neutral Conductor is made of Aluminium Alloy Consisting of 7 strands each having tensile strength not less than 294 N/mm<sup>2</sup> with elongation 4% and suitably compacted to smooth round surface to avoid damage to XLPE Insulation of phase conductor. The conductor shall be of heat treated aluminium-magnesium-silicon alloy wires containing approximately 0.5 percent magnesium and approximately 0.5 percent silicon conforming to IS: 398 (Part-IV)-1979. There shall be no joints in any wire of messenger conductor except those made in base rod or wires before final drawing. The direction of the outer layer of wires in messenger conductor shall be right hand. The Minimum Guaranteed weight of messenger wire (Aluminium alloy) shall be 256.7 kgs/ km

### **4.0 INSULATION:**

The XLPE Insulation shall be suitable for specified LT System voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical stress under steady state and transit operating conditions. The insulation of the cable shall be of high standard quality and conform to clauses 11 of IS: 7098 (Part-1)/1985 of test amendment thereof. The make of XLPE material to be used by manufacturer in production of ordered LT ABC shall be as follows:

1. M/s Kalpana Industries
2. M/s Polylink Polymer, Vadodra
3. M/s Borealis Polymer Industries.
4. M/s Sun Petrochemicals Pvt. Ltd., Mumbai.
5. M/s DOW
6. M/s KLJ, Silvassa

## **5 WORKMANSHIP AND QUALITY ASSURANCE**

The workmanship shall be neat clean and of highest grade/quality.

## **6 CURRENT RATING**

The Conductor will have current rating and derating factors as per relevant Indian Standards.

The current rating shall be based on maximum conductor temperature of 900 c with ambient site conditions specified in General Requirement of specification for continuous

operation at the rated current

## **7.0 OPERATION**

7.1 Cable shall be suitable for laying overhead.

7.2 Cable shall have heat and moisture resistant proven with proven record of distribution network service.

## **8.0 LENGTHS:**

The cable shall be supplied in standard drum lengths i.e. 500  $\pm$ 5% meters Non-standard lengths of not less than 100 meters is acceptable. Total non-standard length should not exceed 5% of the ordered quantity.

## **9.0 PACKING**

The cable shall be supplied on non-returnable wooden drums of heavy standard construction conforming to IS: 10418: 1982 and latest amendment thereof and being suitable for transport by goods train or truck and for storage at site. The wood used for construction of the drums shall be properly seasoned and wood preservative shall be applied to the entire drum.

All ferrous parts shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit of storage. Each drum shall have the following information marked on its with indelible in along with other important information including technical data:-

- II) PVVNL. Specn. No.
- III) Consignee & Destination Railway Station
- IV) Trade name of trademark .if any
- V) Name of the manufacturer
- VI) Nominal sectional area of the conductor of the cable
- VII) Drum No.
- VIII) No. of cores
- IX) Type of cable & Voltage for which it is suitable
- X) Gross weight of the drum (Approx.)
- XI) Length of cable in the drum with individual lengths if more than one.
- XII) Net weight of the cable
- XIII) ISI certification mark, if available

A layer of waterproof paper shall be applied to the surface of the drum and over the outer cable layer. A clear space of at least 40 mm shall be left between the cable and the lapping. The packing shall be adequate to protect the cable from damage in transit and contractor shall be responsible for it and make good at his own expenses any and all damage due to improper packing etc.

**10.0 IDENTIFICATION MARKING:**

For the identification of individual cores longitudinal ridges or number printing over cores used to identify phase conductors

**11.0 EMBOSSING:**

The manufacturer shall emboss

11.1 Property of PVVNL

11.2 Name of manufacturer

11.3 Year of Manufacturer

11.4 Specification No.

11.5 Voltage grade and

11.6 Size of cores at the interval of one-meter length throughout the length of the cable.

The identification embossing shall be done on only one of the insulated phase conductor.

**12.0 GUARANTEED TECHNICAL PARTICULARS:**

The guaranteed technical particulars as detailed in the specification shall be guaranteed and a statement of guaranteed technical particulars shall be furnished in the format along with the bid without which the Bid shall be treated as Non -Responsive.

**13.0 TEST CERTIFICATE:**

The tenderer shall furnish an authenticated copy of results of successful type test report. The successful type test report as carried out over the cable of same design, size, type & manufacturing process during last five years (Counted from the date of tender opening) testing laboratories of CPRI/ERDA shall be acceptable.

The purchaser reserves the right to get the cable type tested at any stage during the pendency of the contract at its own expenses in any government recognized testing laboratory. The transportation and arrangement of testing of sample to test laboratory shall be responsibility of the contractor.

**14.0 INSPECTIONS AND TESTING**

14.1 The inspection shall be carried out by the purchaser's representative during manufacture and before dispatch. The supplier shall keep the purchaser informed in advance, about the manufacturing programme so that arrangement can be made for inspection. The manufacturer shall grant free access to the purchaser's representative, at a reasonable time, when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser, shall not relieve the supplier of his obligation of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment

is found to be defective.

14.2 All Acceptance tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the Bidder and purchaser at the time of purchase. The purchaser reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items. The supplier shall give 15 days (for local supply)/ 30 days (incase of foreign supply) advance intimation to enable the purchaser to depute his representative for witnessing the acceptance and routine tests. Material shall be dispatched only after getting the dispatch authorization from Inspectors representing purchaser, after successful testing.

14.3 If successful type tests have been carried out on the offered design during last five years (counted from the date of tender opening), repetition of type tests is not required. On the other hand, if the offered design is not type tested during last five years, the cable shall be subjected to all type test in accordance with IS: 1554 (Part-I)/1988 and amendment thereof at recognized test house of repute. All charges/fee/transportation etc. to conduct these tests shall be borne by Contractor. Regular supply of the material shall commence only after successful type testing and dispatch authorization from the competent authority.

However, the purchaser reserves the right to get cable type tested at any stage during the currency of contract at his own expenses in any reputed test house. The transportation and arrangement of testing of sample to test laboratory shall be the responsibility of the contractor. Routine tests report shall be sent by the manufacturers with their offer for inspection, the acceptance tests as laid down in the referred ISS (with latest amendments) shall be carried out by the inspecting officer of the PVVNL on Samples selected at random.

## **15.0 CHECKING OF CABLE LENGTH**

Sufficient facilities should exist at contractor's premises to measure the cable length by the inspecting officers For this purpose motorized system to facilities quick measurement should be available at he works.

GUARANTEED TECHNICAL PARTICULARS OF AERIAL BUNCHED



**CABLE      3x120+1x95+1x16**

1.		Manufacture name & address	Required value	Offered value
2.		Rated voltage	1100 V	
3.		Phase conductor details		
	i)	No of phase conductors	3	
	ii)	Nominal sectional area of each conductor in sq.mm	120	
	iii)	Minimum Tensile strength of each strand in N/sq.mm	90	
	iv)	Diameter of compacted conductor in mm(Approx)	13.2	
	v)	Max. D.C. resistance at 20°C (Ohm/Km)	0.253	
	vi)	Insulation thickness (mm) nominal	1.50	
		Insulation thickness (mm) minimum	1.25	
	vii)	Standard specification to which this material shall conform	IS-8130/1984 & IS:14255/1995	
4.		Street light conductor Detail		
	i)	Nominal sectional; area of conductor in sq.mm	16	
	ii)	Minimum Tensile strength of each strand in N/sq.mm	90	
	iii)	Diameter of compacted conductor in mm (approx)	4.4	
	iv)	Max. D.C. resistance at 20°C (Ω /Km)	1.91	
	v)	Insulation Thickness (mm) nominal	1.20	
		Insulation thickness (mm) minimum	0.98	
	vi)	Standard specification to which this material shall conform	IS:8130/1984& IS:14255/1995	
5.		<b>Total Minimum Guaranteed weight of aluminium in Phase as well as Street light conductors (kg/km)</b>	<b>1016.3</b>	
6.		Messenger details:		
	i)	Nominal sectional area of the conductor in sq.mm	95	
	ii)	No. of strands	7	
	iii)	approximate overall dia of complete conductor (mm)	11.7	
	iv)	<b>Minimum Guaranteed weight of messenger(Al. alloy) Kg/Km</b>	<b>256.7</b>	
	v)	Minimum breaking load of the conductor in Kn	26.5	
	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 (Ω /Km)	0.357	
7.		Insulation of phase & street light conductor:		
	i)	Material	XLPE	

ii)	Standard specification to which this material shall conform	7098(Part-I/1988)	
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## **11 TECHNICAL SPECIFICATION OF FRP FENCING**

### 1.00 Fencing

#### a. Product materials for fencing

The minimum requirements are as follows:

##### i.Chain Link fence fabric in accordance to IS-2721

1. Size of mesh : 75 mm
2. Nominal wire size : 4.0 mm dia
3. Width of chain link : 2000 mm
4. Class of zinc coating : medium
5. Zinc coated after weaving.

##### ii.Posts

###### Angle Section

Intermediate : L 65 x 65 x 6

Straining posts : L 65 x 65 x 6

Stay post : L 65 x 65 x 6

1. All structural steel shall conform to IS: 2062 and shall be painted with a coat of approved steel primer and two coats of synthetic enamel paint.
2. The Chain Link fabric shall be fixed to the post at the top and bottom of the fence by welding/fixing 50 mm MS flat all through its length.
3. Fencing top shall be either of galvanised barbed wire or tape. Barbed wire shall conform to IS: 278.

4. The barbed wire may consist of not more than two splices per reel. The barbed wire shall be formed by twisting two line wires, one containing the barbs. The barbed wire shall be designated as A-4 IS: 278 and shall be galvanized.
5. Above chain link, 3-rows (6 nos) of barbed tape/wire shall be provided in each arm of the Y shaped barbed arm at top.
6. With barbed tape/wire above the chain link fence, the total fence height shall be minimum 2500 mm above finished gravel level.
7. Barbed tape/wire arms shall be same as intermediate and straining post.
8. Tension wire: single strand, high tensile, galvanised steel wire, 4 mm diameter.
9. Fittings and hardware: cast aluminum alloy or galvanized steel, malleable or ductile cast iron turnbuckles to be drop forged.
10. GI chain link mesh shall be as per IS: 2721. Mesh size 75 mm and nominal wire size shall be 4.0 mm diameter.

On the results of these additional tests, the whole or portion of the barbed wire/tape shall be accepted or discarded by the Purchaser, as the case may be.

b. Installation

1. Contractor shall submit the fencing drawing Fence shall be installed along lines shown on approved drawings.
2. Post holes shall be excavated by approved methods.
3. Intermediate posts shall be spaced 2.5 m apart measured parallel to ground surface.
4. Straining posts shall be installed at equal intervals not exceeding 25.0 m.
5. Straining posts shall be installed at sharp changes in grade, at corners, at change of direction and where directed.
6. All corner post will have two-stay post and every tenth post will have a transverse stay post.

7. Posts shall be set in 1:2:4 plain cement concrete Blocks of minimum dimension 400 mm x 400 mm x 1000 mm deep Concrete work shall conform to relevant clause. Post shall be braced and held in plumb position and true alignment and elevation until concrete has set.
8. Fence fabric shall not be installed until concrete has cured a minimum of 7 days.
9. Bottom and top of the fence fabric shall be fixed with MS flats of 50 mm x 6mm (min).
10. Fence fabric shall be laid out with barbed edge on top, stretched tightly and shall be fastened to intermediate, post gate and straining post with 50 x 6 flats.
11. Fabric shall be secured to tension wires with tie wires at 400 mm intervals. Tie wires shall be given not less than two twists.
12. Barbed tape shall be spliced with standard wire splices.
13. Barbed tape shall be stretched to have uniform tension.
14. Barbed tape shall be attached to barbed wire arms with approved metal clips.
15. Toe wall of one Brick/Random Rubble masonry, with notches over 75 mm thick PCC (1:4:8) shall be provided below all fencing and shall be minimum 200 mm above and 200 mm below finished ground level. All exposed surfaces of brick toe wall shall be provided with 1:6 cement sand plaster and coated with two coats of colour wash with a base coat of white wash with lime. Rubble masonry toe wall shall be with raised & cut pointing and 50 mm PCC (1:2:4) band coping.
16. Proper earthing shall be done for fencing also.

## **12 TECHNICAL SPECIFICATION FOR SMC FEEDER PILLAR PANEL**

### **1. Scope of Supply**

This shall include Design, Manufacture, testing at manufactures works before dispatch, packing, delivery of material to DISCOM Stores and submission of documents to purchaser.

### **2. Codes & Standards**

The equipment shall confirm to this specification and latest revision of following codes with all amendments:-

	<b>Title</b>	<b>Indian Standard</b>
2.1	IS: 5039	Specification for Distribution pillar below 1000V AC
2.2	IS: 13947 part 2	Low voltage switchgear
2.3	IS: 8623	Specification for Low voltage switchgear
2.4	IS: 12063	Classification of degree of protection provided by enclosure of electrical equipment
2.5	IS: 13703	Low voltage HRC Fuses
2.6	IS: IS: 191	Specification for Copper
2.7	IS: 5082	Wrought Aluminum & Al alloy plates & Sheets for electrical applications

### **3. Service Conditions**

The feeder pillar panel shall be designed to work satisfactory under following service conditions:-

	<b>Title</b>	<b>Indian Standard</b>
3.1	Supply Voltage	3 Phase neutral, AC 433 Volt +/- 10 %
3.2	Supply Frequency	50 Hz +/- 5%
3.3	Location of Panel	Outdoor, on foot path pr road side
3.4	Pollution	Heavily Polluted and Dry
3.5	Humidity	90 % Maximum
3.6	Ambient Temperature	Average 40 Deg C, Maximum 50 Deg C
3.7	Incoming Supply to feeder pillar panel	From distribution transformer of main feeder panel
3.8	Seismic Zone	4

#### 4. Feeder Pillar Configuration

The feeder pillar panel shall have the following configuration:-

	Feeder Pillar Type	Incoming feeder (Circuit Ways) & Cable Size	Outgoing feeder (Circuit Ways) & Cable Size
4.1	A – 1, 8-Way	2 x 400 Amp TP Fuse / Cable Size 4C x 300 Sqmm	6 x 250 Amp TP Fuse / Cable Size 4C x 150 Sqmm
4.2	B – 1, 5-Way	1 x 400 Amp TP Fuse / Cable Size 4C x 300 Sqmm	4 x 250 Amp TP Fuse / Cable Size 4C x 150 Sqmm
4.3	C – 1, 7-Way	1 x 250 Amp TP Fuse / Cable Size 4C x 150 Sqmm	5 x 100 Amp TP Fuse, 1 x 250 Amp TP fuse / Cable Size 4C x 95 Sqmm

#### 5. Panel Construction

The feeder Pillar panel construction shall confirm to following features:-

5.0	Panel Construction	Free Standing floor mounted	
5.1	Ingress Protection class of enclosure	IP 44 as per IS 12063	
5.2	Material	Sheet Moulding Compound (SMC) As per confirming to IS: 13410	
5.3	Thickness of enclosure	3 mm Min	
5.4	Cable Entry Hole	From Bottom Only	
5.5	Pad Locking facility	For front and Rear door	
5.6	Door Opening angle	Min 120 Deg.	
5.7	External hardware	Galvanized Steel Nut and Bolt	
5.8	Phase and Neutral Bus bar	EC grade Aluminum	
5.9	Bus bar color coding for R,Y, B and Neutral	Heat shrinkable tape of color Red, Yellow, Blue & Black respectively	
5.10	Bus bar Size in mm	Phase	Neutral
5.10.1	8 - Way	50 x 10 mm	50 x 10mm
5.10.2	5 - Way	50 x 6 mm	50 x 6 mm
5.10.3	7 Way	50 x 6 mm	50 x 6 mm
5.11	Earth Bus at panel bottom	25 x 6 mm Aluminum	
5.12	Neutral bus bar	With hole for connection I/c and O/g cables up to 300 sqmm	

5.13	Bus bar support insulators	SMC / DMC,
5.14	Cable Size Incoming for 8 Way Panel	4C x 300 Sqmm cable
5.15	Incoming for 5 & 7 Way panel	4C x 300 Sqmm cable for 5 Way & 4C x 150 Sqmm cable for 7 Way panel
5.16	Outgoing for 8 Way Panel	4C x 150 Sqmm cable
5.17	Outgoing for 5 Way & 7 Way Panel	4C x 150 Sqmm cable for 5 Way & 4C x 95 Sqmm cable for 7 Way panel
5.18	Terminal Shape	' Z ' Strips, 02 nos. per terminal
5.19	Z Strip dimensions supported on insulators	8 Way panel Incomer 50 x 10mm
		5 & 7 Way panel Incomer 50 x 10mm
		All outgoing feeders 40 x 6 mm
5.20	Ease of taking current reading with open clamp type ammeter	Possible with Z strip terminal
5.21	Gland plate at panel bottom	M.S plate, 3 mm thickness
5.22	Cable Supports	Non ferrous clamp at bottom
5.23	Earth studs on both side panel bottom	With M 10 galvanized steel Nut & bolts
5.24	Panel Maximum dimensions in mm	Height Depth
	8 - Way	1200 mm 1100 mm 400 mm
	5 - Way	1200 mm 1100 mm 400 mm
	7 - Way	1200 mm 1100 mm 400 mm
5.25	Colour of Panel	Off White

## 6. Fuse Base

The equipment shall have all the following features:-

6.1	Fuse base connection to main bus bar	By bus bar and not by flexible jumpers
6.2	Current rating of fuse base at maximum ambient temperature 50 Deg C	8 – Way I/c 400 Amp, O/g 250 Amp 5 & 7 Way I/c 400 Amps. O/g 250 Amp
6.3	Fuse base current carrying part	Plated copper as per IS 191
6.4	Fuse base insulating material	Sheet Moulding Compound (SMC) As per confirming to IS: 13410
6.5	HRC Fuse Pullers 1 no / Type of Fuse	Suitable for 400 Amp / 250 Amp HRC Fuse

**7. Operational requirements**

7.1	Clearance between phase to phase and phase to earth	Minimum 25 mm
7.2	Continues rated operating voltage	433 Volts +/- 10 %
7.3	Power frequency high voltage withstand capacity for one minute	2000 Volts
7.4	Insulation resistance value for phase and neutral bus bar	Minimum 100 Mohms with 500 V Megger
7.5	Temperature rise above ambient 45 Deg C	As per IS: 13947 - 1

**8. Testing and Inspection**

The equipment shall have all the following features:-

8.1	Type Test	Only type tested components – fuse base, insulators and aluminum bus bar shall be accepted
		Test reports as per relevant IS to be submitted by vendor
8.2	Test report validity	Valid for last 5 years
8.3	Acceptance and routine test (Inspection test witness by purchaser)	1) Visual inspection, dimension check
		2) Insulation resistance test for main and auxiliary circuit
		3) High voltage test on main and auxiliary circuit
		4) Operational check
8.4	Tolerance on panel enclosure	Maximum +/- 5 mm
8.2.9	No negative tolerance on bus bar dimensions and bus bar clearance	
8.2.10	Prototype panel to be approved by DISCOM	



**13 63,100,200 & 315 kVA L.T. Distribution Box****1. SCOPE:**

This Specification covers the design, manufacture, testing at works and supply of Distribution Boxes made out of **CRCA MS** for controlling the L.T. feeders from the L.T. side of Distribution Transformers. The system shall be A.C. 3 phase, 4 wire, 433 V, 50 HZ with effectively grounded neutral.

**2. SERVICE CONDITIONS:**

The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions as specified by employer which is as hereunder;

- 2.1 Maximum ambient temperature (Degree C)
- 2.2 Maximum temperature in shade (Degree C)
- 2.3 Minimum Temperature (Degree C)
- 2.4 Relative Humidity (percent)
- 2.5 Maximum Annual rain fall (mm)
- 2.6 Maximum wind pressure (kg/sq.m)
- 2.7 Maximum altitude above mean sea level ( Meter)
- 2.8 Isoceran level (days per year)
- 2.9 Siesmic level (Horizontal Acceleration)

Moderately hot and humid tropical climate conducive to rust and fungus growth ....

**3. SYSTEM DETAILS:**

Distribution Boxes are meant for control and protection of Distribution Transformers with relevant parameters as under:-

S.N.	Particulars	Details
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1.	KVA rating	63 KVA	100 KVA	200 KVA	315 KVA
2.	Voltage	433 V, 3 Ph, ( 3x 250 V)			
3.	Frequency	50 HZ			
4.	Phases	3 phase, solidly grounded neutral			
5.	Approximate full load current of transformer	84 A	133 A	270 A	440 A
6.	No. of Outgoing circuits	2 nos		3 nos	4 nos

### 3.4 Applicable Standards:

IS :13947/ (Part 3) (amended upto date) for Isolator (Switch Disconnecter)

IS: 13947/ (Part2)(amended upto date) for L.T. MCCBs.

IS: 8623 (amended upto date) for enclosure Box & for degree of protection provided by enclosures of electrical equipments.

IS: 4237, IS:8623 (amended upto date) – for general requirement of L.T. switchgears.

IS 13703 ( Part I & II amended upto date) for HRC Fuse Base and HRC Fuse Link.

IS: 5 /2007 - Colours of Ready Mixed paints and Enamels.

IS: 13871/1993 (amended upto date) – Powder coatings – specifications

IS : 6005/1998 (amended upto date) – Code of Practice for phosphating of iron and steel.

IS: 13411/1992 (amended upto date) – Glass Reinforced Polyester Dough Moulding Compounds

### 3.5 MANUFACTURE/CONSTRUCTION OF BOXES:

Distribution Boxes shall have Isolator (Switch Disconnecter) and HRC fuse base with links on incoming circuit and single pole MCCBs & Link Disconnecter on outgoing circuits with necessary interconnecting Bus Bars/ Links.

Standard General Arrangement of Isolators, HRC fuse base with links, MCCBs,

Link Disconnecter, Neutral Links, Bus Bars, connecting links, Cable termination arrangement etc inside the Box is shown in the enclosed drawings.

### 3.6 INCOMING CIRCUIT –

#### 6.1 Isolator (Switch Disconnecter) -

Each distribution box shall have one triple pole Isolator (Switch Disconnecter), conforming to relevant latest IS. The supplier shall indicate makes and types of offered isolator in GTP. The supplier shall submit Type Test Report of the Isolator as specified in Cl. No. 12.3 (II) for approval of Employer before commencement of supply. The Switch disconnecter to be provided in the Distribution Box will be as per Employer specification.

The Isolator should be front operated triple pole type. The casing of Isolator shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D<sub>3</sub> Grade as per IS:13411 (amended upto date), no separate enclosure is required. Isolator Base should withstand the breaking capacity of 80 kA. To extinguish the arc immediately in isolators, in each phase arc-chutes with minimum 12 strips shall be provided.

The isolator should be front operated triple pole type. The isolator shall be robust in construction and easy for operation. The handle of the isolator should be detachable easily for security purpose while working on L.T. circuits.

The characteristics of Isolator shall be as follows:

S.N.	Characteristics	Rating			
		63 KVA	100 KVA	200 KVA	315 KVA
1.	Basic uninterrupted duty	200 A		600A	
2.	Mechanism	Manual quick make quick break			
3.	Standard applicable	IS : 13947 amended upto date			
4.	Utilization category	AC –23 A			
5.	Mechanical Endurance	As per IS 13497 amended upto date			
6.	Electrical Endurance	As per IS: 13947 amended upto date			
7.	Rated Duty	Uninterrupted			
8	Making /Breaking capacity	Not less than requirement of AC –23 A category			
9.	Two seconds rating	4 KA		8 KA	

10.	Rated insulation voltage	660 V
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The terminal connector strips of the isolator shall be projecting out of isolator of 80 mm (minimum) in length on cable connection side and 60mm (minimum) on HRC fuse base side as shown in the drawings. In 63 /100/200/315 KVA distribution box, the cross section of the strips on outside of the isolator shall be provided as below:

63/100 KVA - 25X5 mm.

200 KVA- 50X 6 mm

315 KVA- 50X 6 mm

The material of isolator strips shall be EC grade tin-plated copper. The terminal strips shall be continuous from the point of contact separation inside the Isolator with cross section as mentioned above throughout the length. Gap of 50mm shall be maintained between each terminal throughout the length.

## 6.2 HRC FUSE

HRC Fuse of suitable capacity shall be provided between outgoing terminal of Switch Disconnector (Isolator) and incoming Busbar to facilitate electrical breaking of the circuit. Each Distribution Box shall have 3 Nos. of HRC Fuse Base with HRC Fuse Links (Blade type Contacts).

The supplier shall indicate in GTP, the make, type and capacity of HRC Fuse Base and Fuse Links offered.

### (i) HRC FUSE BASE

The base of the HRC Fuse shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D<sub>3</sub> Grade as per IS:13411/1992. The Fuse Base shall be sturdy in construction.

The extension terminal connector strips of the Fuse Base shall be projecting out on both sides, made with two pieces ( half portion of the terminal contact and extension strip should be continuous in one piece), as shown in the drawing. The dimensions shall be as shown in the drawing. The material for both strips shall be tin plated EC Grade copper. HRC Fuse Base & fuse link should have withstand the breaking capacity of 80 kA.

HRC Fuse base shall be suitable for fuse of 200A for 63/100 KVA distribution box and 400 A for 200 KVA and 630A for 315 kVA distribution box.

(ii) **HRC FUSE LINK**

The HRC Fuse Links shall be sturdy in construction of “Din Type”. Breaking Capacity shall be 80 kA. For fault indication red pop up indicator should come out instantly on fusing. Manufacturer’s name, current rating, breaking capacity and type shall be marked on HRC fuse link.

HRC Fuse link Current rating for 63/100 /200/315 KVA distribution box shall be as follows:

63 KVA	-	100 A
100 KVA	-	160 A
200 KVA	-	315 A.
315 KVA	-	500 A

The supplier shall submit Type Test Report of the HRC fuse base and HRC fuse link as specified in Cl. No. 12.3 (III) for approval of Employer before commencement of supply. The HRC fuse base with links to be provided in the Distribution Box will be as per Employer approval given in the detailed purchase order.

**3.7 OUTGOING CIRCUITS:**

(i) **MCCBs**

Each distribution box shall have 6 nos. of single-pole MCCBs in 63 KVA /100 KVA Box, 9 nos of single-pole MCCBs in 200 KVA box and 12 nos of single-pole MCCBs in 315 KVA box to protect outgoing circuits. MCCB shall be of reputed make and shall confirm to latest IS. The supplier shall indicate the makes and types of MCCBs offered in GTP. The supplier shall submit Type Test Report of the MCCB as specified in Cl. No. 12.3 (IV) for approval of Employer before commencement of supply. The MCCBs to be provided in the Distribution Box will be as per Employer approval as given in the detailed purchase order.

MCCB shall have quick make quick break mechanism. Making of MCCB shall only be manual but breaking of MCCBs shall be electrical as well as manual.

The detailed specification for MCCBs shall be as under.

S.No	Particulars	Details			
1.	KVA rating	63 KVA	100 KVA	200 KVA	315 KVA
2.	Rated current	150 A		200 A	
3.	Fixed overload release setting ( A)	60 A	90 A	120 A	120 A
4.	No. of poles	Single pole			
5.	Rated service short circuit breaking capacity ( kA) which is equal to ultimate breaking capacity as per IS 13947 (amended upto date)	10 KA at 0.4 p.f . ( lag)			
	The sequence of operation for this test shall be, O - t - CO - t - CO, and t = 3 min.). The test shall be done at 250V at 0.4 p.f. (lag). Voltage rating phase to phase 433 V and phase to earth 250V.				
6.	Power factor for short circuit (Max.)	0.4 lag			
7.	Utilization category	A			
8.	Rated Insulation Voltage	660 V			

The Busbar dropper and Terminal connection strip of Link Disconnecter shall be placed in contact terminal of MCCB as shown in the drawing.

The rated service short circuit breaking capacity as specified above, shall be based on the rated service short circuit test carried out at specified power factors.

To extinguish the arc immediately in MCCBs, arc-chutes with minimum 8 strips shall be provided.

While the above stipulation regarding the test power factor and the sequence of operation shall be binding, the other procedure for making the short circuit test and circuit etc. shall generally be in accordance with the Indian Standard applicable to the type of circuit breakers under test.

## 7.2 TIME CURRENT CHARACTERISTICS of MCCBs:

The L.T. MCCBs shall have time current characteristics as follows:

Multiple of normal Current setting	Tripping time
1.05	More than 2.5 hrs.
1.2	More than 10 minutes and less than 2 hrs.
1.3	Less than 30 minutes
1.4	Less than 10 minutes
2.5	Less than 1 minute
4.0	Not less than 2 seconds
6.0	Less than 5 seconds
12.0	Instantaneous (less than 40 milli seconds.)

For above time/current characteristic, the reference calibration temperature of the breaker shall be 50°C. Deration, if any, up to 60°C. Ambient temperature shall not exceed 10% of the current setting indicated above.

### c. LINK DISCONNECTOR :

Link Disconnecter of 200 A capacity shall be provided between outgoing terminal of MCCB & cable connection to facilitate mechanical breaking (manual isolation) of the circuit. 63 /100 kVA Distribution Box shall have 6 Nos. of link Disconnectors, 200 kVA distribution box shall have 9 nos of link Disconnectors and 315 kVA distribution box shall have 12 nos of link Disconnectors.

The supplier has to indicate the makes and types of Link Disconnecter offered in GTP. The supplier shall submit Type Test Report of Link Disconnecter as specified in Cl. No. 12.3 (V) for approval of Employer before commencement of supply. The link Disconnectors to be provided in the Distribution Box will be as per EMPLOYER's approval as given in the detailed purchase order.

The base of the Link Disconnecter shall be of non-tracking, heat resistant insulating material of Dough Moulding Compound (DMC) of D<sub>3</sub> Grade as per IS:13411 (amended upto date). The Link Disconnecter shall be sturdy in construction and easy in operation.

The link of Link Disconnecter shall be of Tin-plated E.C. grade copper. The

construction of the Link Disconnecter shall be such that it shall be hinged type on cable connection end and disconnectable at the MCCB end. The disconnection will be with the help of special handle/puller. One handle/puller shall be supplied along with each Distribution Box. The terminal connector strips of the Link Disconnecter of 25 x 3 mm cross section, shall be projecting out of Link disconnecter for minimum length of 80 mm. on cable connection side and 40 mm on MCCB outgoing side. The cross section of knife edge link shall be 20 x 5 mm. The material for both the strips and links shall be tin-plated E.C. grade copper. The size of bimetallic lugs hole & the hole on the disconnectors strip on cable side should be same.

### 3.8 BUSBARS AND CONNECTIONS:

The Incomer feeder should be on right side of the distribution box and all outgoing feeders will be on left side of the distribution box, with phase sequence RYB to be maintained. The phase busbars, incoming droppers and feeder droppers from busbars shall be of EC Grade Aluminium. The phase busbar strips shall be of size 25X8 mm for 63 KVA/100 KVA and 40X10 mm for 200 and 40X15 for 315 KVA box. Feeder droppers shall be 25X8 mm. Incomer dropper of 25 x 8 mm cross section for 63 /100 KVA box and 40 x 10 mm cross section for 200KVA box and 40X15 for 315 KVA box be provided. All busbars and droppers shall be properly drilled and de-burred. Each bus bar shall be of one single strip without any joint.

Busbars shall be provided with durable PVC insulating sleeves of standard colour code for different phases. Corrugated/Spring & Plain washers shall be used for Nut-Bolt connections.

Busbars shall be mounted on suitable size support insulators which should be tightened from inside. i.e. once fitted, should not be able to removed.

Minimum clearances, wherever shown, shall be as per General Arrangement Drawing enclosed with this specification. Other clearances shall be as per requirement of IS: 4237 amended upto date.

### 3.9 ENCLOSURE:

9.1 The Box & Doors shall be made up of CRCA MS sheet of 2mm thickness.

9.2 The manufacturing process of Box shall be **Deep Drawn / Sheet Bending Process** (Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated



15.05.2017)

- 9.3 In case of distribution boxes, the rounding of corners and slope on top shall be as shown in the drawing.
- 9.4 The welding process of distribution boxes shall be done by MIG (Metal Inert Gas) welding and workmanship/finishing should be good enough.
- 9.5 **For Deep Drawn/ Sheet Bending Process (Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017)** **Box:** the general clear dimensions of 63 / 100 KVA Distribution Box shall be 1000 x 1010 x 325 (LXHXW)mm. The center height of distribution box on front side shall be 1000 mm The general clear dimensions of 200 kVA distribution box shall be 1305 x 1050 x 325 (LXHXW) mm and for 315 kVA distribution box shall be 1545 x 1050 x 325 (LXHXW) mm. The center height of the distribution box on front side shall be 1050 mm
- 9.6 The Base and doors of enclosure shall be individually in one piece without any welding, except for fixing of the accessories like hinges, clamps, mounting clamps, bolts etc.
- A. 63/100 kVA boxes shall have two doors as shown in the drawing fixed on right & left side of the box with four hinges provided from inside of box. On closing of doors, right door shall rest on the left door. Hinges shall not be visible and approachable after closing the box.
- B. 200/315 kVA boxes shall have two doors as shown in drawing fixed on right side & left side of the box with four hinges on both sides shall be provided from inside of box. On closing of doors, right door shall rest on the left door. Hinges shall not be visible and approachable after closing the box.

Base and doors shall have flange / collars as shown in drawing. Collar of Base and doors shall overlap by 10mm. Rubber gasket of suitable size shall be provided in between base and doors, such that it provides proper sealing between the door and base of box to avoid penetration of dust & ingress of water. Degree of protection shall be **IP- 33** as per IS-8623 ( amended up to date ). Rubber Gasket shall be fixed with suitable adhesive. Four hinges on each side shall be provided from inside of the box to fix the doors. Hinges shall be minimum 50 mm in length & made from 2mm thick sheet. Hinge stainless steel pin diameter shall be 4mm. The hinges shall not be visible from outside.

- 9.7 The MCCBs, Link Disconnecter, Isolator and HRC fuse base with link shall be housed inside the enclosure. Isolator operating handle shall be accessible only after opening of the doors.
- 9.8 Four set of Louvers (two sets on each side) of suitable size shall be provided as shown in drawing. The louvers shall be provided such that heat dissipation is proper. The perforated sheet of 20 SWG with 2.5 mm holes shall be welded from inside of the louvers.
- 9.9 Mounting of components inside the enclosure shall allow free air circulation keeping the clearances as per drawings attached with specification.

**9.10 Locking Arrangement to the Box:**

The doors shall be closed with a push fit locking arrangement such that on pressing/pushing the right door, the distribution box gets locked from inside from top & bottom. This arrangement shall be operational for opening of the door with a handle provided outside the door. Handle shall be removable type only. A Nylon washer shall be provided between the handle and door to avoid penetration of water. One central lock with brass levers shall be provided inside the door. Key way shall be provided on the door for operating the central lock from outside. Key way shall be provided with cover.

- 9.11 A suitable cable termination arrangement with support insulators shall be provided on Isolators and Link Disconnectors. The bimetallic lugs of adequate size, as per enclosed specification & drawing, shall be provided. Clearances, Creepages and convenience in making connections shall be ensured.
- 9.12 EC grade Aluminium Neutral Busbar of 300 x 25 x 8 mm for 63/100 KVA box and 525 x 40 x 10 mm for 200 KVA and 40 x 15mm for 315 KVA Box capable of carrying for full load current. Neutral Busbar shall be isolated with respect to body. The bimetallic lugs of adequate size, as per enclosed specification & drawing, shall be provided. Neutral Busbar shall be as shown in the drawing attached with the specifications.
- 9.13 Bolts of M10 mm and 35 mm length with 2 Nos. plain washer and two Nos. nut are to be provided on both the sides for earthing of the distribution box. Earthing bolt is to be fixed on U-structure (Earth Clamp) welded on both sides of the distribution box. Thickness of earth clamp shall be 2mm. The top surface of the earth clamp shall be

properly Zinc plated. Earthing nut bolt and washer should be zinc plated. There should be no powder coating on top surface of the earthing clamps.

- 9.14 Three bottom plates for 63/100 KVA and 4 bottom plates for 200 KVA and 5 bottom Plates for 315 KVA shall be provided for incoming and outgoing cables as shown in the drawing. Bottom plate of size 125mm x 125mm fixed with four screws from inside shall be provided for incoming and outgoing cables. Bottom plates shall be provided with suitable holes and rubber glands for the cables. Rubber glands shall be made such that internal diameter of glands provided for cables should be closed with the rubber film of minimum 1mm thickness. Cable will go through the glands by cutting the film of the glands. Bottom plates shall also be provided with cable clamps as shown in drawing.
- 9.15 Necessary fixing arrangement shall be provided at the back of the enclosure to ensure proper fixing on double pole structure by means of suitable clamps at 4 places.
- 9.16 Danger marking shall be provided in red colour on the right door of the distribution box. Marking shall be scratch proof and properly readable.
- 9.17 All the components inside the Box shall be mounted on CRCA MS strips of 2mm thickness. The mounting strips shall be provided with required bends or ribs to give the extra strength and shall be powder coated or zinc plated.
- 9.18 All joints of current carrying parts shall be bolted with 8.8 grade High Tensile MS Nuts & Bolts, Corrugated/spring & Plain Washers. The nuts & bolts should be of hexagonal type. All the nuts, bolts & washers should be properly zinc plated.
- 9.19 Each distribution box shall be supplied with proper packing in five ply - corrugated box.
- 9.20 Name plate having details such as Month & year of manufacturing, , Sr.No, and rating of Distribution box, XXXXX"Name of Employer" shall be riveted on the Distribution box door. Name of Manufacturer shall be duly embossed on the door of the distribution box. The name plate should be of stainless steel of thickness 1 mm.
- 9.21 Incoming and outgoing circuit should be duly highlighted with paint by stencil printing.
- 9.22 Adequate slope on the top of box shall be provided to drain out rainwater from the top.

9.23 3 Nos. MCCBs and 3 Nos. HRC fuse links in spare should be invariably provided with each box.

9.24 Good-quality plastic sticker leaflet should be pasted inside of distribution box door. The matter of instruction leaflet shall be provided by the employer. All the instructions in leaflet should be in Hindi/English/Local language.

### 3.10 CABLE TERMINATION:

Adequate size of Bimetallic lugs shall be provided for 3½ core, LT XLPE cable on incoming side and out going side for 63/100/200/315 KVA boxes as below :

	Incoming side	Outgoing Side
63 KVA	70 sq.mm	50/ 70 sq.mm
100 KVA	150 sq.mm	50/70 sq.mm
200 KVA	300 sq.mm	150 sq.mm.
315 KVA	300 sq.mm	150 sq.mm.

3.11 **LUG :** Bimetallic lug should be made for electrolytic grade aluminum. Each lug should be copper coated by electrolytic process and rich layer of tin should be mounted through out the lug to protect from Galvanic Corrosion. The lugs shall be such that the rich layer of tin should not peel of during operation. Individual lot should be pre filled with conductive inhibition compound and lug should be duly capped to prevent oozing of compound. The ductility of material should be such that flow ability of material be adequate to flow in to the strand of the conductor and withstand on crimping pressure of 8500 PSI. The cut cross section of the joints shall be homogeneous.

### 3.12 FINISHING OF DISTRIBUTION BOX:

The outer side and inside surface of the box shall be properly Pre-treated /Phosphated in seven tank process as per IS: 6005 and shall be applied powder coating of minimum 40 micron thickness. The Colour shade of light Admiralty gray (as per employer requirement) for 63, 100, 200 and 315 KVA box as per IS: 5/2007 (Colours of Ready Mixed paints and Enamels) shall be applied inside & outside surface of the box or as per state practice. Powder coating shall be suitable for outdoor use, conforming IS: 13871 (amended upto date) – Powder coatings. The process facility shall be in-house to ensure proper quality for outdoor application.

### 3.13 TESTS & TEST CERTIFICATES:

In case of bought out items, routine and acceptance tests as per relevant IS and this specification shall be carried out at the original manufacturers' works.

#### a) Routine Test (Carried out on all boxes):

Overall Dimensions Checking.

Insulation Resistance Tests.

High Voltage Test at 2500 V, 50 Hz AC for one minute.

12.1.4. Operation Test on MCCB/Isolator/Link Disconnecter / HRC fuse base and fuse links.

#### b) Acceptance Tests (on complete Distribution Box):

Following tests shall be carried out as per acceptance tests in addition to routine tests on one random sample of each rating out of the lot offered for inspection:

i) Temperature rise test on one sample of each rating.

Temperature rise test will be carried out as per the procedure given below:

For temperature rise test, a distribution box with all assembly of MCCBs / Link Disconnectors / Isolator / HRC fuse base with link shall be kept in an enclosure such that the temperature outside the box shall be maintained at 50 ° C.

20% more current than transformer secondary capacity i.e. for 63 KVA Distribution Transformers full load current 84A, 20 % more is 100 A shall be kept in incoming circuit keeping outgoing circuits short, till the temperature stabilizes and maximum temperature rise should be recorded.

ii) Time-Current Characteristics

The MCCB should be tested for time current characteristics at 1.05 & 1.2 times of overload release setting current and should pass the requirement given in clause- 7.2.

#### c) TYPE TESTS :

**1 ON COMPLETE BOX:**

- a. Temperature rise test:-** The temperature rise test should be carried out as per IS: 8623

High voltage test shall be carried out as per IS:8623 amended upto date.

Short Time Withstand Current Test on Distribution Box shall be carried out as per IS 8623 or latest version.

The Distribution Box should be subjected to Short Time Withstand Current Test for 4KA for 2 seconds for 63/100 KVA Box and 8 KA for 2 second for 200/315 KVA box) all the circuits independently. The test should be carried out after by-passing MCCBs.

Degree of protection for **IP- 33** on complete box shall be carried out as per IS: 13947/1993 or the latest version thereof.

Time /current characteristic test on MCCBs shall be carried out as per clause **7.2** of this specification as stated above.

**2 ON ISOLATOR (SWITCH DISCONNECTOR):**

All type tests on Isolator (Switch Disconnecter) as per IS: 13947 (Part III) amended up to date shall be carried out.

**3 ON HRC fuses base and HRC fuse links :**

All type tests on HRC fuses and HRC fuse links IS 13703 ( Part I & II amended upto date) for HRC Fuse Base and HRC fuse link shall be carried out.

**4 ON MCCB:**

All type tests on MCCB as per IS-13947 amended upto date shall be carried out.

**5 ON Link Disconnecter:**

Following tests shall be carried out on link disconnecter as per IS:

Short Circuit Withstand Strength

Temperature rise Limits

Mechanical Operations

#### **12.4 TYPE - TEST CERTIFICATES:**

The Distribution Box, Isolator (Switch Disconnecter), HRC fuse, HRC Fuse Link and MCCB offered shall be fully type tested as per relevant IS and this specification. The Supplier shall furnish detailed type test reports before commencement of supply. The detailed Type Test Reports shall be furnished with relevant oscillogram and certified Drawings of the equipment tested. The purchaser reserves the right to demand repetition of some or all the Type Tests in presence of purchaser's representative at purchaser's cost.

All the type tests shall be carried out from laboratories accredited by National Accreditation Board of Testing And Calibration Laboratories (NABL), Department of science & technology , Govt. of India to prove that the complete Box, Isolator, HRC fuse, Link Disconnecter & MCCB meet the requirements of the specification. The Manufacturer should also furnish certificate from laboratories that laboratories are having all the requisite test facility available in house. The type test Reports conducted in manufacturers own laboratory and certified by testing institute shall not be acceptable.

The Supplier should furnish the particulars giving specific required details of Distribution Boxes, MCCBs, Isolator and Link Disconnecter.

#### **3.14 TESTING & MANUFACTURING FACILITIES :**

Supplier must be an indigenous manufacturer. The Supplier must clearly indicate what testing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out all Routine & Acceptance Tests. These facilities should be available to Employer's Engineers, if deputed to carry out or witness the tests in the manufacturer's works. The supplier must have all the in-house testing facilities to carry out the acceptance tests on the Box.

The supplier shall furnish detailed process of manufacturing & Powder coating.

#### **3.15 PROTOTYPE & DRAWINGS:-**

The manufacturer has to manufacture the prototype Unit for each rating as per this specification before bulk manufacturing. The manufacturer should intimate the readiness of prototype to employer. The Project Manager will inspect the prototype for approval. The manufacturer should submit the final drawings in line with this specification and prototype to employer for approval before bulk manufacturing. The approval of prototype & drawings shall be a responsibility of manufacturer/Contractor. Tentative drawing of box is enclosed herewith.



**14 11kV Porcelain Insulators and Fittings****INSULATORS****1. SCOPE**

This specification covers details of porcelain insulators (Pin and Strain Insulators) for use on 11 KV overhead power lines in rural electric distribution system.

**2. APPLICABLE STANDARDS**

Except when it conflicts with the specific requirements of this specification, the insulators shall comply with IS:731 and IS:3188 as amended from time to time.

**3. GENERAL REQUIREMENTS**

- 3.1** The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
- 3.2** Unless otherwise specified, the glaze shall be brown in colour. The glaze shall cover all the porcelain parts of insulators except those areas which serve as support during firing or are left unglazed for the purpose of assembly.
- 3.3** The design of insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.
- 3.4** Cement used in construction of insulators shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
- 3.5** The insulators should preferably be manufactured in automatic temperature - controlled kilns to obtain uniform baking and better electrical and mechanical properties.

**4. CLASSIFICATION AND DIMENSIONS**

- 4.1** Both pin and strain insulators shall conform to Type B of IS:731.
- 4.2** The dimensions of pin insulators shall be as shown in Fig. 1.
- 4.3** The strain insulators shall be of Ball and Socket type or Tongue and Clevis type, as required by the Purchaser. The dimensions of these insulators shall be as per Fig. 2.

**5. TEST VOLTAGES**

- 5.1** The test voltages of insulators shall be as under:

Highest System voltage	Visible Discharge Test	Wet Power Frequency withstand Test	Power Frequency puncture withstand test		Impulse voltage withstand Test
			Pin Insulator	Strain	

				Insulator	
kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(rms)	kV(Peak)
12	9	35	105	1.3 times of the actual dry flash over voltage of the Insulator	75

## 6. FAILING LOAD

- 6.1** Mechanical Failing Load (For Pin Insulators only) The insulators shall be suitable for a minimum failing load of 5 KN applied in transverse direction.
- 6.2** Electro-Mechanical Failing Load (For Strain Insulators) The insulators shall be suitable for a minimum failing load of 45 KN applied axially.

## 7. CREEPAGE DISTANCE

The minimum creepage distance shall be as under :

Highest System Voltage	Normal and Moderately polluted atmosphere	Heavily Polluted atmosphere	
		Pin insulator	Strain insulator
KV	mm	mm	Mm
12	230	320	400

**Note :** Higher value of creepage distance has been specified for strain insulators as these are normally used in horizontal position in 11 KV lines.

## 8. TESTS

The insulators shall comply with the following tests as per IS:731 :-

### 8.1 Type Tests

- Visual examination
- Verification of dimensions
- Visible discharge test
- Impulse Voltage Withstand Test
- Wet Power Frequency Voltage Withstand Test
- Temperature cycle test

- g) Mechanical Failing load test (for Pin Insulators only) to be carried out as per procedure described at Sub-clause 8.4
- h) 24-hour Mechanical strength Test for Strain Insulators
- i) Puncture Test
- j) Porosity Test
- k) Galvanizing Test
- l) Electro-mechanical failing load test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4.
- m) Thermal Mechanical Performance Test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4

## **8.2 ROUTINE TESTS:**

- a) Visual examination
- b) Mechanical routine test (for strain insulator only)
- c) Electrical routine test (for strain insulator only)
- d) Hydraulic Internal Pressure test on shells for strain insulators to be carried out as per procedure described at Sub-clause 8.4

## **8.3 ACCEPTANCE TEST:**

- a) Verification of Dimensions
- b) Temperature cycle Test
- c) Electro-mechanical failing load test (for strain insulators only) to be carried out as per procedure described at Sub-clause 8.4
- d) Puncture test (for strain insulators only)
- e) Porosity test
- f) Galvanizing test

## **8.4 Following procedure shall be used for conducting tests on insulators :**

### **1 Hydraulic Internal Pressure Test on Shells (For Disc Insulators)**

The test shall be carried out on 100% shells before assembly.

Thermal Mechanical Performance Test (if applicable):

Thermal Mechanical Performance Test shall be performed in accordance with IEC- 383-1-1993 Clause 20 with the following modifications:

- (1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.
- (2) The acceptance criteria shall be

- (a)  $X$  greater than or equal to  $R + 3S$ .

Where

$X$ - Mean value of the individual mechanical failing load.

$R$ - Rated electro-mechanical / mechanical failing load.

$S$ - Standard deviation.

- (b) The minimum sample size shall be taken as 20 for disc insulator units.

- (c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

## **2 Electromechanical/Mechanical Failing Load Test.**

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

- (i)  $X$  greater than or equal to  $R + 3S$  , Where  
 $X$ - Mean value of the electro-mechanical/mechanical/ failing load.  
 $R$ - Rated electro-mechanical / mechanical failing load.  
 $S$ - Standard deviation.
- (ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.
- (iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.

## **9. MARKING**

**9.1** Each insulator shall be legibly and indelibly marked to show the following:

- a) Name or trademark of manufacturer
- b) Month and year of manufacture
- c) Minimum failing load in KN
- d) ISI certification mark, if any

**9.1.1** Markings on porcelain shall be printed and shall be applied before firing.

## **10. PACKING**

All insulators (without fittings) shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Where more than one insulator is packed in a crate, wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate.

## **11. INSPECTION**

- 11.1** All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.
- 11.2** The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

## **INSULATOR FITTINGS**

### **1. SCOPE**

This specification covers details and test requirements for (i) Pins for 11 KV Insulators, (ii) Helically Formed Pin Insulator Ties (iii) Fittings for Strain Insulators with Helically Formed Conductor Dead-Ends and (iv) Fittings for Strain Insulators with conventional Dead-End Clamps.

### **2. APPLICABLE STANDARDS**

Pins shall comply with the requirements of IS:2486 (Pt. I & II). Helically formed fittings shall comply with IS:12048-1987. Fittings for strain insulators shall comply with the requirements of IS:2486 Pt. I to IV.

### **3. PINS FOR INSULATORS**

#### **3.1 General Requirements**

The pins shall be of single piece obtained preferably by the process of forging. They shall not be made by joining, welding, shrink fitting or any other process using more than one piece of material. The pins shall be of good finish, free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided. All ferrous pins, nuts and washers, except those made of stainless steel, shall be galvanized. The threads of nuts and tapped holes, when cut after galvanizing shall be well oiled or greased.

#### **3.2 Dimensions**

Pins shall be of small steel head type S 165P as per IS:2486 (Part-II) having stalk length of 165mm and shank length of 150mm with minimum failing load of 5 KN. Details of the pins are shown in Fig. 3.

#### **3.3 Tests**

Insulator pins shall comply with the following test requirements as per IS:2486 (Part-I)-1993 or latest version thereof:

**3.3.1. Type Tests**

- a) Checking of threads on heads
- b) Galvanizing test
- c) Visual examination test
- d) Mechanical test

**3.3.2 Acceptance Tests**

- a) Checking of threads on heads
- b) Galvanising test
- c) Mechanical test

**3.3.3 Routine Test**

Visual examination test

**4. HELICALLY FORMED PIN INSULATOR TIES**

**4.1** Helically formed ties used for holding the conductor on the pin insulator (Fig.4) shall be made of aluminum alloy or aluminized steel or aluminum-clad steel wires and shall conform to the requirements of IS:12048-1987.

**4.2** The ties shall be suitable for pin insulator dimensions as per Fig. 1 of Pt. I and conductor sizes to be specified by the purchaser.

**Note:** Helically formed insulators ties are made to suit specific sizes of conductors, which should be clearly specified by the purchaser.

**4.3** Elastomer pad for insulator shall be used with the ties to avoid abrasion of the conductor coming into direct contact with the insulator.

**4.4 Tests**

The ties shall be subjected to the tests specified in IS:12048-1987.

**5. FITTINGS FOR STRAIN INSULATORS WITH HELICALLY FORMED CONDUCTOR DEAD-ENDGRIPS****5.1 Fittings for Strain Insulators of Tongue & Clevis Type**

**5.1.1** The fittings shall consist of the following components:

- a) Cross arm strap conforming to IS: 2486 (Pt.II)-1989.
- b) Aluminium alloy die cast thimble-clevis for attaching to the tongue of strain insulator on one end and for accommodating the loop of the helically formed dead-end fitting at the other end in its smooth internal contour. The thimble shall be suitable for all sizes of conductors ranging from 7/2.11mm to 7/3.35mm ACSR. The thimble clevis shall be attached to the insulator by a steel cutter pin used with a non-ferrous split pin of brass or stainless steel. The thimble shall have clevis dimensions as per IS:2486 (Pt.II)-1989.

- c) Helically formed dead-end grip having a pre-fabricated loop to fit into the grooved contour of the thimble on one end and for application over the conductor at the other end. The formed fitting shall conform to the requirement of IS:12048-1987.

**Note :** As the helically formed fittings are made to suit specific sizes conductors, the purchase should clearly specify the number of fittings required for each size of conductor.

**5.1.2** Nominal dimensions of the T&C type insulator fittings are shown in Fig. 5.

## **5.2 Fittings for Strain Insulators of Ball & Socket Type**

**5.2.1** The fittings shall consist of the following components:

- a) Cross arm strap conforming to IS:2486 (Pt.II)-1989.
- b) Forged steel ball eye for attaching the socket end of the strain insulator to the cross arm strap. Forging shall be made of steel as per IS:2004-1978.
- c) Aluminium alloy thimble-socket made out of permanent mould cast, high strength aluminium alloy for attaching to the strain insulator on one end and for accommodating the loop of the helically formed dead-end fittings at the other end in its smooth internal contour. The thimble-socket shall be attached to the strain insulator with the help of locking pin as per the dimensions given in IS:2486 (Pt.II)-1989 and
- d) Helically formed dead-end grip as per clause 5.1.1(c) above.

**5.2.2** Nominal dimensions of the Ball & Socket type insulator fittings are shown in Fig. 6.

## **5.3 Tests**

The helically formed fittings for strain insulators shall be subjected to tests as per IS:12048-1987. The other hardware fittings shall be tested as per IS:2486 (Part-I).

## **6. FITTINGS FOR STRAIN INSULATORS WITH CONVENTIONAL DEAD-END CLAMPS ALTERNATIVE TO FITTINGS COVERED IN CLAUSE 5)**

**6.1** Fittings for strain insulators with conventional dead-end clamps for use with tongue & clevis or ball & socket type insulators shall consist of the following components:

- a) Cross arms strap conforming to IS:2486 (Pt.II)-1989
- b) Dead-end clamp made of aluminum alloy to suit ACSR conductors from 7/2.11mm to 7/3.35mm. The ultimate strength of the clamp shall not be less than 3000 Kg. The shape and major dimensions of clamps suitable for B&S and T&C insulators are shown in figures 7 & 8 respectively.

## **6.2 Tests**

The fittings shall be subjected to type, routine and acceptance tests in accordance with the stipulations of IS:2486 (Pt.I).

**Note:** Fittings for strain insulators as stipulated in Clause 5 are preferable to the fittings stipulated in Clause 6 both from the point of view of better quality of construction and ease of application.

**7. PACKING**

**7.1** For packing of GI pins, strain clamps and related hardware, double gunny bags or wooden cases shall be used. The heads and threaded portions of pins and the fittings shall be properly protected against damage.

**7.2** The gross weight of the packing shall not normally exceed 50 Kg. Helically formed fittings shall be packed in card-board / wooden boxes. Fittings for different sizes of conductors shall be packed in different boxes and shall be complete with their minor accessories fitted in place and colour codes on tags/fittings shall be marked to identify suitability for different sizes of conductors as per IS:12048-1987.

**8 . INSPECTION**

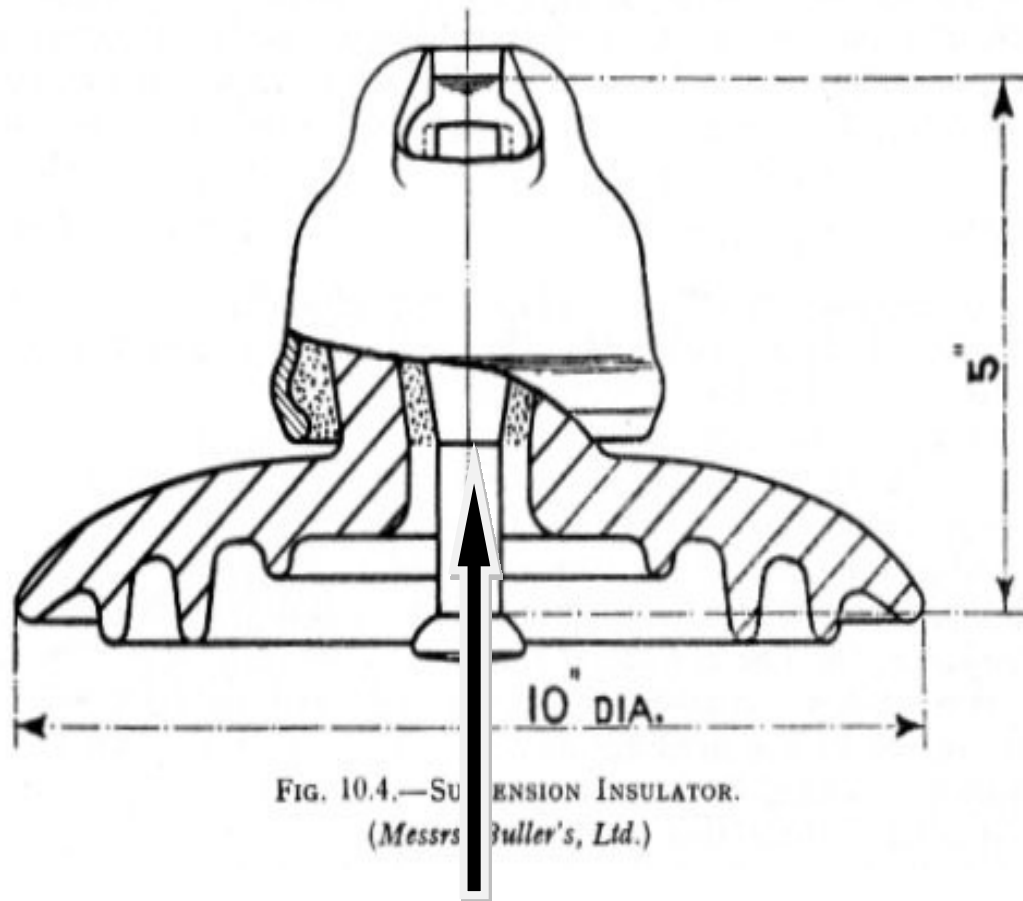
**8.1** All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.

**8.2** The purchaser has the right to have the test carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

**ANNEXURE-I**

**HYDRAULIC PRESSURE TEST ON DISC INSULATOR SHELL**





120 KG C/ M sq +/- 10 on the shell before cap and pin assembly to check the integrity of Porcelain

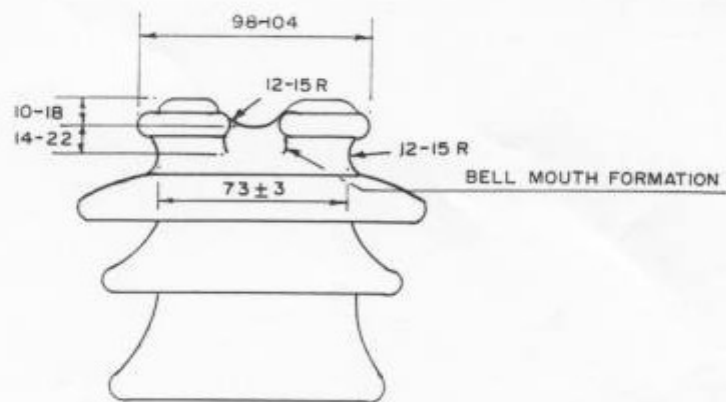
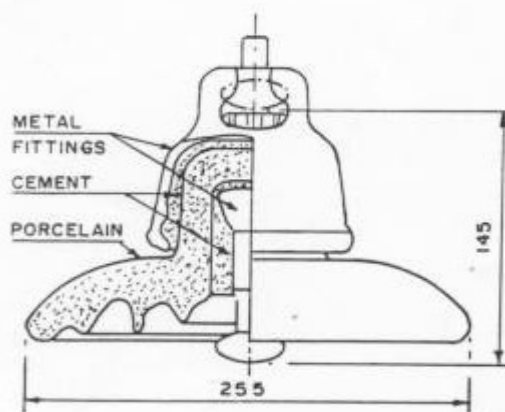
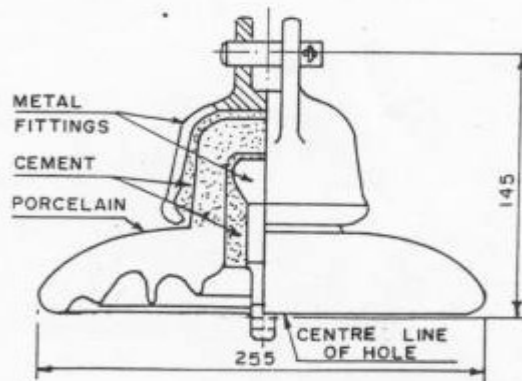
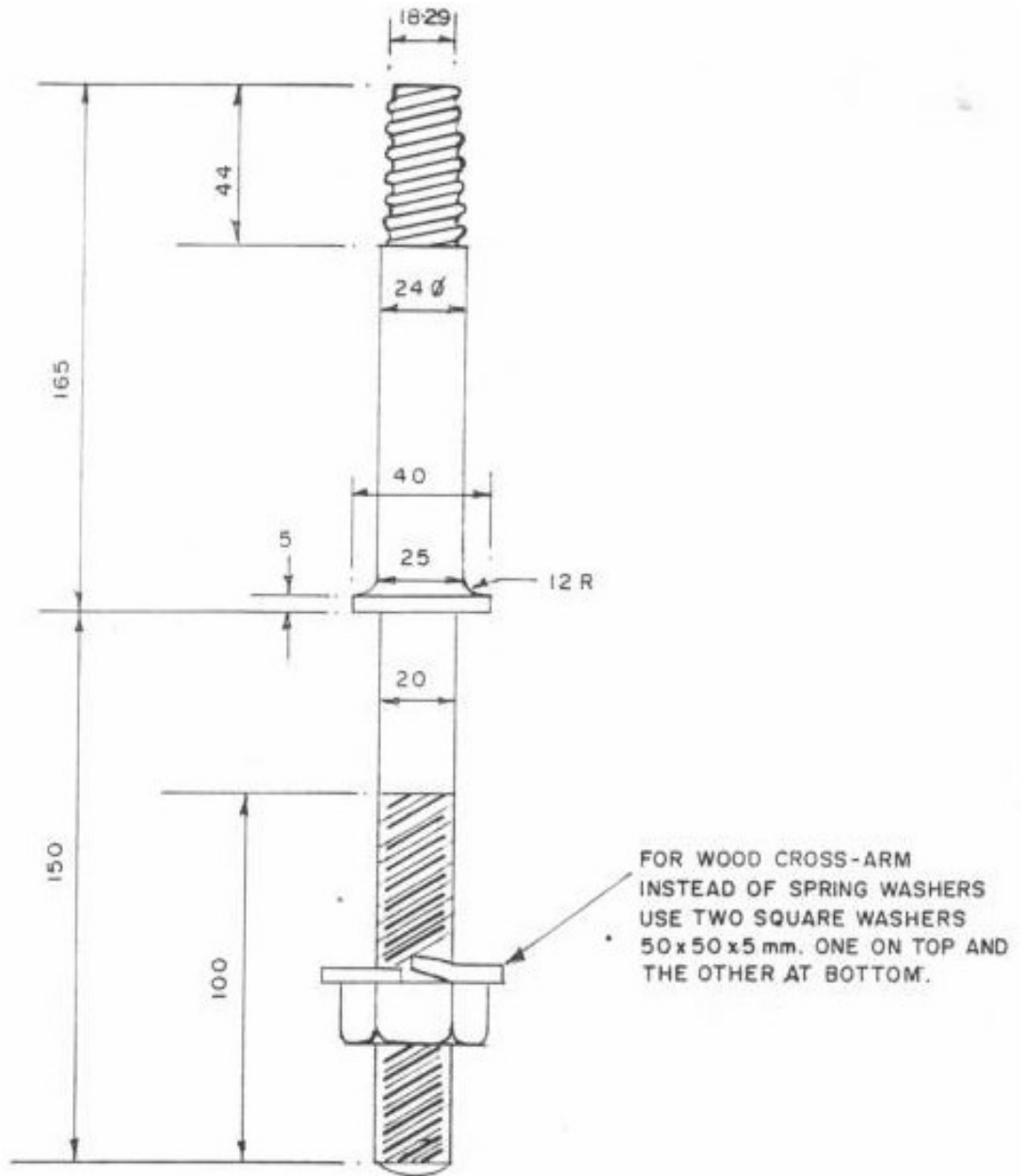


FIG-1.

११ के० वी० पिन विद्युतरोधक का विस्तार  
DIMENSIONS OF 11 KV. PIN INSULATOR

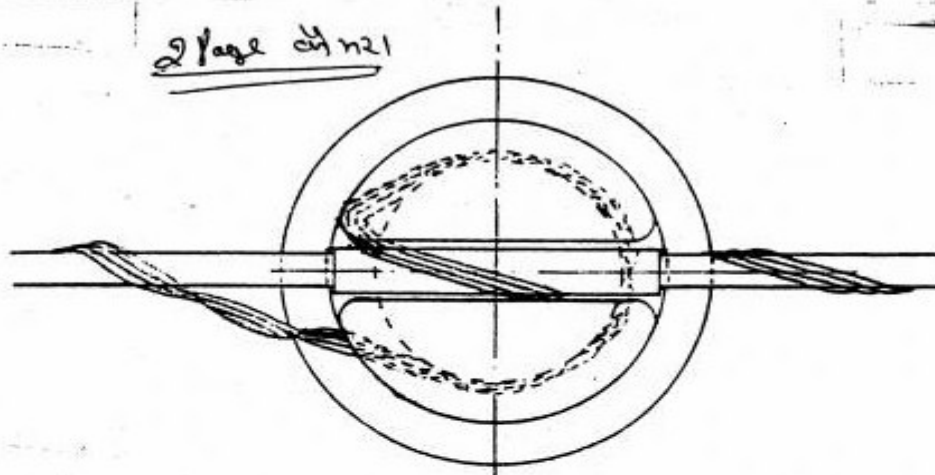
FIG-2A  
BALL AND SOCKET TYPE.FIG-2B  
TONGUE AND CLEVIS TYPE.

विकृति विद्युतरोधक का विस्तार  
DIMENSIONS OF STRAIN INSULATORS



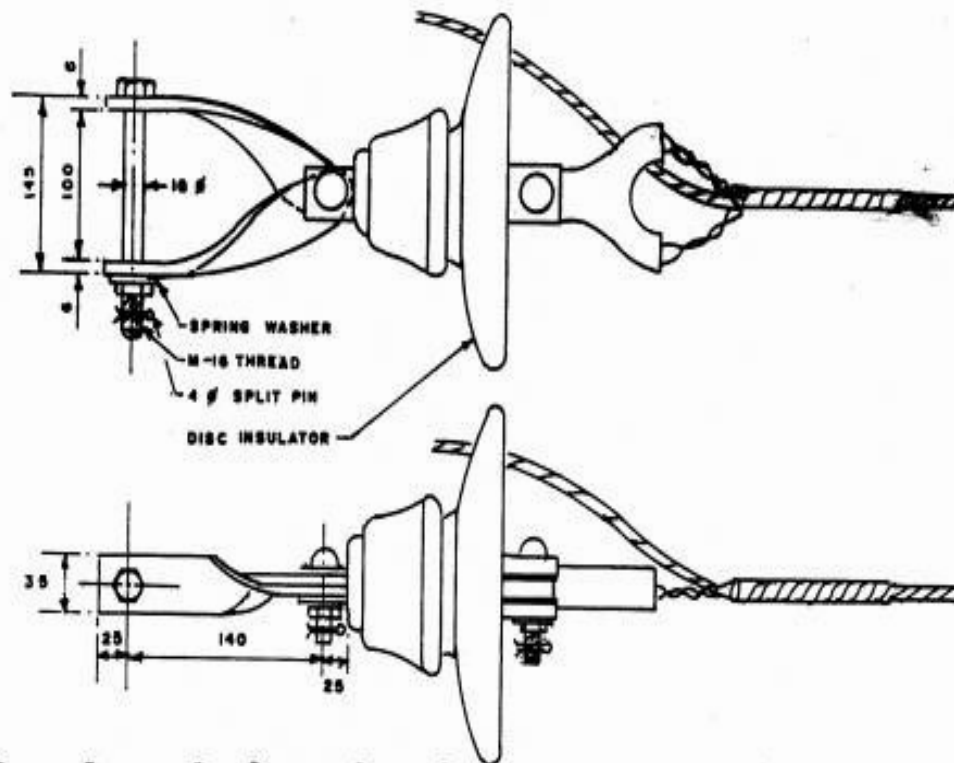
विद्युत रोधक पिन  
INSULATOR PIN  
(TYPE S 165P)  
AS PER IS: 2486 Pt.II.

FIG-3.

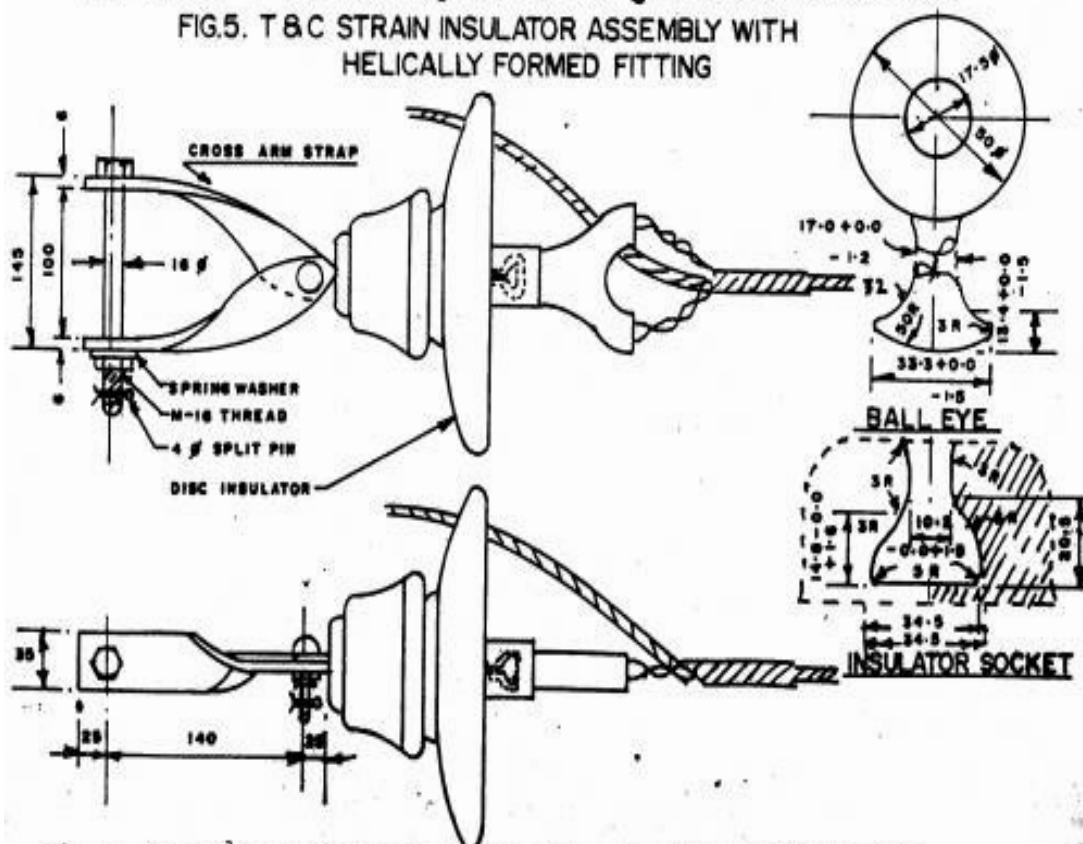


चित्र.४. ११ के. वी. पिन इन्सुलेटर टाई  
(सीधी और १०° तक कोणीय स्थिति के लिए उपयुक्त)

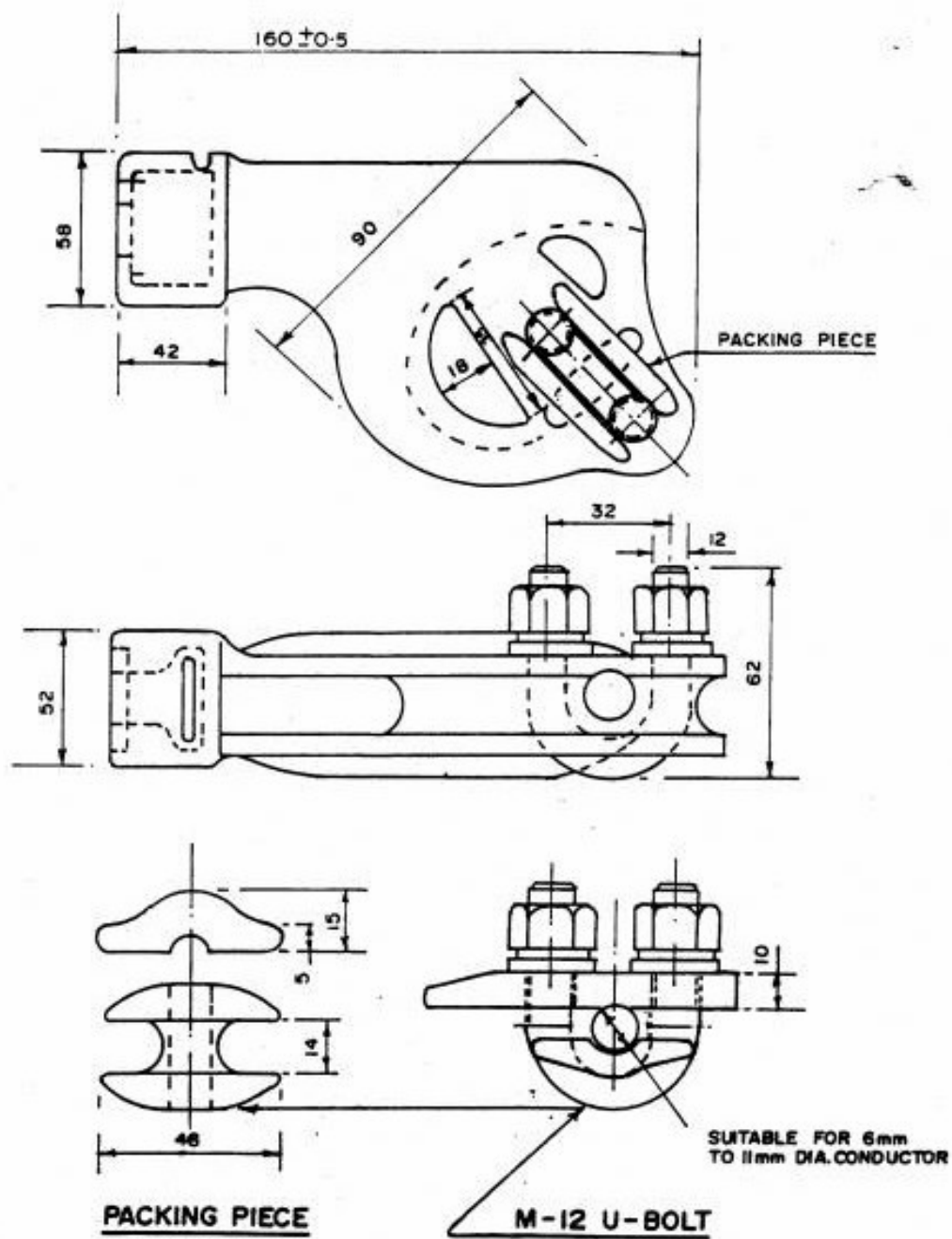
FIG:- 4 - 11 KV PIN INSULATOR TIE  
(SUITABLE FOR STRAIGHT RUNS AND ANGLE LOCATIONS UPTO 10°)



चित्र. ५. टी. सी. स्ट्रेन इन्सुलेटर एसेम्बली घुमावदार आकार फिटिंग सहित  
FIG.5. T & C STRAIN INSULATOR ASSEMBLY WITH  
HELICALLY FORMED FITTING

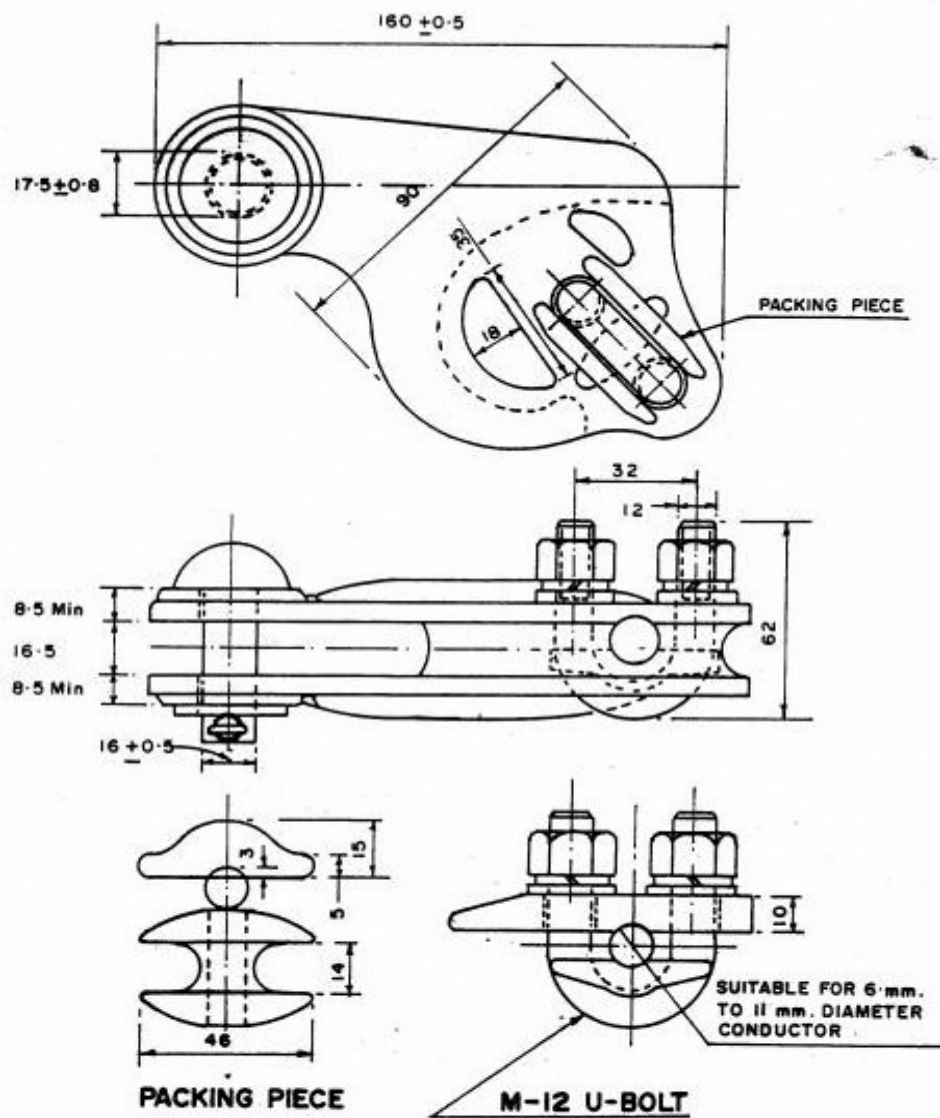


चित्र ६. बी. एण्डे एम्. स्ट्रेन इन्सुलेटर एसेम्बली युग्मवद्धार आकार फिटिंग सहित  
FIG.6. B&S STRAIN INSULATOR ASSEMBLY WITH  
HELICALLY FORMED FITTINGS



चित्र- 10. बॉल और सॉकेट प्रकार के विद्युत् रोधक के लिए त्र के. वी. विकृति (स्ट्रेन) क्लैम्प  
 FIG. 10 - 11KV. STRAIN CLAMP FOR BALL AND SOCKET TYPE INSULATOR.

ALL DIMENSIONS ARE IN mm.



चित्र: ८. टंग और क्लेविस् टाइप विद्युतरोधक के लिए ११ के. वी. विकृति क्लैम्प

FIG. 8. 11 KV. STRAIN CLAMP FOR TONGUE AND CLÉVIS TYPE INSULATOR.

ALL DIMENSIONS ARE IN mm.

## **15 Porcelain Insulators and Insulator Fittings for 33 kV Overhead Power Lines**

### **1. SCOPE**

This specification covers the details of the porcelain insulators and insulator fittings for use on 33 KV lines in rural electric sub-transmission systems.

### **2. APPLICABLE STANDARDS**

Unless otherwise stipulated in this Specification, the insulators shall comply with the Indian Standard Specification **IS:731-1971** and the insulator fittings with **IS:2486 (Pt.I)-1971 and IS:2486 (Pt.II)-1974** or the latest version thereof.

### **3. INSULATORS**

#### **3.1 General Requirements**

**3.1.1** The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

**3.1.2** Unless otherwise specified, the glaze shall be brown in color. The glaze shall cover all the porcelain parts of the insulator except those areas which serve as supports during firing or are left unglazed for the purpose of assembly.

**3.1.3** The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

**3.1.4** Cement used in the construction of the insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings, and its thickness shall be as uniform as possible.

#### **3.2 Classification**

**3.2.1** Only Type 'B' insulators as defined in Indian Standards shall be used.

**3.2.2** The string insulators shall only be of ball and socket type.

#### **3.3 Basic Insulation Levels**

**3.3.1** The test voltages of the insulators shall be as under :



**Table (Clause 3.3.1)**

Highest System Voltage	Visible Discharge Test	Wet Power Frequency Withstand Test	Power Frequency Puncture Withstand Test		Impulse Voltage Withstand Test
			Pin	String Insulator Units	
kV (rms)	kV (rms)	kV (rms)	kV (rms)	kV(rms)	kV (Peak)
36	27	75	180	1.3 times the actual dry flash over voltage of the Unit.	170

**3.3.2** In this specification, power frequency voltages are expressed as peak values divided by 2 and impulse voltages are expressed as peak values.

**3.3.3** The withstand and flashover voltages are referred to the 'Reference Atmospheric Conditions' as per Indian Standard.

### **3.4 Mechanical Load**

The insulators shall be suitable for the minimum failing loads specified as under:

Pin Insulator Failing loads	String Insulator Units	
	Failing Loads	Commended Pin Ball Shank Diameter
10 KN	45 KN	16 mm

### **2.5 Creepage Distance**

The minimum creepage distance shall be as under:

Highest System Voltage	Normal and Moderately Polluted Atmosphere (Total)	Heavily polluted Atmosphere (Total)
1	2	3
36KV	580mm	840mm

**Note:** For insulator used in an approximately vertical position the values given in Col. (2) or (3) shall apply. For insulators used in an approximately horizontal position, the value given in Col. (2) shall apply but the value in Col. (3) may be reduced by as much as 20%.

### **3.6 Tests :**

The insulators shall comply with the following tests as per **IS:731-1971** and latest version thereof.

### **3.6.1 Type Tests**

- a) Visual examination,
- b) Verification of dimensions,
- c) Visible discharge test,
- d) Impulse voltage withstand test,
- e) Wet power-frequency voltage withstand test,
- f) Temperature cycle test,
- g) Electro-mechanical failing load test
- h) Mechanical failing load test (for those of Type B string insulator units to which electromechanical failing load test (g) is not applicable).
- i) Twenty-four hours mechanical strength test (for string insulators only when specified by the purchaser.
- j) Puncture Test
- k) Porosity test and
- l) Galvanizing test

### **3.6.2 Acceptance Tests**

The test samples after having withstood the routine tests shall be subjected to the following acceptance test in the order indicated below:

- a) Verification of dimensions.
- b) Temperature cycle test
- c) Twenty four hours mechanical strength test (for string insulator units only when specified by the purchaser)
- d) Electro-mechanical failing load test.
- e) Puncture test.
- f) Porosity test and
- g) Galvanizing test

### **3.6.3 Routine Test**

- a) Visual examination.
- b) Mechanical routine test (for string insulator units only) and
- c) Electrical routine test (for string insulator units only)

### **3.7 Marking**

**3.7.1** Each insulator shall be legibly and indelibly marked to show the following:

- a) Name or trademark of the manufacturer
- b) Month and year of manufacture
- c) Minimum failing load in Newtons
- d) Country of the manufacture and
- e) ISI Certification mark, if any.

**3.7.2** Marking on porcelain shall be printed and shall be applied before firing.

### **3.8 Packing**

All insulators (without fittings) shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Where more than one insulator is packed in a crate, wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate. Disc insulators, however, may be assembled in string and packed inside a crate to prevent movement.

## **4. INSULATOR FITTINGS**

### **4.1 Pins for Pin Insulators**

#### **4.1.1 General Requirements**

**4.1.1.1** The pin shall be a single piece obtained preferably by the process of forging. It shall not be made by joining, welding, shrink-fitting or any other process from more than one piece of material. It shall be of good finish, free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided.

**4.1.1.2** All ferrous pins, nuts and washer except those made of stainless steel shall be galvanized. The threads of nuts shall be cut after galvanizing and shall be well oiled and greased.

#### **4.1.2 Type & Dimensions**

**4.1.2.1** Pins with large steel head Type L300N as per **IS:2486 (Pt.II)** having stalk length of 300 mm and shank length of 150 mm with minimum failing load of 10 KN shall be used.

**4.1.2.2** The complete details of the pin are given in Fig.1.

#### **4.1.3 Tests**

Insulator pins shall comply with the following tests as per **IS:2486 (pt.I)**.

##### **4.1.3.1 Type Tests**

- a) Visual examination test
- b) Checking of threads on heads
- c) Galvanising test and
- d) Mechanical test

##### **4.1.3.2 Acceptance Tests**

- a) Checking of threads on heads
- b) Galvanising test and
- c) Mechanical test

##### **4.1.3.3 Routine Test**

Visual examination

#### **4.2 String Insulator Fittings**

##### **4.2.1 General Requirements**

**4.2.1.1** All forgings and castings shall be of good finish and free of flaws and other defects. The edges on the outside of fittings, such as at the ball socket and holes, shall be rounded.

**4.2.1.2** All parts of different fittings which provide for interconnection shall be made such that sufficient clearance is provided at the connection point to ensure free movement and suspension of the insulator string assembly. All ball and socket connections shall be free in this manner, but care shall be taken that too much clearance between ball and socket is avoided.

**4.2.1.3** All ferrous fittings and the parts other than those of stainless steel, shall be galvanized. Small fittings like spring washers, nuts, etc. may be electro-galvanized.

#### **4.2.2. Type and Dimensions**

**4.2.2.1** Only ball and socket type insulator sets shall be used. The nominal dimensions of the ball and sockets, ball eye and cross-arm straps are given in Fig. 2. An assembly drawing of the complete insulator string is given in Fig. 3.

**4.2.2.2** Strain clamps shall be suitable for ACSR conductors 7/3.35 mm<sup>2</sup> (50 mm<sup>2</sup> Al. area), 7/4.09mm (80mm<sup>2</sup> Al. area) and 6/4.72mm + 7/1.57 mm (100 mm<sup>2</sup> Al. area). The ultimate strength of clamps shall not be less than 41 KN.

#### **4.2.3 Tests**

String insulator fittings shall comply with the following tests as per **IS:2486 (Pt.I)**.

##### **4.2.3.1 Type Tests**

- a) Slip strength test
- b) Mechanical test
- c) Electrical resistance test
- d) Heating cycle test
- e) Verification of dimensions
- f) Galvanising/Electroplating test, and
- g) Visual examination test

**4.2.3.2 Acceptance Tests**

- a) Verification of dimensions
- b) Galvanising/Electroplating test, and
- c) Mechanical tests

**4.2.3.3 Routine Tests**

- a) Visual examination test and
- b) Routine mechanical test

**4.2.4 Marking**

**4.2.4.1** The caps and clamps shall have marked on them the following :

- a) Name or trade mark of the manufacturer and
- b) Year of manufacture

**4.3 Packing**

**4.3.1** For packing of GI pins, strain clamps and related hardware, double gunny bags (or wooden cases, if deemed necessary) shall be employed. The heads and threaded portions of pins and the fittings shall be properly protected against damage. The gross weight of each packing shall not normally exceed 50 Kg. Different fittings shall be packed in different bags or cases and shall be complete with their minor accessories fitted in place. All nuts shall be hand-tightened over the bolts and screwed upto the farthest point.

**4.3.2** The packages containing fittings may also be marked with the ISI certification mark.

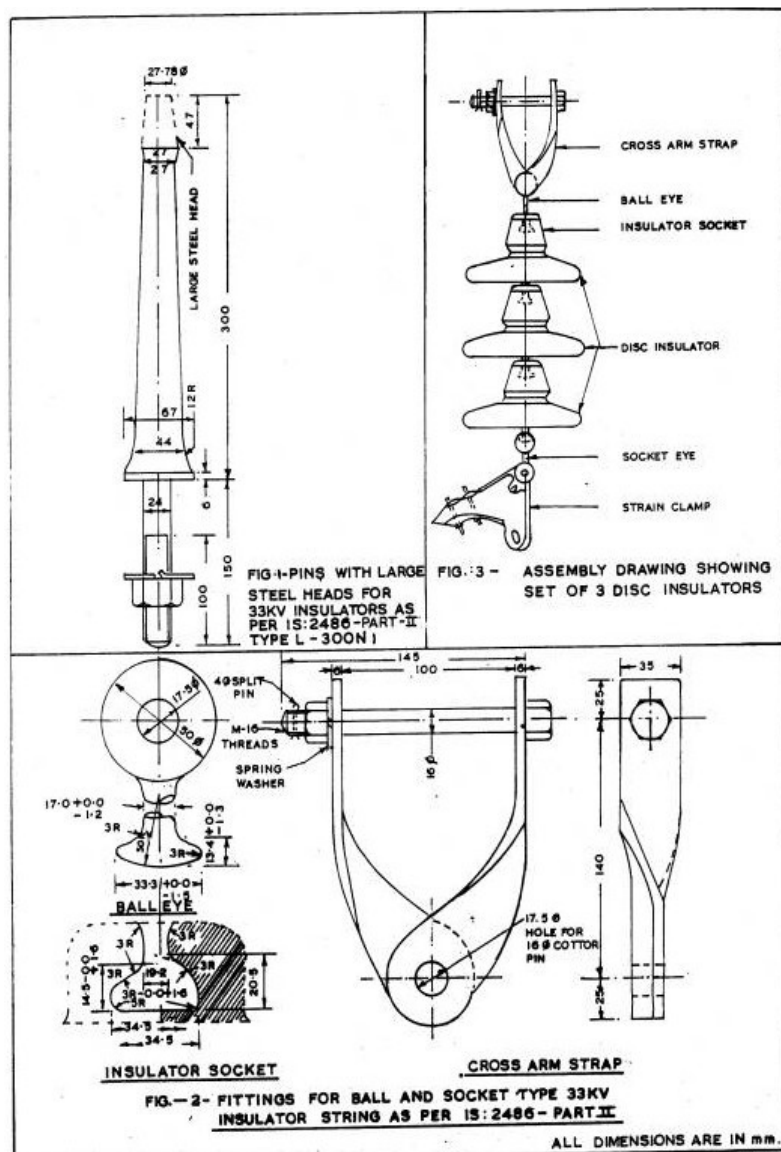


Fig.2 & Fig.3

## **16 33 kV and 11 kV Post Insulator**

### **1 GENERAL REQUIREMENTS**

- I.** The porcelain shall be sound and free from defects, thoroughly vitrified and smoothly glazed.
- II.** Unless otherwise specified the glaze shall be brown in colour. The glaze shall cover all the exposed porcelain part of the insulator except those areas which serve as support or required to be left un-glazed.
- III.** Precaution shall be taken during design and manufacture to avoid the following:
  - a) Stress due to expansion and contraction which may lead to deterioration.
  - b) Stress concentration due to direct engagement of the porcelain with the metal fittings.
  - c) Retention of water in the recesses of metal fitting and
  - d) Shapes which do not facilitate easy cleaning by normal methods.
- IV.** Cement used in the construction of the post insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. Further, the cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
- V.** All ferrous metal parts except those of stainless steel, shall be hot dip galvanized and the uniformity of zinc coating shall satisfy the requirements of IS : 2633. The parts shall be galvanized after mechanising. The finished galvanized surface shall be smooth.
- VI.** The threads of the tapped holes in the post insulators metal fittings shall be cut after giving anti-corrosion protection and shall be protected against rust by greasing or by other similar means. All other threads shall be cut before giving anti-corrosion protection. The tapped holes shall be suitable for bolts with threads having anti-corrosion protection and shall conform to IS : 4218(Part-I to VI). The effective length of thread shall not be less than the nominal diameter of the bolt.
- VII.** The post insulator unit shall be assembled in a suitable jig to ensure the correct positioning of the top and bottom metal fitting relative to one another. The faces of the metal fittings shall be parallel and at right angles to the axis of the insulator and the



corresponding holes in the top and bottom metal fittings shall be in a vertical plan containing the axis of insulator.

## 2 CLASSIFICATION

The post insulators shall be of type 'B' according to their construction, which is defined here under:

A post insulator or a post insulator unit in which the length of the shortest puncture path through solid insulating material is less than half the length of the shortest flash over path through air outside the insulator.

## 3 Standard insulation levels:

- I. The standard insulator levels of the post insulator or post insulator unit shall be as under:

Highest system voltage	Visible discharge test	Dry one minute power frequency withstand test.	Wet one minute power frequency withstand test.	Power frequency puncture withstand test.	Impulse voltage withstand test.
12 kV (rms)	9 kV(rms)	35 kV(rms)	35 kV(rms)	1.3 times the actual dry flash over voltage of the unit (kVrms)	75 kV peak
36 kV (rms)	27 kV(rms)	75 kV(rms)	75 kV(rms)	1.3 times the actual dry flash over voltage of the unit (kVrms)	170 kV peak

- II. In this standard, power frequency voltage is expressed as peak values divided by  $\sqrt{2}$ . The impulse voltages are expressed as peak values.
- III. The withstand and flashover voltage are referred to the atmospheric condition.

## 4 TESTS

**I. The insulators shall comply with the following constitute the type tests:**

- a) Visual examination.
- b) Verification of dimensions.
- c) Visible discharge test.
- d) Impulse voltage withstand test.
- e) Dry power frequency voltage withstand test.
- f) Wet power frequency voltage withstand test.
- g) Temperature cycle tests.
- h) Mechanical strength tests.
- i) Puncture test.
- j) Porosity test.
- k) Galvanizing test.

Type test certificates for the tests carried out on prototype of same specifications shall be enclosed with the tender and shall be subjected to the following acceptance test in the order indicated below.\

**II. Acceptance test:**

The test samples after having withstood routine test shall be subjected to the at least following acceptance test in the order indicated below:

- a) Verification of dimensions.
- b) Temperature cycle tests.
- c) Mechanical strength tests.
- d) Puncture test.
- e) Porosity test.
- f) Galvanizing test.

**III. Routine tests:**

The following shall be covered under routine tests on each post insulator or post insulator unit.

- a) Visual examination as per Cl. No.- 9.12 of IS: 2544/1973
- b) Mechanical routine test as per Cl. No.- 9.14 of IS: 2544/1973
- c) Electrical routine test as per Cl. No.- 9.13 of IS: 2544/1973

**5 MARKING****I. Each post insulator shall be legibly and indelibly marked to show the following.**

- a) Name or trademark of the manufacturer.

- b) Month & year of manufacture.
- c) Country of manufacture.

- II. Marking on porcelain shall be printed and shall be applied before firing.
- III. Post insulator or post insulator units may also be mark with I.S.I. certification mark.

## 6 PACKING

All post insulators shall be pack in wooden crates suitable for easy but rough handling and acceptable for rail, transport. Where more than one insulator is packed in a crate wooden separator shall be fixed between the insulators to keep individual insulator in position without movement within the crate.

**Table-I**

Highest System Voltage in kV	Minimum Creepage distance in mm
	Post insulator
12	320
36	900

## ANNEXURE – A

### 1 Hydraulic Internal Pressure Test on Shells (if applicable)

The test shall be carried out on 100%-disc strain insulator shells before assembly. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

### 2 Thermal Mechanical Performance Test

Thermal Mechanical Performance Test shall be performed in accordance with IEC-383-1-1993 Clause 20 with the following modifications:

- (1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.
- (2) The acceptance criteria shall be
  - (a)  $X$  greater than or equal to  $R + 3S$ .

Where,

$X$  Mean value of the individual mechanical failing load.

- R Rated electro-mechanical / mechanical failing load.  
S Standard deviation.

- (b) The minimum sample size shall be taken as 20 for disc insulator units.
- (c) The individual electromechanical failing load shall be at least equal to the rated value. Also, puncture shall not occur before the ultimate fracture.

### 3 Electromechanical/Mechanical Failing Load Test.

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

- (i)  $X$  greater than or equal to  $R + 3S$

Where,

$X$  Mean value of the electro-mechanical/mechanical/ failing load.

$R$  Rated electro-mechanical / mechanical failing load.

$S$  Standard deviation.

- (ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.
- (iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also, electrical puncture shall not occur before the ultimate fracture.

### 4 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analysed as per IS:209. The purity of zinc shall not be less than 99.95%.

### 5 Tests for Forgings

The chemical analysis, hardness tests and magnetic particle inclusion test for forgings, will be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

### 6 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inclusion for castings will be as per the internationally recognised procedures for these

tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

## **17.0 TECHNICAL SPECIFICATION FOR SUPPLY OF 33 KV SINGLE CIRCUIT UNGALVANIZED STEEL LATTICE STRUCTURE 36' LONG ALONG WITH 1 NO. 33 KV CROSS ARMS (CHANNEL) & 48 NOS. M. S. BOLT WITH NUTS**

### **1. SCOPE**

This specification covers fabrication, testing & delivery of fabricated steel items as a complete package, complete in all respect as per GTP/Drawings (to be provided by the purchaser to the successful bidder). The steel sections generally used, tentative unit weight & BOM of fabricated item is enclosed at Schedule-I. The final bill of material for the purpose of payment shall be prepared and submitted by the supplier after approval of model assembly by the purchaser.

### **2. CLIMATIC CONDITIONS**

I. Peak ambient temperature	50 Degree C
II. Maximum average ambient temperature	40 Degree C
III. Maximum temperature attainable	60 Degree C
IV. Maximum relative humidity	100 %
V. Minimum relative humidity	50 %
VI. Average number of thunder storm days per annum	40
VII. Average number of rainy days per annum	100
VIII. Average annual rainfall	10-100 cm
IX. Maximum wind pressure	100 Kg/sq.m
X. Altitudes not exceeding	1000 mtrs.

### **3. REQUIREMENT**

The approximate quantities required of finished fabricated steel items are indicated in the Schedule-I (schedule of requirement along with approximate weight).

The quantities mentioned in the schedule of requirement (Schedule-I) are provisional. However, the net quantity shall be determined later-on at the time of finalization of the tender. The purchaser reserves the right to increase or decrease the tendered quantity/weight of structure. The purchaser also reserves the right to split the quantity and to entrust the order for the supply on one or more Suppliers. The bidder shall agree to supply part quantity ordered on him at the rates/ prices mentioned in the tender or accepted by the purchaser.

### **4. STANDARDS:**

All materials and equipments shall comply in all respect to the requirements of the latest edition of the relevant Indian Standard Specification(s) except so far as modified in this specification. Where the relevant ISS is not available, the material / equipment should comply the latest BSS. All the item should be made / fabricated / tested from steel sections conforming to IS:2062 (latest amendments)

## **5. FINANCIAL RESOURCES AND EXPERIENCE:**

The bidder shall furnish the details regarding his previous experience in performing same or similar comparable work, the technical strength and manufacturing facilities available and also financial capability along with the tender. The bidder is also required to furnish the following information.

- a. Standing of the firm as manufacturer/Supplier
- b. Approximate qty, fabricated so far at his works on monthly basis.
- c. Testing facilities available at his works..

## **6. MATERIAL:**

The supplier shall make his own arrangement for the procurement of steel sections before commencement of work. The purchaser shall be at liberty to have samples of steel used, tested/checked in any laboratory at his own cost and reject the supply, if it is below standard.

All the material required for the fabrication shall be stocked in adequate quantity by the supplier to ensure that the progress of the work is not jeopardized. No relaxation in the delivery time shall be allowed on the pretext of non- availability or short supply of raw materials.

## **7. WORKMANSHIP:**

The fabrication shall be done in such a way that there is a good finish of the fabricated structures. The steel structure shall be fabricated accurately adhering to dimensions as per the approved drawings. All the steel sections shall be carefully leveled/ straightened and made true to method which shall not injure the material so that when assembled the adjacent surface are in close contact through out. No rough edges shall be permitted anywhere throughout the work. Holes must be perfectly circular. The tolerance(s) as per drawing/ clause hereunder is permissible. All burrs left by drills or punches shall be removed completely. No bolts holes shall be more than 1.5 mm bigger than the corresponding bolt diameter.

In general all fabrication work shall conform to provision of IS-802 (part-I) 1978 latest amended. However the details given in this specification shall prevail in specified items. The overlapping of the M.S. Flat on M.S. Angle shall be minimum 30 mm.

The holes near the bend lines of absent member, on both sides of bent lines shall be punched/ drilled after bending and relative position of these holes, shall be maintained with the use of proper templates/jigs and fixtures.

Punched holes must be square to the plates and the wall of the holes parallel. The following maximum tolerance of accuracy of punched holes is permissible.

- a) Holes must be perfectly circular and no tolerance in this respect is permissible.
- b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm i.e. the allowable taper in punched holes should not exceed 0.8 mm on diameter.
- c) Holes must be square with the plates or angles and slant holes will not be permitted.

All burrs left by drills or punches shall be removed completely. Drifting or riming to enlarge defective holes shall not be permitted. Minimum edges distance from the centre of any bolt holes shall not be less than what has been indicated hereunder :-

Dia of bolts in mm	Minimu flange width of sec. tion in mm	min.rolled edge distance in mm	Min sheared edge distance in mm
16	45	20	23

## 8. DRAWING & MODEL ASSEMBLY:

3 sets of drawing shall be furnished by the successful bidder based for according approval of the purchaser before commencement of work.

The Supplier shall offer one set of model assembly (proto type) for the respective structure as per the drawings provided to him for checking/ approval of the purchaser before commencement of supplies.

In case any deviation is detected, during the process of preparing the model assembly, the Supplier shall intimate the purchaser or his authorized representative at the time of inspection of model assembly. The final bill of material shall be as per approved bill of material.

**After inspection and checking of the model assembly of the lattice structure shall be type tested for radiography inspection (X-rays) of welding and shall be witness by the officer or type testing shall be arranged at independent/ NABL accredited lab or CPRI/Govt. approved lab.**

The Supplier shall take-up the mass fabrication of the structure(s) only after the purchaser has approved the model assembly along with bill of material.

Any period taken beyond 30 days for approval of model assembly shall be to bidders account. No extra time shall be allowed in commencement period in getting the prototype approval.

## 9. MARKING

Each individual structure / brackets shall carry a code number conforming to component number given to it in the fabrication drawing / Bill of material. The code number of approved size shall be stamped with a metal die of 16 mm size on the member and shall be legible. The name of manufacturers in suitable code and the word “PVVNL” shall also be stamped / punched on each individual section with metal die of not less than 16 mm size.

If the above marking is not found on the material received in the stores, the receipted challan shall not be given by the concerned stores. The challan shall only be issued after verification of material by the Store officer.

#### **10. INSPECTION, TESTING & CHECKING:**

The finished product before acceptance shall be subject to inspection in respect of workmanship, checking of dimension/weight & testing as per requirement of relevant IS:2062 (latest amended), approved drawings and bill of material, at the suppliers works if not supported by test certificates of main producers viz. SAIL/TISCO/RINL. The certificate for type test (chemical composition & mechanical properties test) issued by prime producer(s) shall be furnished along with the inspection call to the Employer otherwise testing shall be arranged at independent Lab on the cost of supplier. The certificate and relevant invoices shall be in the name of the firm on whom the order is placed by the PVVNL. **In case bidder use the steel sections manufactured by prime producers then the inspecting officer shall verify and record in the inspection report regarding stamping and mark of prime producers.** The certificate(s) in the name of other parties/ sources shall not be accepted and in such cases the tests for chemical and mechanical properties shall have to be arranged in the presence of inspecting officer(s) at recognized lab/**any independent lab/test house having the testing equipments (used in the testing), calibration by NABL/NPL Accredited calibration laboratories or equivalent.**

The supplier shall present the latest Calibration Certificate(s) of testing instruments/equipments to be used for the testing of the material covered in the purchase order to the authorized inspecting officer/inspecting agency of the purchaser. The testing instruments/ meters/ apparatus etc. should be got calibrated by the supplier from time to time from independent test laboratory/ house having valid accreditation from National/ Accreditation Board for testing and calibrating laboratories for testing equipments/ original manufacturer having trace ability to NABL/NPL or equivalent.

The calibration certificate(s) should not in any case be older than one year at the time of presenting the same to the inspecting officer/inspecting agency of the purchaser. The testing instruments/equipments should be duly sealed by the Calibrating agency and be indicated in the calibration certificate(s).

#### **11. TESTS**

Test before dispatch:- The various steel section/structure before dispatch shall be subject to following test as per IS:2062( latest amendment) at the manufacturer's works Routine test/acceptance test

- (i) Dimensional checking and visual inspection
- (ii) Weight checking
- (iii) Chemical composition test
- (iv) Mechanical property test
- (v) Checking of welding

#### **12. SAMPLING:**



The inspection shall be carried out on each lot separately. The following number of pieces selected at random shall be subject to inspection/ testing and checking.

- a) Workmanship and dimension checking : 3 % samples from finished item.
- b) Chemical test : One sample of each steel section from the entire lot of material offered for inspection.
- c) Tensile test : One sample of each steel section from every 50 MT or Part thereof.
- d) Bend test : One sample of each steel section from every 50 MT or Part thereof.

### 13. TOLERANCE IN DIMENSIONS:

The tolerance(s) shall be permissible as per IS: 1852-1985 (latest amended). Further the following tolerance(s) on fabricated items will also be allowed.

- i) Tolerance in overall length  $\pm 3\text{mm}$
- ii) Tolerance in edge dimensions (centre of hole to end)  $\pm 2\text{mm}$
- iii) Tolerance in hole centre  $\pm 2\text{mm}$
- iv) Circular holes No tolerance
- v) Weight Tolerance  $+2\%$  to  $(-) 4\%$

### 14. GUARANTEED TECHNICAL PARTICULARS:

The bidder shall furnish the guaranteed technical particulars of the material as required in the schedule-IV by mentioning specific figures therein. Any item of the TP left unfilled or simply written as per ISS etc. shall be considered as incomplete GTP and such tender is liable to be rejected.

### 15. PACKING AND FORWARDING

The finished items complete in all respect dully inspected and cleared for dispatch, shall have to be delivered in stores by Road. Unloading of material at store(s) is Suppliers responsibility.

### 16. CRITERIA FOR ACCEPTANCE

The inspected material should be strictly in accordance to the GTP of the specification otherwise the material shall be treated as rejected and shall not be accepted.

### 17. WEIGHT

The weight of structure shall mean the weight of structures calculated by using standard sectional weights of all steel structural members of the sizes indicated in the fabrication drawings and/or subsequently revised drawings and bill of material without taking into consideration the reduction in weight due to drilling of bolt-holes, skew cuts, chamfering etc. or the increase in weight due to galvanization.

The material shall be acceptable if found within permissible tolerance limit i.e. +2% and (-) 4%.

### **Schedule-I**

**STATEMENT SHOWING THE REQUIREMENT OF COMPLETE PACKAGE OF 33 KV S/C UNGALVANIZED STEEL LATTICE STRUCTURE 36' LONG (WITH MATERIAL) ALONG WITH 1 NOS. 33 KV CROSS ARMS (CHANNEL) & 48 NOS. M. S. BOLT WITH NUTS (TN-1632).**

<b>S. No.</b>	<b>Type of Structure</b>	<b>Unit Wt. In MT</b>	<b>Provis. Qty. in Nos./Sets</b>	<b>Total Wt. of steel in MT</b>	<b>Generally section involved</b>
A.	33 KV S/C Un-Galvanized steel lattice structure. (Normal Tower)	0.42119	4000	1,687.96	MS Angle 65 x 65 x 5 mm 50 x 50 x 6 mm MS Flat 50 x 6 mm 50 x 10 mm
B	33 KV Cross Arm (Channel)	0.022179	4000	88.716	MS Channel 100 x 50
C	M.S. Nuts & Bolts (M16x45N)	0.000135	1,92,000	25.92	MS Rod of 16 mm
	<b>Total Weight</b>			1,802.596	

**BILL OF MATERIAL****33 KV S/C UNGALVANISED STEEL LATTICE STRUCTURE 36' LONG WITH ACCESSORIES WITH TOP HAMPERS NUTS & BOLTS AGAINST TN-1632.**

Item No.	Section	Length of Members and Weight			
		Length MM	Qty. No.	Sect. Wt. Kg. / M.	Total Weight Kg.
1.	LEG L 50x50x6 MM	5500	8	4.5	198.00
2.	Belt L 50x50x6 MM	710	4	4.5	12.78
3.	Belt L 50x50x6 MM	645	4	4.5	11.61
4.	Belt L 50x50x6 MM	580	4	4.5	10.44
5.	Belt L 50x50x6 MM	505	4	4.5	9.09
6.	Belt L 50x50x6 MM	455	4	4.5	8.19
7.	Flat 50x10 MM	410	2	3.93	3.22
8.	Flat 50x10 MM	350	2	3.93	2.75
9.	Flat 50x10 MM	280	2	3.93	2.20
	Belt Flat 50x10 MM	265	2	—	2.08
10.	Bracing Flat 50x6 MM	470	4	2.36	4.44
11.	Bracing Flat 50x6 MM	475	4	2.36	4.48
12.	Bracing Flat 50x6 MM	535	4	2.36	5.05
13.	Bracing Flat 50x6 MM	535	4	2.36	5.05
14.	Bracing Flat 50x6 MM	535	4	2.36	5.05
15.	Bracing Flat 50x6 MM	550	4	2.36	5.19
16.	Bracing Flat 50x6 MM	585	4	2.36	5.52
17.	Bracing Flat 50x6 MM	660	4	2.36	6.23
18.	Bracing Flat 50x6 MM	665	4	2.36	6.27
19.	Bracing Flat 50x6 MM	705	4	2.36	6.65
20.	Bracing Flat 50x6 MM	850	4	2.36	8.02
21.	Bracing Flat 50x6 MM	860	4	2.36	8.12
22.	Bracing Flat 50x6 MM	875	4	2.36	8.26
23.	Bracing Flat 50x6 MM	960	4	2.36	9.06
24.	Bracing Flat 50x6 MM	960	4	2.36	9.06
25.	Bracing Flat 50x6 MM	960	4	2.36	9.06
26.	Bracing Flat 50x6 MM	1145	4	2.36	10.81
27.	Bracing Flat 50x6 MM	1150	4	2.36	10.86
28.	Belt Angle 50x50x6 MM	800	4	4.50	14.40
29.	Butt Joint L 65x65x5 MM	462	4	4.90	9.05
30.	Butt Joint Flat 50x6 MM	462	4	2.36	4.36
31.	Butt Joint Flat 50x6 MM	196	4	2.36	1.85
	<b>Wt. of Tower only</b>				<b>417.20</b>
32.	X-Arms Channel 100x50 MM	2320	1	9.56	22.18
33.	Top Hampers Flat 50x10 MM	1015	1	3.93	3.99
34.	MS Bolts & Nuts M 16x45		48	0.135	6.48
	<b>Total weight in Kg.</b>				<b>449.85</b>



**SCHEDULE-II****DETAILS OF APPLICABLE STANDARDS/SPECIFICATION/ MANUALS:**

The material shall comply with the relevant provisions made in the following Indian standards Specification (now BIS) with latest amendments.

- |   |                               |                             |
|---|-------------------------------|-----------------------------|
| 1 | IS:2062: (Latest amended)     | Method of testing           |
| 2 | IS:1852/1973 (Latest amended) | Rolling & cutting Tolerance |

All materials and sections shall comply in all respect with the requirement of latest addition of relevant Indian Standard Specification except as modified in this Specification. Where the relevant ISS is not available, the material/sections should comply with the latest BSS. All the item should be made/fabricated from steel sections conforming to IS: 2062/1999 (latest amended). Rolling and cutting tolerances for hot rolled steel products shall be governed as per IS: 1852/1985 (latest amended).

**SCHEDULE-III****(to be filled by the bidder)****GUARANTEED & OTHER TECHNICAL PARTICULARS FOR 33 KV SINGLE CIRCUIT UNGALVANIZED STEEL LATTICE STRUCTURE 36' LONG ALONG WITH 1 NO. 33 KV CROSS ARMS (CHANNEL) & 48 NOS. M. S. BOLT WITH NUTS COMPLETE PACKAGE****A. GENERAL :**

1. Maker's Name :
2. Address for correspondence :
3. Address of Works :

**B. STANDARDS & SPECIFICATION:**

1. Dimension : As per approved drawing.
2. Testing
- a) Steel : As per IS:2062 (Latest amended). If no supported by test certificate of steel from main producers.

**C. TOLERANCE :**

- a) Steel : As per IS:1852-1973(Latest amended)
- b) Length : +/- 3 mm
- c) Edge dimensions : +/- 2 mm
- d) Hole centre : +/- 2 mm
- e) Weight tolerance : +2% to (-) 4%

**D) GUARANTEED WEIGHT OF : As per BOM STRUCTURE****E) Properties of steel (for class 'A')**

- (a) Chemical composition.
  - (i) Carbon % (Max.) : 0.23
  - (ii) Manganese % (Max.) : 1.50
  - (iii) Sulphur % (Max.) : 0.05
  - (iv) Phosphorus % (Max.) : 0.05
  - (v) Silicon % (Max.) : 0.40
  - (vi) C.E. % (Max.) : 0.42
- (b) Mechanical Properties :
  - UTS (Mpa) Min. : 410
  - Y.S.(Mpa) Min. : 240
  - E.L. (%) Min. : 23

**F) Marking:- : PVVNL.**

## **18.0 TECHNICAL SPECIFICATION FOR SUPPLY OF 33 KV DOUBLE CIRCUIT UNGALVANIZED STEEL LATTICE STRUCTURE 42' LONG ALONG WITH 3 NOS. 33 KV CROSS ARMS (CHANNEL) & 48 NOS. M. S. BOLT WITH NUTS**

### **1. SCOPE**

This specification covers fabrication, testing & delivery of fabricated steel items as a complete package, complete in all respect as per GTP/Drawings (to be provided by the purchaser to the successful bidder). The steel sections generally used, tentative unit weight & BOM of fabricated item is enclosed at Schedule-I. The final bill of material for the purpose of payment shall be prepared and submitted by the supplier after approval of model assembly by the purchaser.

### **2. CLIMATIC CONDITIONS**

I. Peak ambient temperature	50 Degree C
II. Maximum average ambient temperature	40 Degree C
III. Maximum temperature attainable	60 Degree C
IV. Maximum relative humidity	100 %
V. Minimum relative humidity	50 %
VI. Average number of thunder storm days per annum	40
VII. Average number of rainy days per annum	100
VIII. Average annual rainfall	10-100 cm
IX. Maximum wind pressure	100 Kg/sq.m
X. Altitudes not exceeding	1000 mtrs.

### **3. REQUIREMENT**

The approximate quantities required of finished fabricated steel items are indicated in the Schedule-I (schedule of requirement along with approximate weight).

The quantities mentioned in the schedule of requirement (Schedule-I) are provisional. However, the net quantity shall be determined later-on at the time of finalization of the tender. The purchaser reserves the right to increase or decrease the tendered quantity/weight of structure. The purchaser also reserves the right to split the quantity and to entrust the order for the supply on one or more Suppliers. The bidder shall agree to supply part quantity ordered on him at the rates/ prices mentioned in the tender or accepted by the purchaser.

### **4. STANDARDS:**

All materials and equipments shall comply in all respect to the requirements of the latest edition of the relevant Indian Standard Specification(s) except so far as modified in this specification. Where the relevant ISS is not available, the material / equipment should comply the latest BSS. All the item should be made / fabricated / tested from steel sections conforming to IS:2062 (latest amendments)

### **5. FINANCIAL RESOURCES AND EXPERIENCE:**

The bidder shall furnish the details regarding his previous experience in performing same or similar comparable work, the technical strength and manufacturing facilities available and also financial capability along with the tender. The bidder is also required to furnish the following information.

- a. Standing of the firm as manufacturer/Supplier
- b. Approximate qty, fabricated so far at his works on monthly basis.
- c. Testing facilities available at his works..

#### **6. MATERIAL:**

The supplier shall make his own arrangement for the procurement of steel sections before commencement of work. The purchaser shall be at liberty to have samples of steel used, tested/checked in any laboratory at his own cost and reject the supply, if it is below standard.

All the material required for the fabrication shall be stocked in adequate quantity by the supplier to ensure that the progress of the work is not jeopardized. No relaxation in the delivery time shall be allowed on the pretext of non- availability or short supply of raw materials.

#### **7. WORKMANSHIP:**

The fabrication shall be done in such a way that there is a good finish of the fabricated structures. The steel structure shall be fabricated accurately adhering to dimensions as per the approved drawings. All the steel sections shall be carefully leveled/straightened and made true to method which shall not injure the material so that when assembled the adjacent surface are in close contract through out. No rough edges shall be permitted anywhere throughout the work. Holes must be perfectly circular. The tolerance(s) as per drawing/ clause hereunder is permissible. All burrs left by drills or punches shall be removed completely. No bolts holes shall be more than 1.5 mm bigger than the corresponding bolt diameter.

In general all fabrication work shall conform to provision of IS-802 (part-I) 1978 latest amended. However the details given in this specification shall prevail in specified items. The overlapping of the M.S. Flat on M.S. Angle shall be minimum 30 mm.

The holes near the bend lines of absent member, on both sides of bent lines shall be punched/ drilled after bending and relative position of these holes, shall be maintained with the use of proper templates/jigs and fixtures.

Punched holes must be square to the plates and the wall of the holes parallel. The following maximum tolerance of accuracy of punched holes is permissible.

- a) Holes must be perfectly circular and no tolerance in this respect is permissible.
- b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm i.e. the allowable taper in punched holes should not exceed 0.8 mm on diameter.



- c) Holes must be square with the plates or angles and slant holes will not be permitted.

All burrs left by drills or punches shall be removed completely. Drifting or riming to enlarge defective holes shall not be permitted. Minimum edges distance from the centre of any bolt holes shall not be less than what has been indicated hereunder :-

Dia of bolts in mm	Minimu flange width of section in mm	min.rolled edge distance in mm	Min sheared edge distance in mm
16	45	20	23

## 8. DRAWING & MODEL ASSEMBLY:

3 sets of drawing shall be furnished by the successful bidder based for according approval of the purchaser before commencement of work.

The Supplier shall offer one set of model assembly (proto type) for the respective structure as per the drawings provided to him for checking/ approval of the purchaser before commencement of supplies.

In case any deviation is detected, during the process of preparing the model assembly, the Supplier shall intimate the purchaser or his authorized representative at the time of inspection of model assembly. The final bill of material shall be as per approved bill of material.

**After inspection and checking of the model assembly of the lattice structure shall be type tested for radiography inspection (X-rays) of welding and shall be witness by the officer or type testing shall be arranged at independent/ NABL accredited lab or CPRI/Govt. approved lab.**

The Supplier shall take-up the mass fabrication of the structure(s) only after the purchaser has approved the model assembly along with bill of material.

Any period taken beyond 30 days for approval of model assembly shall be to bidders account. No extra time shall be allowed in commencement period in getting the prototype approval.

## 9. MARKING

Each individual structure / brackets shall carry a code number conforming to component number given to it in the fabrication drawing / Bill of material. The code number of approved size shall be stamped with a metal die of 16 mm size on the member and shall be legible. The name of manufacturers in suitable code and the word “PVVNL” & “TN No.” shall also be stamped / punched on each individual section with metal die of not less than 16 mm size.

If the above marking is not found on the material received in the stores, the receipted challan shall not be given by the concerned stores. The challan shall only be issued after verification of material by the Store officer.

## 10. INSPECTION, TESTING & CHECKING:

The finished product before acceptance shall be subject to inspection in respect of workmanship, checking of dimension/weight & testing as per requirement of relevant IS:2062 (latest amended), approved drawings and bill of material, at the suppliers works if not supported by test certificates of main producers viz. SAIL/TISCO/RINL. The certificate for type test (chemical composition & mechanical properties test) issued by prime producer(s) shall be furnished along with the inspection call to the CE (MM), otherwise testing shall be arranged at independent Lab on the cost of supplier. The certificate and relevant invoices shall be in the name of the firm on whom the order is placed by the PVVNL. **In case bidder use the steel sections manufactured by prime producers then the inspecting officer shall verify and record in the inspection report regarding stamping and mark of prime producers.** The certificate(s) in the name of other parties/ sources shall not be accepted and in such cases the tests for chemical and mechanical properties shall have to be arranged in the presence of inspecting officer(s) at recognized lab/**any independent lab/test house having the testing equipments (used in the testing), calibration by NABL/NPL Accredited calibration laboratories or equivalent.**

The supplier shall present the latest Calibration Certificate(s) of testing instruments/equipments to be used for the testing of the material covered in the purchase order to the authorized inspecting officer/inspecting agency of the purchaser. The testing instruments/ meters/ apparatus etc. should be got calibrated by the supplier from time to time from independent test laboratory/ house having valid accreditation from National/ Accreditation Board for testing and calibrating laboratories for testing equipments/ original manufacturer having trace ability to NABL/NPL or equivalent.

The calibration certificate(s) should not in any case be older than one year at the time of presenting the same to the inspecting officer/inspecting agency of the purchaser. The testing instruments/equipments should be duly sealed by the Calibrating agency and be indicated in the calibration certificate(s).

## 11. TESTS

Test before dispatch:- The various steel section/structure before dispatch shall be subject to following test as per IS:2062( latest amendment) at the manufacturer's works Routine test/acceptance test

- (i) Dimensional checking and visual inspection
- (ii) Weight checking
- (iii) Chemical composition test
- (iv) Mechanical property test
- (v) Checking of welding

## 12. SAMPLING:

The inspection shall be carried out on each lot separately. The following number of pieces selected at random shall be subject to inspection/ testing and checking.

- a) Workmanship and dimension checking : 3 % samples from finished item.

- b) Chemical test : One sample of each steel section  
from the entire lot of material  
offered for inspection.
- c) Tensile test : One sample of each steel section  
from every 50 MT or Part thereof.
- d) Bend test : One sample of each steel section  
from every 50 MT or Part thereof.

### 13. TOLERANCE IN DIMENSIONS:

The tolerance(s) shall be permissible as per IS: 1852-1985 (latest amended). Further the following tolerance(s) on fabricated items will also be allowed.

- i) Tolerance in overall length  $\pm 3\text{mm}$
- ii) Tolerance in edge dimensions (centre of hole to end)  $\pm 2\text{mm}$
- iii) Tolerance in hole centre  $\pm 2\text{mm}$
- iv) Circular holes No tolerance
- v) Weight Tolerance  $+2\%$  to  $(-) 4\%$

### 14. GUARANTEED TECHNICAL PARTICULARS:

The bidder shall furnish the guaranteed technical particulars of the material as required in the schedule-IV by mentioning specific figures therein. Any item of the TP left unfilled or simply written as per ISS etc. shall be considered as incomplete GTP and such tender is liable to be rejected.

### 15. PACKING AND FORWARDING

The finished items complete in all respect dully inspected and cleared for dispatch, shall have to be delivered in stores by Road. Unloading of material at store(s) is Suppliers responsibility.

### 16. CRITERIA FOR ACCEPTANCE

The inspected material should be strictly in accordance to the GTP of the specification otherwise the material shall be treated as rejected and shall not be accepted.

### 17. WEIGHT

The weight of structure shall mean the weight of structures calculated by using standard sectional weights of all steel structural members of the sizes indicated in the fabrication drawings and/or subsequently revised drawings and bill of material without taking into consideration the reduction in weight due to drilling of bolt-holes, skew cuts, chamfering etc. or the increase in weight due to galvanization.

The material shall be acceptable if found within permissible tolerance limit i.e.  $+2\%$  and  $(-) 4\%$ .

**Schedule-I**

**STATEMENT SHOWING THE REQUIREMENT OF COMPLETE PACKAGE OF 33 KV D/C UNGALVANIZED STEEL LATTICE STRUCTURE 42' LONG (WITH MATERIAL) ALONG WITH 3 NOS. 33 KV CROSS ARMS (CHANNEL) & 48 NOS. M. S. BOLT WITH NUTS(TN-1657).**

S.No.	Type of structure	Unit wt. in MT.	Provisional qty. in Nos./ sets	Total wt. in MT	Generally section invoice
A.	33 KV (D/C) Un-Galvanized steel lattice Structure (42' long)	0.507805	1500	761.707	M.S. Angle 65x65x5 mm 75x75x6 mm 50x50x6 mm M.S. Flat 50x6 mm 50x10 mm
B	33 KV Cross Arm (Channel)	0.022179	4500	99.805	Channel 100x50 mm
C	M.S. Nuts & Bolts (M16x45N)	0.000135	72000	9.72	MS Rod of 16 mm
	<b>Total weight</b>			871.232	

**BILL OF MATERIAL**  
**33 KV D/C LATTICE STRUCTURE 42' LONG AGAINST TN-1657**

Sr. No.	Item No.	Section	Length in MM	Qty. in Nos.	Sect. Wt. Kg. / M.	Total Weight Kg.
		<b>M. S. Angle</b>				
1	1	Legs 65 x 65 x 5 MM	6400	8	4.9	250.88
2	2	Belt 50 x 50 x 6 MM	470	4	4.5	8.46
3	3	Belt 50 x 50 x 6 MM	580	4	4.5	10.44
4	4	Belt 50 x 50 x 6 MM	640	4	4.5	11.52
5	5	Belt 50 x 50 x 6 MM	750	4	4.5	13.50
6		Belt 50 x 50 x 6 MM	810	4	4.5	14.58
7	6	Belt 50 x 50 x 6 MM	915	4	4.5	16.47
8	32	Butt Joint 75 x 75 x 6 MM	462	4	6.8	12.56
		<b>M. S. Flat</b>				
9	7	50 x 10 MM	285	2	3.93	2.24
			270	2	3.93	2.12
10	8	50 x 10 MM	350	2	3.93	2.75
11	9	50 x 10 MM	435	2	3.93	3.42
		<b>Bracing</b>				
12	10	M. S. Flat 50 x 6 MM	375	4	2.36	3.54
13	11	M. S. Flat 50 x 6 MM	415	4	2.36	3.92
14	12	M. S. Flat 50 x 6 MM	445	4	2.36	4.20
15	13	M. S. Flat 50 x 6 MM	470	4	2.36	4.44
16	14	M. S. Flat 50 x 6 MM	490	4	2.36	4.63
17	15	M. S. Flat 50 x 6 MM	515	4	2.36	4.86
18	16	M. S. Flat 50 x 6 MM	550	4	2.36	5.19
19	17	M. S. Flat 50 x 6 MM	575	4	2.36	5.43
20	18	M. S. Flat 50 x 6 MM	575	4	2.36	5.43
21	19	M. S. Flat 50 x 6 MM	660	4	2.36	6.23
22	20	M. S. Flat 50 x 6 MM	685	4	2.36	6.47
23	21	M. S. Flat 50 x 6 MM	720	4	2.36	6.80
24	22	M. S. Flat 50 x 6 MM	750	4	2.36	7.08
25	23	M. S. Flat 50 x 6 MM	850	4	2.36	8.02
26	24	M. S. Flat 50 x 6 MM	780	4	2.36	7.36
27	25	M. S. Flat 50 x 6 MM	910	4	2.36	8.59
28	26	M. S. Flat 50 x 6 MM	955	4	2.36	9.02
29	27	M. S. Flat 50 x 6 MM	1055	4	2.36	9.96
30	28	M. S. Flat 50 x 6 MM	1025	4	2.36	9.68
31	29	M. S. Flat 50 x 6 MM	1030	4	2.36	9.72
32	30	M. S. Flat 50 x 6 MM	1140	4	2.36	10.76
33	31	M. S. Flat 50 x 6 MM	1200	4	2.36	11.33
34	32	M. S. Flat 50 x 6 MM	462	4	2.36	4.36
35	33	M. S. Flat 50 x 6 MM	196	4	2.36	1.85
					<b>TOTAL</b>	<b>507.81</b>
		<b>33 KV Cross Arms Channel</b>				
		<b>(Unit Wt.)</b>				
36	34	M. S. Channel 100 x 50x6	2320	3	22.179	66.537

		(@ 22.179 Kg./Cross Arms)			Per unit	
37	35	M. S. Bolts with Nuts		48	0.135	6.48
		M 16 X 45 N	<b>Total wt. in kg.</b>			<b>580.827</b>



**SCHEDULE-II****DETAILS OF APPLICABLE STANDARDS/SPECIFICATION/ MANUALS:**

The material shall comply with the relevant provisions made in the following Indian standards Specification (now BIS) with latest amendments.

- |   |                               |                                    |
|---|-------------------------------|------------------------------------|
| 1 | IS:2062: (Latest amended)     | Raw material and Method of testing |
| 2 | IS:1852/1973 (Latest amended) | Rolling & cutting Tolerance        |

All materials and sections shall comply in all respect with the requirement of latest addition of relevant Indian Standard Specification except as modified in this Specification. Where the relevant ISS is not available, the material/sections should comply with the latest BSS. All the item should be made/fabricated from steel sections conforming to IS: 2062/1999 (latest amended). Rolling and cutting tolerances for hot rolled steel products shall be governed as per IS: 1852/1985 (latest amended).



**SCHEDULE-III****(to be filled by the bidder)****GUARANTEED & OTHER TECHNICAL PARTICULARS FOR 33 KV DOUBLE CIRCUIT UNGALVANIZED STEEL LATTICE STRUCTURE 42' LONG ALONG WITH 3 NOS. 33 KV CROSS ARMS (CHANNEL) & 48 NOS. M. S. BOLT WITH NUTS COMPLETE PACKAGE (TN-1657)****A. GENERAL :**

1. Name of firm :
2. Address for correspondence :
3. Address of Works :

**B. STANDARDS & SPECIFICATION :**

1. Dimension : As per approved drawing.
2. Testing
  - a) Steel : As per IS:2062 (Latest amended).  
If not supported by test certificate of prime producers.

**C. TOLERANCE :**

- a) Steel : As per IS:1852-1973(Latest amended)
- b) Length : +/- 3 mm
- c) Edge dimensions : +/- 2 mm
- d) Hole centre : +/- 2 mm
- e) Weight tolerance : +2% to (-) 4%

**D) GUARANTEED WEIGHT OF : As per BOM STRUCTURE****E) Properties of steel (for class 'A')**

- (a) Chemical composition.
  - (i) Carbon % (Max.) 0.23
  - (ii) Manganese % (Max.) 1.50
  - (iii) Sulphur % (Max.) 0.05
  - (iv) Phosphorus % (Max.) 0.05
  - (v) Silicon % (Max.) 0.40
  - (vi) C.E. % (Max.) 0.42
- (b) Mechanical Properties :
 

UTS(Mpa) Min.	410
Y.S.(Mpa) Min.	240
El (%) Min.	23

**E) Marking PVVNL**



## 20. 11 kV/22 kV/33 kV Composite Insulators

### 1) SCOPE :

This specification covers the design, manufacture, testing and supply of 11KV / 22KV / 33 KV Composite Insulators. The composite insulators shall be of the following type:

- i) Long rod insulators for conductors in tension application at angle / cut points the insulators shall be of tongue & clevis type.
- ii) Line post insulators or pin insulators for straight line locations

### 2) SERVICE CONDITIONS :

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

Maximum ambient temperature (Degree C)	...	50
Minimum ambient temperature (Degree C)	...	3.5
Relative Humidity (%)	...	10 to 100
Maximum Annual Rainfall (mm)	...	1450
Maximum Wind pressure (kg/m.sq.)	...	150
Maximum wind velocity (km/hour)	...	45
Maximum altitude above mean sea level (meter)	...	1000
Isoceraunic level (days/year)	...	50
Seismic level (Horizontal acceleration)	...	0.3 g
Moderately hot and humid tropical climate Conductive to rust and fungus growth		

### 3) SYSTEM PARTICULARS:

a) Nominal System Voltage	11 kV	22 kV	33 kV
b) Corresponding highest system Voltage	12 kV	24kV	36 kV
c) Frequency	50 Hz with 3% tolerance		
d) Number of phase	3	3	3

e) Neutral earthing	effectively grounded.
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#### 4) STANDARDS :

Unless otherwise specified elsewhere in the specifications insulators shall conform to the latest revisions of all relevant standards available at the time of placement of the order. The standards are listed in Annexure 'A'.

#### 5) GENERAL REQUIREMENTS

- i) The composite insulators shall generally conform to latest Standards as listed in Annexure 'A'
- ii) The Composite Insulators will be used on lines on which the conductors will be A.A.A. Conductor of size up to 200 sq. mm. and ACSR of any size up to Panther (0.2 sq. inch copper equivalent). The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.
- iii) Supplier must be an indigenous manufacturer and manufacturer of composite insulators of rating 33 kV or above OR must have developed proven in house technology and manufacturing process for composite insulators of above rating OR possess technical collaboration /association with a manufacturer of composite insulators of rating 33kV or above. The Manufacturer shall furnish necessary evidence in support of the above, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the Employer.
- iv) Insulator shall be suitable for both the suspension and strain type of load & shall be of tongue & clevis type. The diameter of Composite Insulator shall be less than 200 mm. The center-to-center distance between tongue & clevis shall be max. 300 mm for 11 kV, 450 mm for 22 kV & 550 mm for 33 kV composite Insulator.
- v) Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134.
- vi) The size of Composite insulator, minimum creepage distance and mechanical strength along with hardware fittings shall be as follows:

Sr. No.	Type of Composite	Nominal	Highest System	Visible Discharge	Wet Power	Impulse Withstand	Minimum	Center to	Min. Failure	Shed Diameter
---------	-------------------	---------	----------------	-------------------	-----------	-------------------	---------	-----------	--------------	---------------

	Insulator Type	System Voltage kV (rms)	Voltage kV (rms)	Test Voltage kV (rms)	Frequency Withstand Voltage kV (rms)	Rated voltage kV (rms)	Creepage Distance (mm) (Heavily Polluted 25mm/kV)	Center Distance Between Tongue & Clevis (mm)	Working load kN	Clearance (mm) (min)
i.	Long Rod Insulator	11	12	9	35	75	320	300	45	75-
		22	24	18	55	125	600	450	70	100
		33	36	27	75	170	900	550	70	100
ii.	Post/Pin Insulator	11	12	9	35	75	320		5	
		22	24	18	55	125	560		10	
		33	36	27	75	170	900		10	

\* Amendment issued vide letter No.REC/DDUGJY/SBD/749 Dated 27-07-2016

vii) Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109:

$(0.04d+1.5)$  mm when  $d \leq 300$ mm.

$(0.025d+6)$  mm when  $d > 300$  mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. However no negative tolerance shall be applicable to creepage distance.

viii) Interchangeability:

The composite insulator together with the tongue & clevis fittings shall be of standard design suitable for use with the hardware of any other indigenous make conforming to relevant standards referred above.

ix) Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

6) **TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS**

Polymeric Insulators shall be designed to meet the high quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

Polymeric Insulators shall consist of THREE parts, at least two of which are insulating parts:-

- (a) Core- the internal insulating part
- (b) Housing- the external insulating part
- (c) Metal end fittings.

i) **CORE**

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free.

ii) **HOUSING:**

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3mm minimum. It shall be one-piece housing using Injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109/92-93 with latest amendments

iii) **WEATHERSHEDS**

The composite polymer weather sheds made of a silicone elastometric compound or silicone alloy compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections It should protect

the FRP rod against environmental influences, external pollution and humidity. The weather sheds should have silicon content of minimum 30% by weight. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

iv) **METAL END FITTINGS:**

End fitting transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. Metal end fittings shall be suitable for tongue & clevis hard wares of respective specified mechanical load and shall be hot dip galvanized after, all fittings have been completed. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibers or crack the core. The gap between fitting and sheath shall be sealed by a flexible silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/ IS: 2486 - Part-II /1989.

7) **WORKMANSHIP**

- 7.1 All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Manufacturers shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.
- 7.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.
- 7.3 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 7.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.

7.5 Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.

7.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress; effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with out projecting points or irregularities, which may cause corona.

All load bearing surfaces shall be sooth and uniform so as to distribute the loading stresses uniformly.

7.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 microm thickness and shall be in accordance with the requirement of IS:4759. the zinc used for galvanizing shall be of purity 99.5% as per IS:4699. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

## 8) **TESTS AND STANDARDS**

Insulators offered shall be manufactured with the same configuration & raw materials as used in the insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. The design & type test reports submitted shall not be more than five years old.

### 8.1 **DESIGN TESTS :**

For polymeric insulators it is essential to carry out design test as per clause 4.1 of IEC 61109 / 92-93 with latest amendments. The design tests are intended to verify the suitability of the design, materials and method of manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which are represented by the one tested and having the following characteristics:

- Same materials for the core, and sheds and same manufacturing method;



- Same material of the fittings, the same design, the same method of attachment;  
  
Same or greater layer thickness of the shed material over the core (including a sheath where used );
- Same or smaller ratio of the highest system voltage to insulation length;
- Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings
- Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.

Manufacturer should submit test reports for Design Tests as per IEC – 61109 (clause – 5). Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract:

UV test: the test shall be carried out in line with clause 7.2 of ANSI C29.13.

## 8.2 TYPE TESTS :

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

- 8.2.1 Following Type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings:

SI. No	Description of type test	Test procedure / standard
1	Dry lightning impulse withstand voltage test	As per IEC 61109(Clause 6.1)
2	Wet power frequency test	As per IEC 61109(Clause 6.2)
3	Mechanical load-time test	As per IEC 61109(Clause 6.4)
4	Radio interference test	As per IEC 61109(Clause 6.5) revised
5	Recovery of Hydrophobicity test	Annexure – B This test may be repeated every 3yrs

		by the manufacturer
6	Chemical composition test for silicon content	Annexure – B Or any other test method acceptable to the Employer
7	Brittle fracture resistance test	Annexure – B

The Manufacturer shall submit type test reports as per IEC 61109. Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

### 8.3 ACCEPTANCE TESTS :

The test samples after having withstood the routine test shall be subject to the following acceptance tests in order indicated below:

(a)	Verification of dimensions	: Clause 7.2 IEC: 61109,
(b)	Verification of the locking system (if applicable)	: Clause 7.3 IEC: 61109,
(c)	Verification of tightness of the interface Between end fittings & Insulator housing	: Clause 7.4 IEC: 61109 amendment 1 of 1995
(d)	Verification of the specified mechanical load	: Clause 7.4 IEC: 61109, amendment 1 of 1995
(e)	Galvanizing test	: IS:2633/IS:6745

### 8.4 ROUTINE TESTS:

Sr.No.	Description	Standard
1	Identification of marking	As per IEC: 61109 Clause 8.1
2	Visual Inspection	As per IEC: 61109 Clause 8.2
3	Mechanical routine test	As per IEC: 61109 Clause 8.3

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50 % of the SML for at least 10 sec.

### 8.5 TESTS DURING MANUFACTURE:

Following tests shall also be carried out on all components as applicable

- (a) Chemical analysis of zinc used for galvanizing
- (b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
- (c) Chemical analysis, hardness tests and magnetic particle inspection for forgings.

#### 8.6 SAMPLE BATCH FOR TYPE TESTING :

The Manufacturer shall offer material for sample selection for type testing only after getting Quality Assurance Plan approved by Employer. The sample for type testing will be manufactured strictly in accordance with the approved Quality Assurance Plan.

#### 9) **QUALITY ASSURANCE PLAN :**

9.1 The Manufacturer shall submit following information:

- i) Test certificates of the raw materials and bought out accessories.
- ii) Statement giving list of important raw material, their grades along with names of sub-Manufacturers for raw materials, list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of Manufacturer's representative.
- iii) List of manufacturing facilities available.
- iv) Level of automation achieved and lists of areas where manual processing exists.
- v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- vi) List of testing equipments available with the Manufacturer for final testing of equipment along with valid calibration reports.
- vii) The manufacturer shall submit Manufacturing Quality Assurance Plan (QAP) for approval

& the same shall be followed during manufacture and testing.

9.2 The Manufacturer shall submit the routine test certificates of bought out raw

materials/accessories and central excise passes for raw material at the time of inspection.

- 9.3 The Employer's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Manufacturer's and sub-Manufacturer's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.
- 9.4 The material for final inspection shall be offered by the Manufacturer only under packed condition. The Employer shall select samples at random from the packed lot for carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.
- 9.5 The Manufacturer shall keep the Employer informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.
- 9.6 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the Employer in writing waives off the inspection. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.
- 9.7 The acceptance of any quantity of material shall in no way relieve the Manufacturer of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective

**10) TEST CERTIFICATE :**

The manufacturerer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications at the NABL approved laboratories to prove that the composite Insulators offered meet the requirements of the specification. These Type Tests should have been carried out within five years prior to the date of opening of this manufacturer

The Employer reserves right to demand repetition of some or all the Type Test in presence of Employer's representative. For this purpose, the manufacturerer shall quote unit rates for carrying out each Type Test. However, such unit rates will not be considered for evaluation of the offer. In case the unit fails in the Type Tests, the

complete supply shall be rejected.

**11) TESTING FACILITIES :**

The manufacturer must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine & acceptance Tests. These facilities should be available to Employer's Engineers if deputed or carry out or witness the tests in the manufacturer works. The insulators shall be tested in accordance with the procedure detailed in IEC 61109 / 92-93 with latest amendments.

**12) DRAWINGS :**

- (i) The Manufacturer shall furnish full description and illustration of the material offered.
- (ii) The Manufacturer shall furnish the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information:

- Long rod diameter with manufacturing tolerances
- Minimum Creepage distance with positive tolerance

- Protected creepage distance
- Eccentricity of the long rod unit

- Axial run out

- Radial run out

- Unit mechanical and electrical characteristics
- Size and weight of ball and socket/tongue & clevis
- Weight of composite long rod units
- Materials

- Identification mark
- Manufacturer's catalogue number

- (iii) After placement of award the Manufacturer shall submit fully dimensioned insulator crate drawing for different type of insulators for approval of the Employer.

**13) RETEST AND REJECTION:**

- 13.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC 61109 for Acceptance & Routine Tests.

For the sampling tests, two samples are used, E1 and E2. The sizes of these samples are indicated in the table below.

Lot Size (N)	Sample Size	
	E1	E2
N < 300	Subject to agreement	
300 < N < 2000	4	3
2000 < N < 5000	8	4
5000 < N < 10000	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot.

The insulators shall be selected by the Employer's representative from the lot at random.

The samples shall be subjected to the applicable sampling tests.

The sampling tests are:

- |   |             |
|---|-------------|
| Verification of dimensions  | - (E1 + E2) |
| Verification of the locking system  | - (E2)      |
| Verification of tightness of the interface between end fittings & Insulator housing | - (E2)      |
| Verification of the specified mechanical load SML                                   | - (E1)      |
| Galvanizing test  | - (E2)      |

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows :

If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs. If two or more insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this

standard and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests. If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

### 13.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

### 13.3 Verification of the locking system (E2)

This test applies only to the insulators equipped with socket coupling as specified by IEC 120 and is performed according to IEC 383.

### 13.4 Verification of tightness of the interface between end fittings & Insulator housing (E2)

One insulator selected randomly from the sample E2, shall be subjected to crack indication by dye penetration, in accordance with ISO 3452, on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and including an additional area, sufficiently extended beyond the end of the metal part.

The indication shall be performed in the following way.

- (i) the surface shall be properly pre-cleaned with the cleaner ;
- (ii) the penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface;
- (iii) with in 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70 % of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero up to 70 % of the SML, and then maintained at this value for 1 minute;

- (iv) the surface shall be cleaned with the excess penetrant removed, and dried;
- (v) the developer shall be applied if necessary;
- (vi) the surface shall be inspected.

Some housing materials may be penetrated by the penetrant. In such cases evidence shall be provided to validate the interpretation of the results.

After the 1 min. test at 70 % of the SML, if any cracks occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

### 13.5 Verification of the specified mechanical load SML

The insulators of the sample E1 shall be subjected at ambient temperature to a tensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75 % of the SML, and then be gradually increased to the SML in a time between 30 sec. to 90 sec.

If 100 % of the SML is reached in less than 90 s, the load (100 % of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1min withstand test at the SML.)

The insulators have passed the test at 13.4 & 13.5 above if:

No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70 % withstand test (a) or during the 1 min.100 % withstand test (b).

No cracks are indicated after the dye penetration method described in 13.4 above.

The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

### 13.6 Galvanizing test

This test shall be performed according to IS: 2633/IS: 6745 on galvanized parts.



**14) MARKINGS :**

14.1 Each insulator shall be legibly and indelibly marked with the following details as per IEC- 61109:

a) Name or trademark of the manufacturer.

b) Voltage & Type

c) Month and year of manufacturing.

d) Min. failing load/guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.

e) 'Employer Name'. Marking

14.2 One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the end fitting of each composite long rod of particular strength for easy identification. The paint shall not have any deteriorating effect on the insulator performance.

Following codes shall be used as identification mark:

For 45 KN long rod units : Blue

For 70 KN long rod units : Red

**15) PACKING :**

15.1 All insulators shall be packed in strong corrugated box of min. 7 ply duly palletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg to avoid hackling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.

15.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

15.3 Suitable cushioning, protective padding, or Dunn age or spacers shall be provided to prevent damage or deformation during transit and handling.

15.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched

on account of faulty packing and faulty or illegible markings. Each wooden case /crate /corrugated box shall have all the markings stenciled on it in indelible ink.

- 15.5 The Manufacturer shall provide instructions regarding handling and storage precautions to be taken at site.

16) **GUARANTEE**

The Manufacturer of insulators shall guarantee overall satisfactory performance of the insulators. The manufacturerer shall furnish in the form attached (Schedule 'A') all the guaranteed technical particulars.

**SCHEDULE – A1****GUARANTEED TECHNICAL PARTICULARS.****COMPOSITE INSULATOR UNIT****11KV(45KN) / 11KV(70KN).****(to be filled separately for each type mentioned above)**

Sr.No	Parameter Name	Parameter type
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	Text
3.1	Material of core (FRP rod) i) E-glass or ECR-glass ii) Boron content	
3.2	Material of housing & weather sheds (Silicon content by weight)	
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	<b>Electrical characteristics</b>	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) (320mm) (mm)	Numeric

Sr.No	Parameter Name	Parameter type
6.1	Center to center distance between tongue & clevis) (300mm) (mm)	Numeric
6.2	Shed diameter (100mm) (mm)	Numeric
7.0	Mechanical characteristics: KN Minimum failing load	Numeric
8.0	<b>Dimensions of insulator</b>	
8.1	Weight Kg	Numeric
8.2	Dia. of FRP rod: mm	Numeric
8.3	Length of FRP rod mm	Numeric
8.4	Dia. of weather sheds (100mm) mm	Numeric
8.5	Thickness of housing mm	Numeric
8.6	Dry arc distance mm	Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	<b>Type of sheds</b>	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	<b>Packing details</b>	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the Manufacturer may like to give	File

**SCHEDULE – A2****GUARANTEED TECHNICAL PARTICULARS.****COMPOSITE INSULATOR UNIT****22KV (70KN)**

<b>Sr.No</b>	<b>Parameter Name</b>	<b>Parameter type</b>
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod) i) E-glass or ECR-glass ii) Boron content	Text
3.2	Material of housing & weather sheds (silicon content by weight )	Text
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	<b>Electrical characteristics</b>	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) mm	Numeric
6.1	Center to center distance between tongue & clevis (mm)	Numeric

Sr.No	Parameter Name	Parameter type
6.2	Shed diameter (mm)	Numeric
7.0	Mechanical characteristics: KN	Numeric
	Minimum failing load	
8.0	<b>Dimensions of insulator</b>	
8.1	Weight Kg	Numeric
8.2	Dia. of FRP rod: mm	Numeric
8.3	Length of FRP rod mm	Numeric
8.4	Dia. of weather sheds mm	Numeric
8.5	Thickness of housing mm	Numeric
8.6	Dry arc distance mm	Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	<b>Type of sheds</b>	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	<b>Packing details</b>	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the Manufacturer may like to give	File

**SCHEDULE – A3****GUARANTEED TECHNICAL PARTICULARS.****COMPOSITE INSULATOR UNIT****33KV (70KN)**

<b>Sr.No</b>	<b>Parameter Name</b>	<b>Parameter type</b>
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod ) i) E-glass or ECR-glass ii) Boron content	Text
3.2	Material of housing & weather sheds (silicon content by weight )	Text
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	<b>Electrical characteristics</b>	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) mm	Numeric
6.1	Center to center distance between tongue & clevis (mm)	Numeric

Sr.No	Parameter Name	Parameter type
6.2	Shed diameter (mm)	Numeric
7.0	Mechanical characteristics: Minimum failing load KN	Numeric
8.0	<b>Dimensions of insulator</b>	
8.1	Weight Kg	Numeric
8.2	Dia. of FRP rod: mm	Numeric
8.3	Length of FRP rod mm	Numeric
8.4	Dia. of weather sheds mm	Numeric
8.5	Thickness of housing mm	Numeric
8.6	Dry arc distance mm	Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	<b>Type of sheds</b>	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	<b>Packing details</b>	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the Manufacturer may like to give	File



**ANNEXURE 'A'****STANDARDS TO BE ADOPTED FOR COMPOSITE INSULATORS**

<b>Sr.</b>	<b>Indian Standard</b>	<b>Title</b>	<b>International Standard</b>
1	-	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000V	IEC: 61109
2	IS: 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC: 60383
3	IS: 2071	Methods of High Voltage Testing	IEC: 60060-1
4	IS: 2486	Specification for Insulator fittings for Overhead power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC: 60120 IEC: 60372
5.	-	Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
6.	IS: 13134	Guide for the selection of insulators in respect of polluted condition	IEC: 60815
7.	-	Characteristics of string insulator units of the long rod type	IEC: 60433
8.	-	Hydrophobicity Classification Guide	STRI guide 1.92/1
9.	-	Radio interference characteristics of overhead power lines and high-voltage equipment.	CISPR: 18-2 Part 2
10.	IS: 8263	Methods of RI Test of HV insulators	IEC: 60437
11.		Standard for Insulators- Composite-Distribution Dead-end Type	ANSI C29.13-2000
12.	IS: 4759	Hot dip zinc coatings on structural steel & other allied products	ISO: 1459 ISO: 1461
13.	IS: 2629	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO: 1461 (E)
14.	IS: 6745	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	ISO: 1460
15.	IS: 3203	Methods of testing of local thickness of electroplated coatings	ISO: 2173
16.	IS: 2633	Testing of Uniformity of Coating of zinc coated articles	
17.	-	Standard specification for glass fiber strands	ASTM D 578-05
18.	-	Standard test method for compositional analysis by Thermogravimetry	ASTM E 1131-03
19.	IS:4699	Specification for refined secondary Zinc	

**Annexure-B****Tests on Insulator units****1 RIV Test (Dry)**

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10kV & 30 kV for 11 kV & 33 kV class insulators respectively under dry condition. The test procedure shall be in accordance with IS:8263 /IEC:437/CISPR 18-2.

**2 Brittle Fracture Resistance Test**

Brittle fracture test shall be carried out on naked rod along with end fitting by applying “1n HNO<sub>3</sub> acid” (63 g conc. HNO<sub>3</sub> added to 937 g water) to the rod. The rod should be held 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

**3 Recovery of Hydrophobicity & Corona test**

The test shall be carried out on 4mm thick samples of 5cm X 7cm.

- i. The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.
- ii. The sample shall be subjected to mechanical stress by bending the sample over a ground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. The test shall be done for 100 hrs.
- iii. Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.
- iv. Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

#### **4 Chemical composition test for Silicon content**

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X- ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.

## 21. Guy Strain Insulators

### 1. SCOPE

This Specification covers porcelain guy strain insulators for use in rural electrification system.

### 2. APPLICABLE STANDARDS

Unless otherwise modified in this specification, the insulators shall comply with IS: 5300-1969 or the latest version thereof.

### 3. GENERAL REQUIREMENTS

**3.1** The porcelain insulator shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

**3.2** The design of the insulator shall be such that the stresses due to expansion and contraction in any part of the insulator shall not lead to its deterioration.

**3.3** The glaze, unless otherwise specified, shall be brown in colour. The glaze shall cover the entire porcelain surface parts except those areas that serve as supports during firing.

### 4. TYPE OF INSULATORS

**4.1** The standard guy strain insulators shall be of designations 'A' and 'C' as per IS:5300.

**4.2** The recommended type of guy strain insulators for use on guy wires of overhead lines of different voltage levels are as follows :

Power Line Voltage	Designation of Insulators
415/240V	A
11000V	C
33000V	C (2 Insulators to be used in series)

### 5. DIMENSIONS

The dimensions of guy strain insulators shall be in accordance with Figs. 1 and 2.

### 6. BASIC INSULATION LEVELS

The test voltage of the insulators shall be as under :

Designation of Insulator	Dry one minute power Frequency withstand	Wet one minute power Frequency withstand voltage
--------------------------	--	--

	voltageKV (rms)	KV (rms)
A	18	8
C	27	13

## 7. MECHANICAL STRENGTH

The insulators shall be suitable for the minimum failing loads specified as under:

Designation of Insulator	Minimum failing load (KN)
A	44
	88

## 8. TESTS

The insulators shall comply with the following routine, type and acceptance tests as per IS:5300.

### 8.1 Routine Test

Visual examination

### 8.2 Type Tests

- Visual examination
- Verification of dimensions
- Temperature cycle test
- Dry one-minute power-frequency voltage withstand test
- Wet one-minute power frequency voltage withstand test
- Mechanical strength test
- Porosity test

### 8.3 Acceptance Tests: (to be conducted in the following order)

- Verification of dimensions
- Temperature cycle test
- Mechanical strength test
- Porosity test

## 9. MARKING

### 9.1 Each insulator shall be legibly and indelibly marked to show the following :

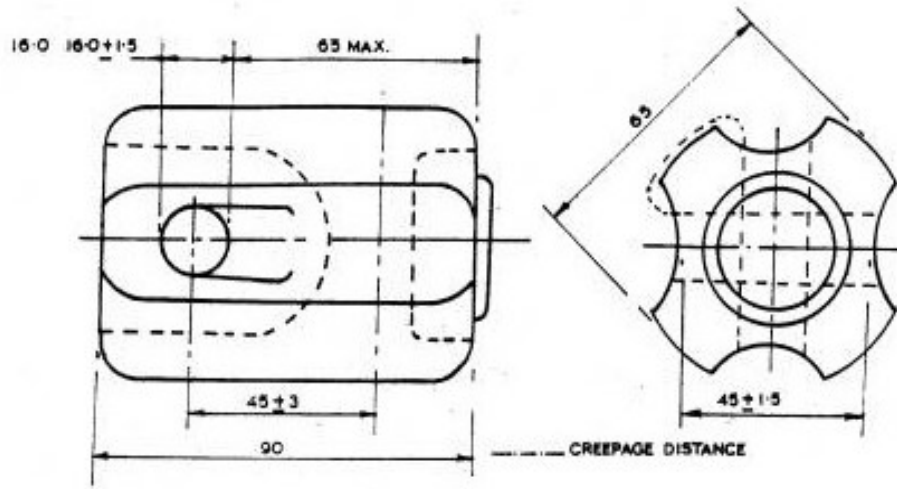
- Name or trade mark of the manufacturer

- b) Year of manufacture
- c) ISI certification mark, if any.

**9.2 Marking on porcelain shall be applied before firing.**

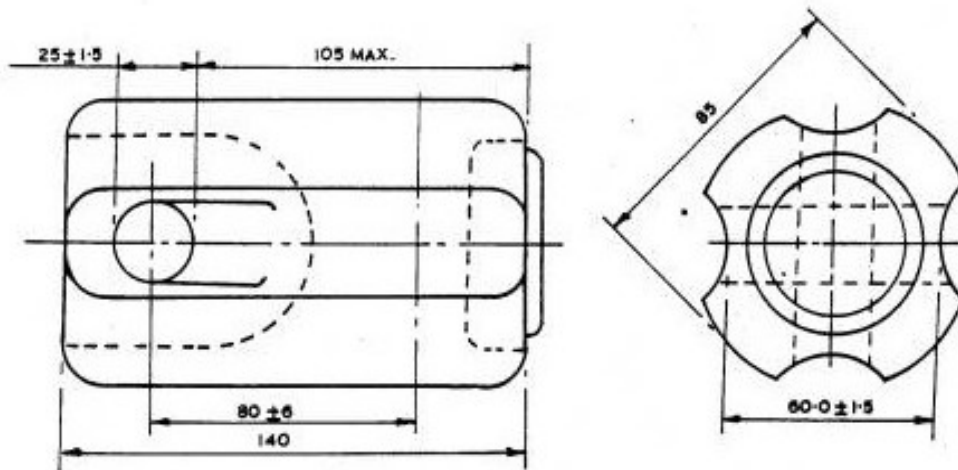
**10. PACKING**

All insulators shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail transport. Wooden separators shall be fixed between the insulators to keep individual insulators in position without movement within the crate.



चित्र-१. तान रस्सी विकृतिसह विद्युतरोधक - संज्ञा अ.

FIG. 1. GUY STRAIN INSULATOR (DESIGNATION- A)



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FIG. 2. GUY STRAIN INSULATOR (DESIGNATION - C )

ALL DIMENSIONS ARE IN mm

## **21. Helically Formed Fittings for 11 kV and LT Lines**

### **1. SCOPE**

This Standard specifies the requirements and tests for helically formed fittings for use on 11 KV and LT overhead lines.

The following types of fittings are covered:-

- a) Conductor dead end fittings
- b) Distribution ties, side ties and double ties
- c) Conductor splices
- d) Guy grip dead-ends
- e) Tap connectors
- f) Service grip dead-ends
- g) Lashing rods

### **2. GENERAL REQUIREMENTS**

**2.1** Aluminium alloy, aluminium-clad steel and galvanised steel wires having required mechanical strength, corrosion resistance and formability, depending on the type of application shall be employed in the manufacture of the fittings. The material of the formed fittings shall be compatible with the conductors with which it is used.

**2.2** In case of formed wires, no joints shall be permitted except those in the base rod or wire before final drawing.

**2.3** Each formed set shall be marked with indelible and distinct colour to indicate starting/cross-over point of application to facilitate its application on the conductor.

**2.4** The ends of the individual wires of the formed fittings shall be suitably debarred to provide a smooth finish so as to avoid any damage to the conductor due to sharp edges.

**2.5** Suitable grit shall be applied to the gripping section of the formed fitting (except lashing rods) in order to enhance its gripping strength.

### **3. PROPERTIES OF WIRES**

**3.1** Materials of the wires used in the manufacture of the fittings covered by this specification shall have the mechanical and electrical properties as specified in



Tables 1,2 and 3. Materials used for chloroprene pad shall have the properties specified in Table 4.

**Table 1****Aluminium Alloy Wires**

Test	Requirements
1. Visual	a) No scratches
	b) No peeling off
	c) No speed crack
	d) No cut mark
2. Dimensions after forming	a) Diameter Tolerance (+) .000 mm (-) .025 mm
	b) Flattening (+) .000 mm (-) .076 mm
3. Tensile strength of formed wires	35 Kg/mm <sup>2</sup>
4. Elongation of finished wire	Min. 2% in a gauge length of 50 mm
5. Conductivity of finished wire	Min. 39% as per IACS
6. <u>Wrap test</u> Wire diameter mm Upto 3.07 From 3.08 to 3.45 From 3.46 to 3.71 From 3.72 to 4.24 From 4.25 and above	Min. number of twists on a mandrel of its own dia without fracture at a rate of 15 turn per minute 18 16 14 12 10

**Table 2****Aluminium Clad Steel Wires**

S.No.	Test	Requirements
1.	Visual	Free from splints, scale, inequalities, flaws and other irregularities :
2.	Dimentional	Roundness to (±) 0.013mm
3.	Tensile strength	As per table 2a below
4.	Weight of coating	As per table 2b below

5.	Wrap test (on a mandrel 2 times the dia of the sample and at the rate of 15 turns/minute)	After close helix, the sample should not fracture
6.	Adherence of coating (in a close helix not exceeding 15 turns/minute) around a cylindrical mandrel having a diameter prescribed in table 2c.	No cracking or flaking to such an extent that the aluminium coating can be removed by rubbing with the bare fingers

**Table 2a**

Wire diameter (mm)	Ultimate tensile strength minimum) MPa	Ultimate elongation (Min.) percent in 254 mm
1.270 to 2.283 including	1280	3.0
2.286 to 3.045 including	1240	3.5
3.048 to 3.515 including	1210	4.0
3.518 to 3.782 including	1170	4.0
3.785 to 4.826 including	1140	4.0

**Table 2b**

Wire diameter (mm)	Min. weight of aluminium coating on uncoated wire surface (gms/m <sup>2</sup> )
1.270 to 1.521 including	70
1.524 to 1.902 including	76
1.905 to 2.283 including	79
2.286 to 2.639 including	85
2.642 to 3.045 including	92
3.048 to 3.553 including	98
3.556 to 4.569 including	104
4.572 to 4.826 including	116

**Table 2c**

Wire diameter	Min. ratio of mandrel diameter to wire diameter
---------------	---

1.270 to 2.283 including	3
2.286 to 3.553 including	4
3.556 to 4.826 including	5

**Table 3****Zinc coated steel wire**

	Test	Requirements
1.	Visual	Free from splints, scale, inequalities and other irregularities :
2.	Dimentional	Roundness to ( $\pm$ ) 0.013mm
3.	Tensile strength of finished wire	As per table 3a below
4.	Weight of zinc coating	As per table 3b below
5.	Wrap test (on a mandrel 2 times the dia of the sample and at the rate of 15 turns/minute)	After close helix of minimum 8 turns, the sample should not fracture.
6.	Adherence of coating (in a close helix not exceeding 15 turns/minute) around a cylindrical mandrel having a diameter prescribed in table 3c.	No cracking or flacking to such an extent that zinc coating can be removed by rabbing with the bare fingers

**Table 3 a**

Wire diameter mm	Ultimate tensile strength (Minimum) MPa	Elongation in 200 mm gauge length minimum (%) mm
1.270 to 2.283 including	1450	3.0
2.286 to 3.045 including	1410	3.5
3.048 to 3.053 including	1410	4.0
3.556 to 4.022 including	1380	4.0

**Table 3b**

Wire diameter (mm)	Minimum weight of zinc coating on uncoated wire surface (gms/m <sup>2</sup> )
--------------------	---

1.270 to 1.521 including	183
1.524 to 1.902 including	198
1.905 to 2.283 including	214
2.286 to 2.639 including	229
2.642 to 3.045 including	244
3.048 to 3.553 including	259
3.556 to 4.69 including	274
4.572 to 4.822 including	305

**Table 3c**

Wire diameter (mm)	Ratio of mandrel diameter to wire diameter
1.270 to 2.283 including	3
2.286 to 3.553 including	4
3.556 to 4.822 including	5

**Table 4****Properties for Chloroprene pad****Chloroprene cushion shall have following properties :**

1a)	Tensile Strength	Minimum 100Kg/cm <sup>2</sup>
b)	Tensile strength (after ageing)	Loss of maximum 25% of the test value obtained in 1(a)
2a)	Elongation	250% minimum
b)	Elongation (after ageing)	Loss of maximum 25% of the test value obtained in 2(a)
3a)	Shore hardness 'A'	65 (±)5
b)	Shore hardness (after ageing)	(±)15% of test values obtained in 3(a)

**Note :** Ageing should be carried out for 70 hours at 100°C.**4. REQUIREMENTS OF FORMED FITTINGS FOR VARIOUS APPLICATIONS****4.1 Conductor Dead-end fittings**

**4.1.1** Formed conductor dead-end fitting for 11 KV lines consists of the following parts for use with disc insulators of clevis and tongue type:

a) Cross arms strap for attaching the fittings to the pole on one side and the disc insulator on the other. These fittings shall conform to the REC Specifications of 11 KV Porcelain Insulators and Fitting.

b) Aluminium alloy die cast thimble clevis for attaching the fitting to the tongue of disc insulator on one end and for accomodating loop of the helically formed fitting at the other end in its smooth internal contour. The thimble clevis is attached to the insulator through a steel cotter pin used with a non-ferrous split pin of brass or stainless steel. The thimble clevis shall have clevis dimensions as per IS : 2486 (Part II) - 1989 and shall have the minimum failing load strength of 3000 kg.

c) Helically formed fitting acting as the dead-end grip.

**4.1.2** The die-cast aluminium alloy thimble clevis shall be manufactured with alloy A6 Designation of IS : 617 - 1975.

**4.1.3** Nuts and bolts used shall be of galvanised steel conforming to IS : 1364 - 1967 and cotter pins conforming to IS : 2004 -1978. Spring washers used shall be electro-galvanised.

**4.1.4** The fitting for LT lines shall comprise of the helically formed fitting to suit the LT shackle insulator as per REC Specification of Porcelain Insulators and Insulator Fittings For 415/240V Overhead Power Lines

**4.1.5** The fittings shall be made to suit the following conductor sizes for 11 KV/LT Lines conforming to REC Specification 1/1971(R-1993) and each fitting shall have a clear identification mark on PVC/metallic/plastic tag, indicating size of the conductor and voltage. The following colour code shall be used for the tag as also for the starting/cross-over marks for quick identification:

20 mm <sup>2</sup> ACSR(Squirrel)	Blue
30 mm <sup>2</sup> ACSR(Weasel)	Red
50 mm <sup>2</sup> ACSR (Rabbit)	Yellow
50 mm <sup>2</sup> ACSR (Rabbit)	Brown
50 mm <sup>2</sup> AAC (Ant)	Grey

## **4.2** Distribution ties side ties and double ties

**4.2.1** Helically formed ties are used to hold the conductor to pin insulators or shackle insulators.]

**4.2.2** Chloroprene pad shall be provided with the formed ties for use on 11 KV lines to avoid abrasion of the conductor

**4.2.3** The conductor sizes and voltage class shall be clearly marked on each fitting and the fittings shall also be identified by color code as per clause 4.1.5.

- 4.2.4** To ensure proper fitting of 11 KV pin insulator ties, the purchaser shall furnish full-dimensions of the insulator top particularly the crown diameter, neck diameter etc. See REC specification 11KV porcelain insulators and fittings.

### **4.3 Conductor Splices**

- 4.3.1** Conductor splices for ACSR conductors shall consist of (i) galvanised steel formed splice for steel core (ii) aluminium alloy formed filler rod (iii) aluminium alloy formed splice for the aluminium strands of the conductor. For AAC conductor, splice is formed with aluminium alloy only.

- 4.3.2** Repair Splice: Repair splices are non-tension splices and are used where some of the outer strands of the conductor are damaged.

### **4.4 Guy Grip Dead-End**

- 4.4.1** Guy grip dead ends have one leg shorter than the other and are suitable for gripping the guy wire. These grips are applied on one side into the thimble eye of the stay rod and on the other side to the guy wire. These can also be used directly with guy insulators.

- 4.4.2** The fittings shall be made of two sizes to suit stay wires of 7/3.15mm(7/10SWG) and 7/2.5 mm(7/12SWG) having UTS values 3625 kg and 2300 kg respectively.

- 4.4.3** The fittings shall be clearly identified on a PVC/mettalic/plastic tag for the size of stay wire with which these are to be used and, in addition, the following colour codes for the tag as well as the corss-over marks shall be adopted for proper identification:

Guy grip for 7/3.15 mm stay wire - Green

Guy grip for 7/2.5 mm stay wire - Black

- 4.4.4** The guy grip shall be supplied complete with thimble to suit the fitting. Thimble shall be made of hot-dipped galvanized steel.

**Note:** The guy grips to be used with guy insulators shall take into account the standard sizes of insulators as per REC specification and the type and size of the guy insulator shall be clearly specified by the purchaser.

- 4.5** Tap Connectors: Tap connectors consist of helically formed aluminium alloy wires for non-tension tapping of conductors and cables from the main line. The

sizes of conductors/cables for which these tap connectors are to be used have to be clearly specified by the purchaser.

- 4.6** Service Grip Dead End: Service grip dead-ends are used with metallic knob to hold one or more service bearer wires.
- 4.7** Lashing Rods: Lashing rods are helically formed wires to secure the bearer wire to the service cable. The number of lashing rods will depend on the length of service.

## **5. DIMENSIONAL REQUIREMENTS OF THE FINISHED FORMED FITTINGS**

- 5.1** The lay of the helix shall be right hand.
- 5.2** The diameter and number of formed rods used per set of fittings to be used on various sizes of conductors shall be as per the approved drawings.
- 5.3** Tolerances of formed fittings: The various requirements of the helically formed fitting shall be within the following tolerances:

	<b>Item</b>	<b>Tolerances</b>
	Pitch length	+ 0.6 mm (-) 0.12 mm
	Internal diameter	+ 1% (-) 3%
	Length of individual rod	( $\pm$ ) 1%
	Difference in length	( $\pm$ ) 1% between the longest and the shortest rod in an individual set

## **6. TESTS**

- 6.1 Type Tests:** The following tests shall constitute the type tests on the finished fittings:

<b>Test</b>	<b>Applicable to</b>
Visual examination	All fittings
Verification of dimension	All fittings
Tensile strength test	All fittings
Electrical resistance test	All aluminium alloy fittings
Wrapping test	All fittings
Slip strength test	Conductor dead-end, guy grip and splices
Resilience test	Conductor dead-end, guy grip and conductor splices

Unbalanced holding Strength Test	Ties only
Fatigue test	Conductor dead-end, ties and splices
Galvanising test	Hardwares and fittings using GI wire
Pull-off strength test	Ties only
Electrical & Mechanical Test	Tap Connectors

**Acceptance Test:** The following shall constitute the acceptance test:

1. Visual examination
2. Verification of dimension
3. Tensile Strength test
4. Electrical resistance test
5. Wrapping test
6. Slip Strength test
7. Resilience test
8. Unbalanced load
9. Galvanisation test
10. Pull-off strength
11. Electrical & Mechanical tests on tap connectors
12. The tests for other requirements as per Tables 1,2,3 & 4 on the individual wires used in making the helically formed fittings and chloroprene pad (where used).

**6.2 Routine Tests:** The following shall constitute the routine tests:

- a) Visual examination
- b) Verification of dimensions

## **7. TEST PROCEDURE**

**7.1** Visual Examination: All fittings and individual wires shall be checked visually for good workmanship, smooth finish and other requirements indicated in Table 1, 2 and 3.

**7.2** Verification of dimensions: The dimensions shall be checked as specified in the tables 1, 2, 3 and clause 5.

**7.3** Tensile Strength Test:

**7.3.1** Individual wire of the helically formed wires shall be straightened by light hammering and tested for tensile strength and elongation in accordance within the IS:398(Part II)-1976. The tensile strength and the elongation of the formed wires shall not be less than the values specified in tables 1, 2 and 3.



**7.3.2** For thimbles and hardware other than formed fittings:

The dead-end clevis thimble and straps shall be tested for tensile strength in accordance with the requirements of mechanical failing load as per IS:2486(Part I)-1993.

**7.4** Electrical Resistance Test: This test shall be done on straightened aluminium alloy formed wires only. The conductivity of the wires should not be less than 39% IACS.

**7.5** Wrapping Test: The individual wires of the formed fittings shall be tested as specified in tables 1, 2 and 3. The wires should not break or show fracture when tested as above.

**7.6** Slip Strength Test: For the conductor dead-end and guy grip dead-end, the test shall be made in accordance with IS:2486(Part I)-1993 and the value of slip/breaking strength shall not be less than 85% of the breaking strength of the conductor for conductor dead-end fitting and 100% for guy wires dead end fittings. In case of tension splices, the test shall be carried out as per IS:2121. No slippage or damage to the fitting shall occur at a value less than 100% of breaking load of the conductor. This test should be repeated after the resilience test.

**7.7** Resilience Test: A set of helically formed fitting is wrapped and un-wrapped on a piece of conductor 3 times successively. The helical fitting should not lose its resilience even after three applications and should be able to pass the slip strength test requirements mentioned in 7.6 thereafter.

**7.8** Unbalanced Holding test: Unbalanced holding strength is the ability of the formed ties to maintain a constant and uniform grip on the conductor when intermittent and repeated unbalanced loads impose a tension imbalance in the span. These imbalances occur due to wind induced motion, impacts, ice conditions and more so when the conductor is broken.

The test is intended to simulate the broken wire condition. A span of minimum 20 meters tensioned for 40% of UTS of the conductor shall be erected in the laboratory and a pin insulator alongwith the insulator tie under test shall be applied in the middle of span. The conductor used for this purpose shall be of the specific size with which the insulator tie is to be used. The test set up shall be such that it should be possible to apply a pull on one of the two dead ends of the conductor. For the purpose of this test, a steel replica of the insulator will be used. During the test, tension on one side of the pin insulator shall be suddenly

released and effect observed. No slippage or damage to the fitting shall occur. After releasing tension from the other end, the fitting should retain the original form. This test will not only check the holding strength of the fitting but will also prove the resilience of the fitting in the event of broken wire.

The test shall be repeated. After releasing the conductor tension on one side, pulling force shall be slowly applied on the other dead-end to pull the conductor till slippage/damage occurs. This force shall not be less than 320 kg.

**7.9 Fatigue Test:** The fittings should be subjected to fatigue test alongwith the conductor by imparting 10 million cycles of peak to peak amplitude at a frequency above 30 cycles for minimum span length of 20 meters, at 40% of UTS of conductor. The amplitude of the vibrations at the antinodal points should be atleast 50% of the diameter of the conductor. The test should be carried out for 10 million cycles as continuously as possible after which the conductor fitting and insulator should be examined. There should be no damage to the conductor or the insulator where the fitting is attached. The fitting should also be able to withstand the test without any damage.

**7.10 Galvanising Test:** Galvanising test should be carried out in accordance with IS:4826-1979 for uniformity and IS:6745-1972 for weight of zinc coating and the fittings will meet the requirements of Table 3.

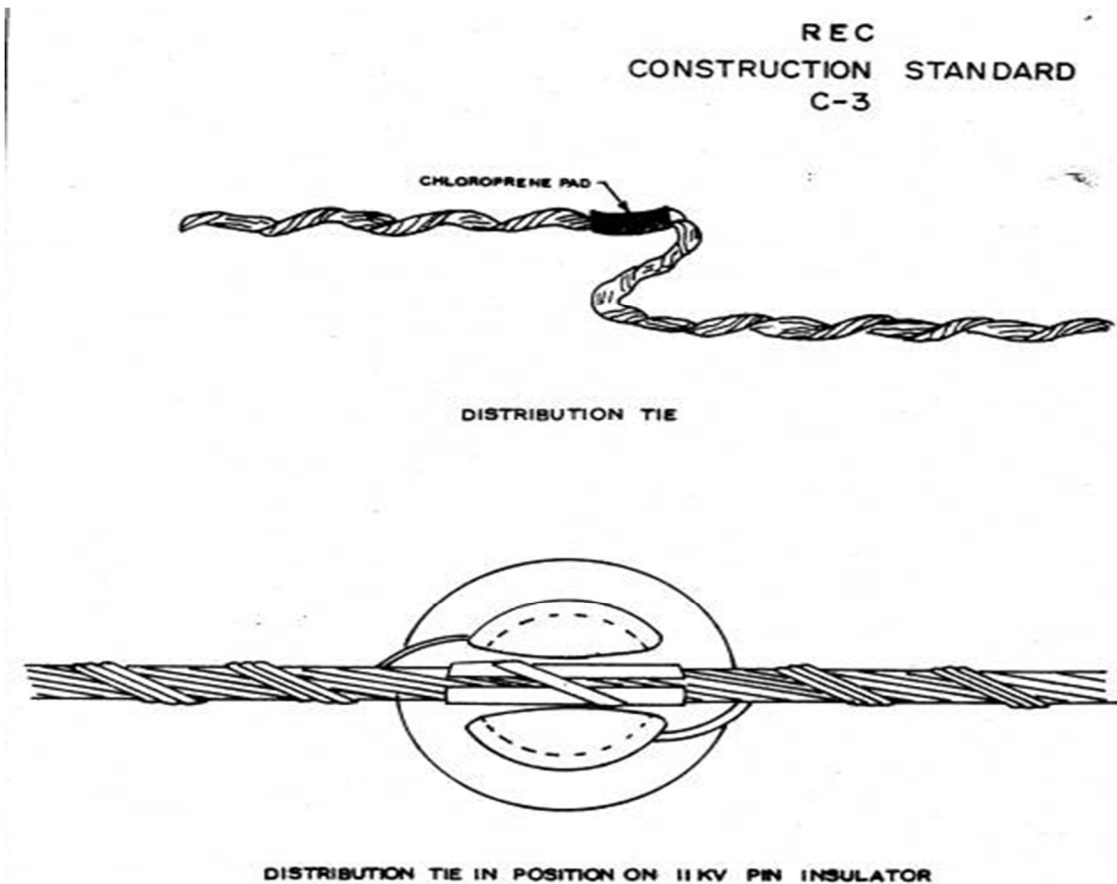
**7.11 Pull-Off Strength Test:** This test is intended to simulate the conductor pull-off conditions created by various factors including elevation difference of the supporting structures on the two sides of the tie. A span of minimum 20 metres tensioned for 40% of UTS of the conductor shall be erected in the laboratory with a conductor of the specified size with which the fitting is intended to be used. A steel replica of pin insulator alongwith the insulator tie under test shall be applied in the middle of span so that a suitable pull-off force can be applied on the pin by means of a machine. The pull-off strength of the tie shall not be less than 200 Kg. for all the three sizes of ACSR.

**7.12 Electrical & Mechanical Test on Tap Connectors:** The tap Connectors shall conform to all the electrical and mechanical properties as per IS:5561.

## **8. PACKING AND MARKING**

**8.1** All helically formed items covered under this specification shall be carefully handled to prevent distortion and damage. These items shall be packed and stored in suitable cartons.

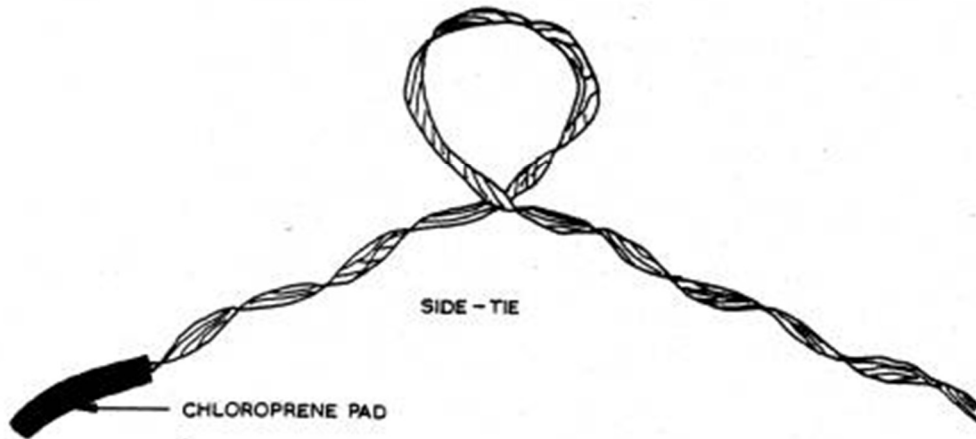
- 8.2 Different colour codes shall be adopted for different conductor sizes and catalogue number and range of outside diameter of the conductor shall be indicated on the packing.
- 8.3 Clevis thimbles and other hardware for conductor dead-ends shall be packed in wooden crates with all necessary markings.
- 8.4 The packings of the fittings should carry the following informations.
- Purchaser's name
  - Manufacturer's name and trade mark
  - Size of conductor, line voltage (when required) and numbers
  - Batch number, date, month and year of manufacture
  - Any other marking agreed to between manufacturer and user.

**NOTE**

FOR DETAILS OF HELICALLY FORMED FITTING REFER REC SPECIFICATION NO. 25/1983

<b>११ के. वी. पिन इन्सुलेटर पर कन्डक्टर स्थपित करना - स्ट्रेट-रन (सर्पित कन्डक्टर के फर्मिड फिटिंग का प्रयोग करना) HOLDING OF CONDUCTOR ON 11KV PIN INSULATOR - STRAIGHT RUN (USING HELICALLY FORMED FITTING)</b>	
SCALE :- H.T.S	JULY, 1984.

REC  
CONSTRUCTION STANDARD  
C-4



SIDE TIE IN POSITION ON 11KV. PIN INSULATOR

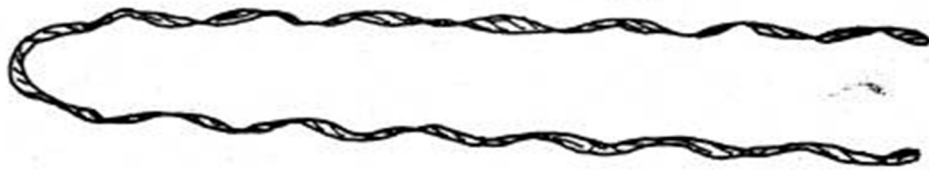
NOTE:- FOR DETAILS OF HELICALLY FORMED FITTINGS  
REFER REC SPECIFICATION NO. 25/1983.

११ के. वी. पिन इन्सुलेटर पर कन्डक्टर  
स्थापित करना - दृढ़ता होके बान  
(हिलेपल आकार के हिलेपल फिटिंग का प्रयोग करना)  
HOLDING OF CONDUCTOR ON  
11KV. PIN INSULATOR - ANGLE LOCATION  
(USING HELICALLY FORMED FITTING)

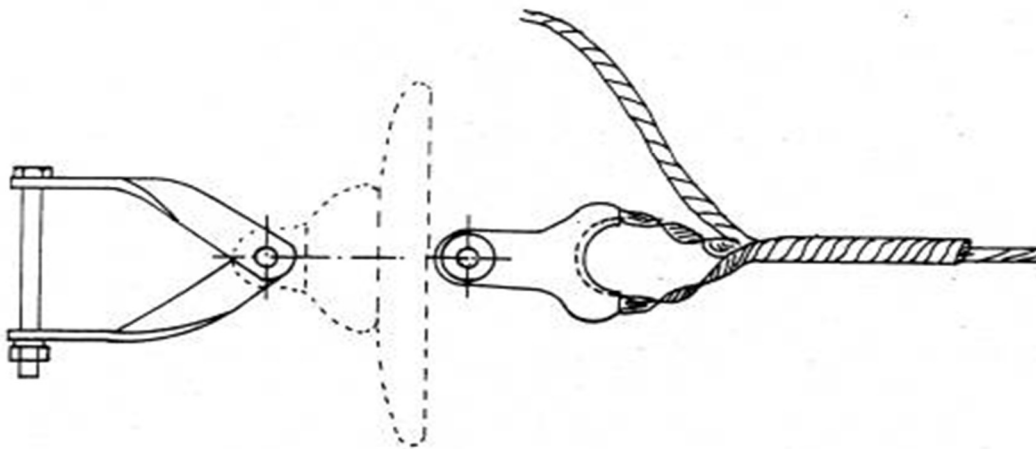
SCALE:-N.T.S

JULY, 1984

REC  
CONSTRUCTION  
C-5 STANDARD



CONDUCTOR DEAD-END FITTING



11KV CONDUCTOR DEAD-END FITTING IN POSITION

11KV STRAIN INSULATOR HARDWARE CONSIST OF:

1. HELICALLY FORMED DEAD-END FITTING
2. CLEVES THIMBLE AND
3. CROSS-ARM STRAP WITH BOLT.

**NOTE:-**

FOR DETAILS OF HELICALLY FORMED FITTING REFER  
REC SPECIFICATION NO. 25/1983

११ के.वी. कन्डक्टर अन्तिम डोर काक्विन्यास  
(सर्पित आकार के फॉर्मड फिटिंग का प्रयोग  
करना)

11KV CONDUCTOR DEAD-END ARRANGEMENT  
(USING HELICALLY FORMED FITTINGS)

SCALE :- N.T.S

JULY, 1984

REC  
CONSTRUCTION STANDARD  
E-31

USE OF LASHING RODS TO SECURE THE OVERHEAD BEARER WIRE AND  
THE PVC SERVICE CABLE



FIGURE-1

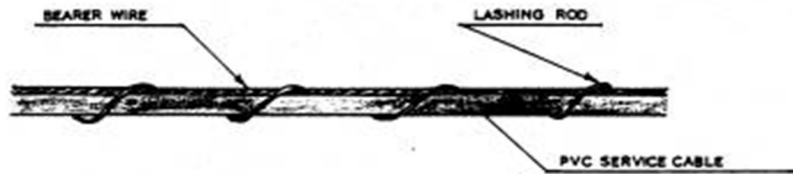


FIGURE-2

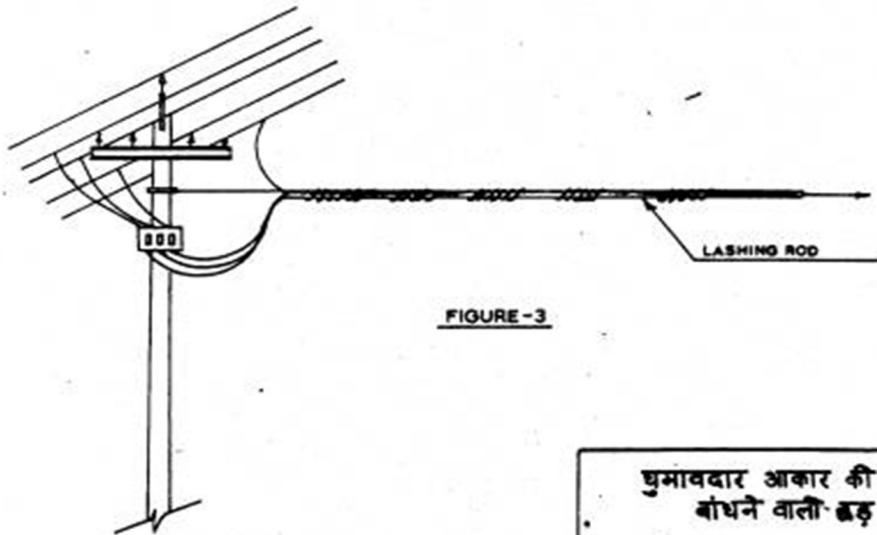


FIGURE-3

FIG-1 SHOWS THE LASHING ROD.  
FIG.2&3 SHOW THE LASHING RODS IN POSITION.

घुमावदार आकार की फिटिंग  
बांधने वाली छड़  
HELICALLY FORMED FITTINGS  
LASHING RODS  
SCALE :- N.T.S JULY-1984

REC  
CONSTRUCTION STANDARD  
E-32

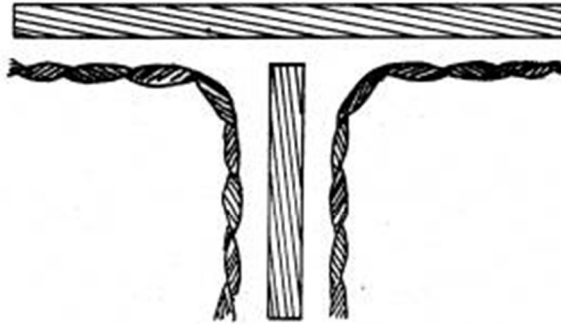


FIGURE - 1

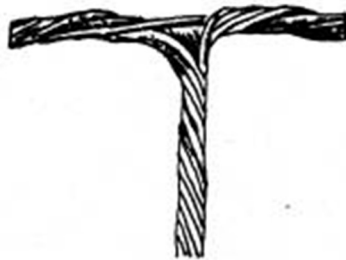


FIGURE - 2

NOTE:-

T-CONNECTORS CAN BE USED TO TAP  
SERVICE CONNECTIONS FROM THE  
LINE OR FOR TAPPING A BRANCH  
LINE FROM THE MAIN LINE.

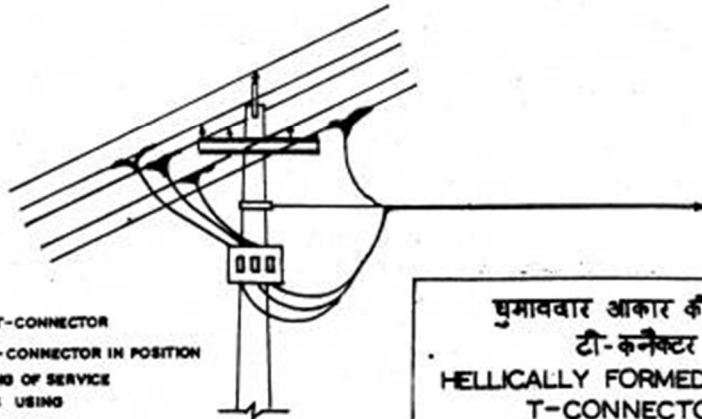


FIGURE - 3

FIG-1 SHOWS THE T-CONNECTOR  
FIG-2 SHOWS THE T-CONNECTOR IN POSITION  
FIG-3 SHOWS TAPPING OF SERVICE  
CONNECTIONS USING  
T-CONNECTORS.

घुमावदार आकार की फिटिंग  
टी-कनेक्टर  
HELICALLY FORMED FITTINGS  
T-CONNECTOR

SCALE:- N.T.S

JULY - 1984

R E C  
CONSTRUCTION STANDARD  
E - 33

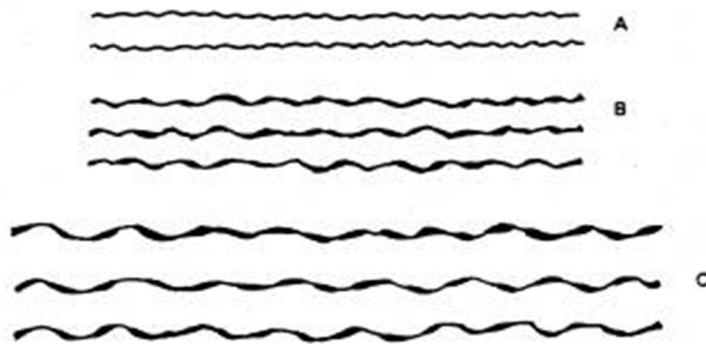


FIGURE-1



FIGURE-2



FIGURE-3

- A      SHOWS THE CORE SPLICE  
B      SHOWS THE FILLER RODS.  
C      SHOWS THE OUTER SPLICE  
FIG.1.    SHOWS THE CORE SPLICE IN POSITION  
FIG.2.    SHOWS THE CORE SPLICE AND FILLER RODS IN POSITION  
FIG.3.    SHOWS THE COMPLETE JOINT AND THE OUTER SPLICE IN POSITION.

घुमावदार आकार की फिटिंग  
ए.सी.एस.आर. के लिए स्पलाईस  
HELICALLY FORMED FITTINGS  
SPLICE FOR ACSR JOINT

SCALE :- N.T.S



## **22. Insulation Piercing Connectors, Anchor (Dead End) & Suspension Accessories & Other Accessories for Aerial Bunched Cables for Working Voltage upto and including 1100 Volts**

### **1.0 SCOPE**

This specification covers the design, manufacture, assembly, testing and supply of Accessories for anchoring, suspending & making connections to Aerial Bunched Cables rated 1100 volts and insulated with cross-linked polyethylene.

### **2.0 STANDARD**

The design, performance and test requirements shall confirm to this specification and the following standards. However in case of any conflict, the requirements of this specification shall prevail.

- NFC 33-020 Insulation Piercing Connectors
- NFC 33-209 LV Aerial Bunched Cables
- NFC 20-540 Environment Testing for Outdoor
- NFC 33-004 Electrical Ageing Test
- NFC 33-040 Suspension Equipments
- NFC 33-041 Anchoring Devices
- IS 14255 LV Aerial Bunched Cables

The Devices shall also be compatible with the cables of sizes & dimensions as defined in the Cable Specifications for the cables with which they are intended to be used.

### **3.0 CLIMATIC CONDITIONS**

For the purpose of designing the climatic conditions as specified in annexure-1 shall be considered.

### **4.0 CABLE DATA**

The standard sizes and characteristics of the phase and street lighting conductors, messenger wires shall be as specified in IS: 14255-1995.

The Accessories of LT XLPE Insulated Aerial Bunched Cables (ABC) with ~~insulated bare~~ messenger cum neutral are specified below:

- a) The ABC accessories should be of proven design with minimum 2 years record of satisfactory operation with a major utility. Order copies and Performance Certificates should be enclosed with the offer.

- b) Since ABC accessories are to be used with ~~insulated~~ bare neutral-cum-messenger, their design should incorporate specific features to prevent damage to the insulation which meeting the required electrical, mechanical & thermal requirements.
- c) All mechanical, electrical & thermal ratings should meet or exceed 90% of the corresponding ratings of the cable, or the values specified herein, whichever are more stringent.
- d) The accessories should provide “Double Insulation” so that a single point failure of insulation will not result in the system tripping.

## 5.0 THE ABC ACCESSORIES

The ABC Accessories shall consist of the following:

a)	Insulation Piercing Connectors (IPC)	:	For making tap-off/branch connectors/service connector to an ABC line.
b)	Anchoring Assembly (AA)	:	For fitting onto a pole for anchoring the end of a length of ABC, or for a major change in direction.
c)	Suspension Assembly (SA)	:	For supporting a length of ABC at an intermediate pole in a length, with small angle of deviation.
d)	Service clamp (sc)	:	For anchor Insulated service lines (armoured or unarmour)
e)	Transformer Connections	:	For connection to the transformer bushing.
f)	Junction Sleeves	:	For Phases, neutral messengers & Street lighting conductor.
g)	ABC Service Main Distribution Box	:	For Distribution of multiple no. of Service Connections from Main AB cable.

### 5.1 Insulation Piercing Connectors (IPC)

- 5.1.1 Insulation Piercing Connectors (IPC) are used for making Tee/Tap-off/Service connectors to an ABC/Bare Overhead Line.

- 5.1.2 Insulation Piercing Connectors are designed to make a connection between the uncut main conductor and a branch cable conductor without having to strip either cable to expose the conductor instead the tightening action of the IPC will first pierce the Insulation, then make good electrical contact between the main end and branch conductor while simultaneously insulating and sealing the connection.
- 5.1.3. Constructional Features of IPC
- 5.1.3.1 The housing shall be made entirely of mechanical and weather resistant plastic insulation material and no metallic part outside the housing is acceptable except for the tightening bolt.
- 5.1.3.2 Any metallic part that is exposed must not be capable of carrying a potential during or after connector installation.
- 5.1.3.3 Screws or nuts assigned for fitting with IPC (Insulating Piercing connector), must be fitted with torque limiting shear heads to prevent over tightening or under tightening (min & max torque values to be specified by Manufacturer).
- 5.1.3.4 The IPC must perform piercing and connection on Main and Branch cable simultaneously.
- 5.1.3.5 The IPCs shall be water proof and the water tightness shall be ensured by appropriate elastomer materials and not by grease, gel or paste alone.
- 5.1.3.6 Design of IPC should be such as to not cause damage to insulation of adjacent conductors due to vibration and relative movement during service.
- 5.1.3.7 The connector shall have a rigid removable end cap which can be slide fitted onto the main connector body on either right or left by the installer (depending on site requirement) for sealing the cut end of the branch cable. Once the connector is fitted, it should not be possible to remove the cap without removing the connector.
- 5.1.3.8 All the metallic parts of the connector should be corrosion resistant and there should not be any appreciable change in contact resistance & temperature after overloads & load cycling.
- The contact plates should be made of tinned copper/**aluminium alloy**.
  - Connector teeth should be factory greased & sealed to retard water or moisture ingress & corrosion.

- The Insulation material should be made of weather & UV resistant reinforced polymer.
- The outer metallic part should have potential free tightening bolts to allow safe installation on live lines.

#### 5.1.4 Mechanical Tightening and Electrical Continuity

- 5.1.4.1 Connectors shall be tightened upto 70% of the minimum torque indicated by the Manufacturer. At this torque electrical contact should have occurred between conductors to be joined. Then connectors shall be tightened up to the breakdown of the shear heads and lastly, upto 1.5 times the maximum torque indicated by the manufacturer.

For the connector fitted with two screws on the same core, after the breakdown of the shear heads tightening may be carried out manually and alternatively using a torque meter. The test conditions shall be as close as possible to those defined for the use of the test machine as per NF-C standard.

- 5.1.4.2 At 1.5 times the maximum torque indicated by the manufacturer, there shall be no breakdown of any part of the connector or the core conductor.
- 5.1.4.3 Maximum rated torque shall not exceed 20 N.m for conductor <95 sq.mm and 30 for >95 but <150 sq.mm.
- 5.1.4.4 Tightening screws shall have hex. Heads of 10 mm, 13 mm or 17 mm only.

#### 5.1.5 Effect of Tightening on Main Core of IPC

- 5.1.5.1 The connector shall be fitted approx. at the centre of the main core, which is secure between two anchoring points 0.5 mtr. To 1.5 mtr.apart. At the time of fitting the connectors, the main core shall be under longitudinal tension at 20% of the load indicated in Table-1:

**Table-1**

<b>Nominal Cross – section (sq.mm.)</b>	<b>Tensile Strength (Newton)</b>
16	1200
25	1800
35	2500
50	3500

70	5000
150	10000

5.1.5.2 Tensile strain shall be increased to the full value indicated in the Table 1 and held minute. There should be no breakdown of the core conductor.

#### 5.1.6 **Effect of Tightening on Branch Core of IPC**

5.1.6.1 Test specimen shall be made up as in clause 5.1.5.1 except that this shall be do the smallest cross sections of main and branch conductors within its range.

5.1.6.2 An increasing tensile load shall be applied to the Branch Conductor along the axis of the recess for the Branch cable. Load shall increase at 100 – 500 N/minute until it reaches the value specified in the Table 2 and maintained for 1 minute.

**Table-2**

Nominal Cross – section (sq.mm.)	Tensile Strength (Newton)
16 (Alu)	290
25	450
35 & above	500

5.1.6.3 No slippage or breaking of conductor shall occur.

#### 5.1.7 Dielectric & Water Tightness Test of IPC

5.1.7.1 The connector is tightened up to the minimum torque indicated by the manufacturer.

5.1.7.2 Connectors are mounted on

- Minimum cross section of main core.
- Maximum cross section of main core.

5.1.7.3 In each case Branch is of minimum cross section.

5.1.7.4 Protection caps for the branch cable are to be used in accordance with the requirements of clause 5.1.3.7. An additional water tight cap of any design may be used to seal one end of the main cable if it is immersed under water. No additional gel or any protection is to be provided while installing connector.

5.1.7.5 The entire assembly shall be immersed at a depth of approx. 30cms. For 30 minutes with the free ends of main and branch cable out of the water.

- 5.1.7.6 An AC voltage of 6 kV shall be applied between the water bath and each of the cores in turn for 1 minute. There shall be no flashover or electrical tripping with a trip setting of 10 mA + 0.5mA.

#### 5.1.8 Electrical & Ageing Test of IPC

- 5.1.8.1 Two test configurations are used according to Table 3 with the connections tightened to the minimum torque specified by their manufacturers and resistance recorded.

**Table - 3**

Configuration	Main core cross section	Branch core cross section Tensile Strength (K.N)
1st Configuration	Maximum	Maximum
2nd Configuration	Maximum	Maximum

- 5.1.8.2 The configurations are subjected to 200 heat cycles by injecting suitable current into them. In each cycle the temperature of the conductor shall be raised from ambient to  $120 + 5^{\circ}\text{C}$  as, measured by a thermocouple.
- 5.1.8.3 The duration of each heating cycle is chosen to maintain a sufficiently steady temperature of  $120 + 5^{\circ}\text{C}$  for 15 minutes. The duration of each cooling cycle is chosen to bring the conductor temperature to within  $2^{\circ}\text{C}$  of ambient.
- 5.1.8.4 Nominal heating current is indicated in the Table-4. It shall be permissible to accelerate the temperature rise by using a current up to 1.5 times the nominal current and to accelerate the cooling period by use of a fan or air blower.

**Table-4**

Nominal Cross – section (sq.mm.)	Nominal Heating Current (A)
16	102
25	139
35	175
50	225
70	283
95	350
120	412
150	480
185	545
240	670

5.1.8.5 The over current test of Clause 5.1.9 shall be done after 50 cycles if the connector is a safety connector designed to ground a phase connector while the line is being worked on.

5.1.8.6 At the end of the 200 cycles the resistance shall again be measured. It shall not differ from the initial value by more than 12%.

#### 5.1.9 **Over Current Test of IPC**

5.1.9.1 Over current test is required to establish the performance of Safety Connectors that are intended to provide a safe path to ground for the phases while the line is de-energised for working. It establishes the performance of the connector under short term over load conditions.

5.1.9.2 After the first 50 cycles of clause 5.1.8, the connectors are subjected to 4 over currents of 1 sec duration each.

5.1.9.3 The conductor temperature at the start of the over current test should be not more than 35°C.

5.1.9.4 Current density during over current shall be 100 A/sq.mm for Aluminium and 95 A/sq.mm for Aluminium – Alloy Conductor.

5.1.9.5 Variation in time of over current is permissible between 0.85 sec & 1.15 sec., provided it maintains the relationship  $I^2 t = K$

$t = K$  where,

$I$  = rms value of over current in Amps.

$t$  = time in seconds

$K$  = Constant

5.1.9.6 After the over current test the electrical ageing test of clause 5.1.8 shall be resumed.

#### 5.1.10 **Type Test of IPC**

5.1.10.1 Type Test Reports should be submitted from an Independent Laboratory of Repute or the Works Laboratory in case of a foreign manufacturer covering the following (on any convenient size of fitting of same design made from the same materials).

5.1.10.2 The installation of the connectors shall be done by the laboratory following instructions provided by the manufacturer.

5.1.10.3 The Test report shall record the embossing and marking on the connector.

5.1.10.4 The following shall constitute Type Tests for IPC :

- Electrical Ageing Test
- Dielectric and Water Tightness Test.
- Mechanical Tightening Test
- Effect of Tightening on main Core
- Effect of Tightening on Branch core
- Over-current Test (Applicable as per relevant clause of latest version of NFC 33020)\*

The following shall be Type Test for Suspension Assembly (SA)

- Mechanical Test
- Voltage Test
- Climatic Aging Test
- Corrosion Test
- Endurance Test under Thermal & Mechanical Stresses (optional till testing facilities are available in India)\*

The following shall be Type Tests for Anchoring Assemblies (AA)

- Mechanical Test
- Voltage Test
- Dynamic Test (Applicable for areas having subzero minimum temperature)\*
- Climatic Aging Test
- Corrosion Test
- Endurance Test under Thermal & Mechanical Stresses

## 5.2 Anchoring Clamp for Insulated Messenger:

The clamps should be designed to Anchor LT-AB cable with insulated messenger. The clamp should consists of an Aluminium alloy corrosion resistant castled body, bail of stainless steel and self adjusting plastic wedges which shall anchor/hold the neutral messenger without damaging the insulation.

\*Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/609 dated 05.10.2018

- No losable part in the process of clamping arrangement
- The clamp should conform to the standard NFC 33041 and 33042 or equivalent I.S. if any.



- The clamp body should be made of corrosion resistant Alluminium alloy, bail should be of stainless steel and wedges should be weather and UV resistant polymer.
- ~~Ultimate tensile strength of the clamp should not be less than 15 kN for 50/70sq.mm insulated messenger wire / 10 KN for 25/35 sq.mm insulated messenger wire.~~
- ~~Slip load of the clamp should not be less than 3 KN for 50/70 sq.mm. messenger wire / 2 KN for 25/35 sq.mm. messenger wire.~~ **Ultimate tensile strength of the clamp should be as per Table-6 of Technical Specification. \***

5.2.1 Anchoring assemblies are used to firmly attach the messenger of ABC to a support and transmit the mechanical tension.

- at the end of a run or to the supporting structures
- at a major change in direction.

5.2.2 Each Anchoring Assembly shall include.

- One number tension bracket.
- One number wedge type tension clamp
- Flexible Rope for fixing tension clamp to bracket.

5.2.3 Anchoring assemblies shall be supplied in sets to ensure compatibility of the materials against corrosion or wear of moving parts.

5.2.1 Tension Bracket of AA

5.2.4.1 The tension bracket shall be made out of a single piece of Aluminium alloy suitable for attachment to a pole either by

- 16mm galvanized steel bolt (s) or
- two stainless Steel straps of 20 x 0.7 mm.

5.2.4.2 The tension bracket should be designed to ensure the Flexible rope cannot slip out at any angle.

5.2.4.3 The tension bracket should be rated and tested for the loads specified in Table-5. The load shall be applied at an angle of 45° from the normal to the surface of mounting of the bracket.

**Table - 5**

Conductor Size (Sq.mm.)	Rating	Load for deformation <10mm (Newtons)	Load for deformation <30mm & no-
-------------------------------	--------	---	---

			<b>break (Newtons)</b>
25-35	500 Kg.	12,000	15,000
50-95	000Kg	15,600	19,500

#### 5.2.5 Flexible Rope of AA

5.2.5.1 The Anchoring assembly shall be supplied with a stainless steel flexible Rope to connect the Tension Clamp to the Tension Bracket.

5.2.5.2 The rope should have sufficient flexibility to ease the torsional movement of the ABC System.

3.1.1.1 The Rope should be pre-fitted with compression type end fittings to secure the tension clamp.

**\*Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/609 dated 05.10.2018**

5.2.5.4 A wear resistant moveable saddle should be un-loosably fitted on the Rope to prevent abrasion at the point of fitting into the tension bracket.

5.2.5.5. The Rope should have sufficient mechanical strength to withstand the mechanical test for the complete assembly tests in this specification.

#### 5.2.6 Wedge Type Tension Clamp of AA

5.2.6.1 Wedge type clamps shall be used for clamping the messenger without damaging the insulation.

5.2.6.2 The clamp shall be capable of clamping an uncut messenger so that it can continue without break to the connecting point or next span.

5.2.6.3 The clamp shall be fully insulating type of mechanical and weather resisting thermoplastic.

5.2.6.4 No bolts or loose parts are allowed as part of the Clamping system.

5.2.6.5 No tools shall be needed for fitting the messenger into the clamp.

5.2.6.6 The clamp shall be self tightening and capable of holding without slippage the load specified in the Table-6.

**Table - 6**

Conductor Size		Rating (Kg.)	T <sub>start</sub> (I <sub>start</sub> final	
Sq. mm.	Dia. (mm)		minute)	I minute)
			(Newtons)	Newtons)
25-35	8-11	1000 Kg.	8,000	10,000
50-54	8-11	1500 Kg.	12,000	15,000
70-95	13.5-16	2000 Kg.	12,000	15,000

5.2.6.7 After fitting the insulated messenger in the clamp, load T<sub>start</sub> will be held for 1 minute & then load increased to T<sub>final</sub> at rate between 5000 – 7,500 N/mtr. In each case there shall be no breakdown of any part of clamp and slippage of messenger in relation to the clamp.

#### 5.2.7 Voltage Test on Clamp of AA

5.2.7.1 Voltage test is carried out on anchor clamps to ensure no damage is caused to the insulated messenger.

5.2.7.2 A conductive rod of dia. corresponding to the average dia. that can be accommodated in the clamp is fitted into the clamp, protruding by approx. 50mm at each end of the tightening piece.

5.2.7.3 The rod and clamp is subjected to tensile load as stated in Table 7 below when fixed to a support in its normal manner.

**Table - 7**

Conductor Size		Normal rating	Load Applied (N)
Sq. mm.	Dia. (mm)		
		(kg)	
25-35	8-11	1000	2000
50-54	8-11	1500	4000
70-95	13.5-16	2000	4000

5.2.7.4 A power frequency voltage of 6 kV is applied for 1 minute between the rod and conductive part of the clamp, or fixation point in absence of conductive part.

5.2.7.5 No breakdown or flashover shall occur. There shall be no tripping due to leakage with a setting of 10 + 0.5 mA.

#### 5.2.8 Endurance under Mechanical & Thermal Stress of AA

- 5.2.8.1 This test is done on clamp rated 1500 Kg. or 2000 Kg. using insulated messenger 50 to 70 sq. mm.
- 5.2.8.2 A neutral messenger is fitted between two anchor clamps, with clamp spacing approx. 5 mtr. & 1 mtr. Of messenger protruding from the end. Marks are made to enable measurement of slippage.
- 5.2.8.3 The sample is subjected to 500 cycles of 90 minutes each as described below:
- 5.2.8.3.1 Messenger temperature is raised by passing an AC current to 60 +30 C within 15 minutes. This temperature is maintained for at least 30 minutes to give a total heating period of 45 mts.per cycle.
- 5.2.8.3.2 Messenger is allowed to cool naturally to ambient for further 45 minutes to complete 90mts. Cycle time.
- 5.2.8.3.3 Mechanical load is applied during the cycle as per table 8 below. Load F1 is applied throughout the cycle, except for a short period of 5 sec. to 60 sec. when it is gradually increased from F1 to F2 at any time during the last 15 minutes of the 90 minute cycle.

**Table - 8**

Conductor Size		Rating (Kg.)	F1 (Newtons)	F2 (Newtons)
Sq. mm.	a. (mm)			
25-35	8-11	1000 Kg.	2,200	5,000
50-54	8-11	1500 Kg.	4,000	7,500
70-95	13.5-16	2000 Kg.	4,500	10,000

- 5.2.8.3.4 There should be no slippage greater than 4 mm after 2 cycles or greater than 8 mm after 500 cycles.
- 5.2.8.3.5 Voltage test is done at the end of the 500 cycles by immersing the test specimen of neutral messenger and clamps in water of resistivity not less than 200 Ohm mtr. For 30 minutes.
- 5.2.8.3.6 A voltage of 10 kV ac is applied for 1 minute between messenger and water bath using a trip setting of 10 + 0.5 am. There should be no breakdown or tripping.

### 5.3 Suspension clamp for insulated neutral messenger:

The clamp should be designed to hang L.T – AB cable with insulated neutral messengers. The neutral messengers should be fixed by an adjustable grip

device. A movable link should allow longitudinal and transversal movement of the clamp body.

- No losable part in the process of clamping arrangement.
- The clamp should conform to the standard NFC 33040 or equivalent I.S, if any.
- The clamp and the link made of Polymer should provide an additional insulation between the cable and the pole.
- The clamps and movable links should be made of weather and UV resistant glass fibre reinforced polymer.
- Clamps should be fixed with pole by eye hook / bracket. Bracket should be made of corrosion resistant alluminium alloy.
- ~~Ultimate tensile strength of the clamp should not be less than 15 KN for 50/70 sq.mm. Insulated messenger wire 4.3 KN for 25/35 sq.mm. Insulated messenger wire.~~
- ~~Maximum allowable load of the clamp should not be less than 20 KN for 50/70 sq.mm. insulated messenger wire/15 KN for 25/30 sq.mm insulated messenger wire.~~ **Ultimate tensile strength of the clamp should be as per Table-10 of Technical Specification.**

**\*Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/609 dated 05.10.2018**

5.3.1 Suspension Assembly is used for supporting an ABC by installation on the messenger at an intermediate point of support such as a pole. It can accommodate small angles of deviation upto 30°.

5.3.2 Each Suspension Assembly shall consist of:

- One number Suspension Bracket.
- One number moveable (articulated) connecting link.
- One number Suspension Clamp.

5.3.3 Suspension Assemblies shall be supplied in sets to ensure compatibility of the materials against corrosion or wear of rotating/moving parts.

5.3.4 Suspension Bracket of SA

5.3.4.1 The Suspension Bracket shall be made from single piece alluminium alloy suitable for attachment to a pole by either.

- a) 16 mm galvanized steel bolt or
- b) Two stainless steel straps.

5.3.4.2 The Suspension Bracket shall be provided with an upper bulge to prevent the clamp from turning over on the Bracket for more than 45° from the horizontal or to within less than 60 mm from the pole / fixing structure.

5.3.4.3 The Suspension Bracket should be so designed to ensure that the articulated link cannot slip out of it.

5.3.4.4 Suspension Brackets shall be designed to withstand a load applied at the anchoring point of the movable link as per Table – 9 below without deformation of more than 10mm or breakdown at 330° below horizontal (there should be no longitudinal component of load parallel to the plane of fixing).

**Table - 9**

Conductor Size Sq. mm.	Dia. (mm)	Normal rating (kg)	Load (N)
25-35	8-11	1500Kg.	12500
70-95	13-17	2000Kg.	14000

5.3.5 Movable (Articulated) Link of SA

5.3.5.1 Movable Links are used between the Suspension Bracket and Suspension Clamp to allow a degree of movement and flexibility between the two.

5.3.5.2 Moveable Links should be made fully of insulating type of mechanical and weather resistant thermoplastic. A metallic wear resistant ring should however be fitted at point of contact between the Suspension Bracket and the movable link.

5.3.5.3 The Movable link should be unloosably fitted to the Bracket and the Clamp.

5.3.6 Suspension Clamp of SA

5.3.6.1 Suspension Clamps are used for locking the messenger of the ABC bundle without damaging the insulation or allowing the messenger to become dismounted from the fitting.

5.3.6.2 The Suspension Clamp shall accommodate messenger wires from 25 to 95 sq.m.

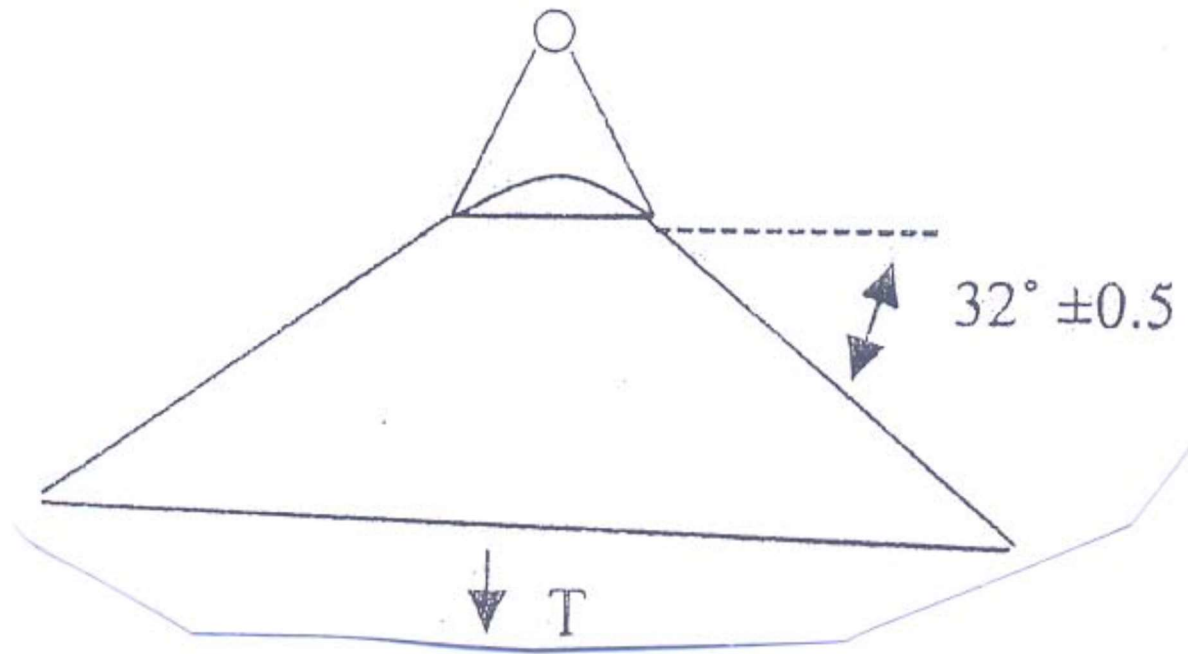
5.3.6.3 The Suspension Clamp shall be made fully of insulating type of mechanically strong and weather resistant plastic.

- 5.3.6.4 Bolts should not be used for clamping / locking the messenger in the Clamp.
- 5.3.6.5 There shall be no losable parts in the Suspension clamp.
- 5.3.6.6 The Suspension Clamp should be unloosably fitted to the rest of the Suspension Assembly.
- 5.3.7 Mechanical Test on Clamp of SA
- 5.3.7.1 The Sub Assembly shall be subjected to a vertical load applied as per drawing in accordance with Table-10. There shall be no breakdown or permanent deformation at load T initial for 1 minute or when the load is increased to T final and released.

**Table - 10**

Conductor Size		Rating (Kg.)	T start (I	T final
Sq. mm.	Dia. (mm)		minute) (Newtons)	(I minute) (Newtons)
25-54	8-15	1500 Kg.	9,600	12,000
70-95	13-17	2000 Kg.	12,800	16,000

Fig. : A



5.3.7.2 A sample messenger shall be fitted into a fixed suspension clamp and subjected to a gradually applied longitudinal load of 300 N. There shall be no permanent slip page.

#### 5.3.8 Voltage Test of SA

A copper foil is wrapped at the clamping point around the maximum size of messenger allowed in that clamp. An ac voltage of 6 KV is applied between the copper foil and nearest conductive point of the clamp or into its absence to the point of fixation. The voltage should be withstood for 1 minute without breakdown or flashover.

#### 5.3.9 Test Under Mechanical & Thermal Stress

5.3.9.1 The test specimen is made up of approx. 10mts. Of messenger wire strung between two anchor clamps with a Suspension Clamp fixed in the middle. Masses of 40 Kg. are suspended at a distance of 1-2mtr. On either side of the Suspension Clamp with a fixing mechanism of mass 2 + 1 Kg.



5.3.9.2 The specimen is subjected to 500 cycles of 90 minutes each. Each cycle consists of the following:

- a) For first 75 minutes a constant longitudinal tension of 4000 N is applied to the messenger for rating of 1500 Kg. and of 4500 N rating of 2000 Kg. while 64cycles right and left oscillation are produced on the clamp 32°on either side of the vertical.
- b) During the first 45 minutes an intermittent current of 4-5 A/sq.mm is applied to maintain the conductor temp at  $60 + 3^{\circ}$  C.
- c) During the next 45 minutes of the cycle the conductor is allowed to cool down naturally to the ambient.
- d) At the 75th minute, after having completed 64 oscillations, the oscillations are stopped and the longitudinal tension is increased to 7500 N for 1500 kg. Rating and 10000 N for 2000 Kg. Rating.

3.9.3 No messenger slippage should occur within the Suspension Clamp during the 500cycles.

5.3.9.4 At the end of the 500 cycles, the messenger is immersed in water for 30 minutes. It is then tested to withstand 10 kV ac for 1 minute with a trip setting of  $10 + 0.5$  mA. There should be no breakdown or flashover.

#### 5.4 Acceptance Tests

5.4.1 The following shall constitute Acceptance Tests for Insulation Piercing Connectors(IPC) :

- Visual \*
- Dimensional (as per SCD and overall dimensions submitted with Tender Offer)\*
- ~~Electrical Ageing Test \*\*\*~~
- Dielectric and Water Tightness Test. \*\*
- Mechanical Tightening Test \*\*
- Effect of Tightening on Main Core \*\*
- Effect of Tightening on Branch Core \*\*

The above tests are to be carried out as per sampling plan below. ~~However electrical ageing test on IPC (market\*\*\*) is to be done on only one connector of each type and size.~~

In case of random failure/defect, double the sample lot is to be drawn and there should be no failure/defect exceeding half the permissible defects (rounded down) shown in the chart.

Lot Size	For tests Marked*		For tests Marked**	
	Sample Size	Max. permissible Defects	Sample Size	Max. permissible Defects
Upto 100	2	nil	2	nil
101 to 1000	6	nil	4	nil
>1001	0.01% subject to min. 6 pieces	0.1% of pieces checked	4	nil

5.4.2 The following shall constitute acceptance tests for Anchor Assemblies:

- Visual \*
- Dimensional (as per SCD and overall dimensions submitted with Tender Offer)\*
- Mechanical Test on Bracket\*\*
- Mechanical Test on Clamp \*\*
- Voltage Test \*

5.4.3 The following shall constitute acceptance tests for Suspension Assemblies:

- Visual \*
- Dimensional (as per SCD and overall dimensions submitted with Tender Offer)\*
- Mechanical Test on Bracket\*\*
- Mechanical Test on Clamp \*\*
- Voltage Test \*

The above tests (for AA & SA) are to be carried out as per sampling plan below. In case of random failure/defect, double the sample lot is to be drawn and there should be no failure/defect exceeding half the permissible defects (rounded down) shown in the chart.

Lot Size	For tests Marked*		For tests Marked**	
	Sample Size	Max. permissible Defects	Sample Size	Max. permissible Defects
Upto 100	2	nil	1	nil

101 - 500	5	1	2	nil
501 - 2500	10	2	2	nil
2501 & above	10 + 0.2 %	2 + 10% pf addl. Sample quantity	4	1

## 6.0 SERVICE CLAMP

The clamps should be designed to anchor insulated service lines (armoured or unarmoured) with 2/4 conductors.

- The clamps should be made of weather and UV resistant polymer.
- No losable part in the process of clamping arrangement
- The clamp should conform to the standard NFC 33042 or equivalent I.S., if any. No losable
- Breaking Load of the clamp should not be less than 3 KN.

## 7.0 TRANSFORMER CONNECTION

- The connection to the transformer should be made with Pre-Insulated lugs for phase and street lighting conductors and with an Aluminum Lug for neutral Messenger. If the Bus-bars-bars are of copper, the Lugs should be preferably Bi-metallic type.
- The Barrel of the lug normally insulated with an Anti-UV black Thermoplastic tube sealed with a flexible ring. Die reference, size and strip length are to be indicated on the plastic.
- Sizes covered 16-70 & upto 150 m2 Aluminium XLPE insulated cable.
- Reference standard NFC 33021 or equivalent I.S. if any.

## 8.0 JUNCTION SLEEVES

- The sleeves should be Pre-Insulated for phases, neutral messengers and street lighting conductors.
- Sleeve should be made of Aluminum, insulated with an Anti-UV black thermoplastic tube hermetically sealed two ends with 2 flexible rings.
- Die reference, size and strip length are indicated on the sleeve itself.
- Sizes needed : 16-70 & upto 150 mm2 for Aluminum XLPE insulated cable.
- Reference standard : NFC 33021 or equivalent I.S. if any.
- Design as per furnished drawing.

## 9.0 EYE HOOKS

- Eye looks should be designed as to hold suspension clamps and Dead end clamps and to be installed with the pole clamp.
- Eye-hooks should be made of forged Galvanized steel.
- The clamps corrosion resistance should conform the standards I.S. 2629 & I.S.2633.
- Bolts and nuts should be made of hot dip Galvanized steel according to VDE 0210 and VDE 0212.
- Ultimate Tensile strength (UTs) of the clamp should 20 KN.
- Design as per furnished drawing.

## **10.0 SERVICE MAIN DISTRIBUTION BOXES**

### **10.1 Scope**

This Distribution Box should be Weather & Moisture Proof with Spring loaded/Bolt& Nut type Bus Bar system & should be able to carry a current according to specified capacity. It can have 1/3-phase input & provision of 4 to 6 nos. of 3-phase or 1-phase outputs. The box should have the provision for special key for locking & Proper arrangement of sealing. The boxes should be assembled on the pole using Metal Tapes & Buckles or Bolts. No. of Boxes per pole may vary with supporting arrangement for more no. of service connections. The Spring used should be of stainless steel having required capacity to provide suitable pressure in the connector.

### **10.2 Construction**

Distribution Boxes should be designed with Bus Bars with spring action contact, or screw-bolt technique. For spring action contact only insertion of the conductor into the specified groove of the Busbar is sufficient for proper connection whereas for Nut Bolt type proper washers & other accessories are to be provided for connections. It should be used for multiple connections (3-phase or 1-phase) in low voltage Distribution Network. The boxes should be suitable for 1/3-phase (4 crores) inputs & provision for 4 to 6 nos. of 3-phase or 1-phase outputs. Bus bars should be with a continuous pair of contact bars with colour code to facilitate the identification of the correct energy phase.

The box should be able to incorporate the input or output cable dia. Of maximum 16mm. (Equivalent to 120Sq.mm.).

The Boxes should consist of special type Lock & key system as well as provision for sealing for complete protection of the service connection contacts.

### **10.3 Current Ratings**

The maximum current rating should be 140A/200A/250A & concerned authority should have the liberty to choose among the above ratings as per their requirement.

#### **10.4 Voltage Ratings:**

The maximum voltage withstand capacity should be 600V.

#### **10.5 Working Temp**

Safe working temperature should be around 80 C for Outer Box & 100OC for metallic  
Bus bars.

#### **10.6 Materials**

Material used in the manufacturing process of the components of this product should be specified in the respective product drawings & can be summarized as follows :

- Outer Box (Base & Cap) : With UV protection & Flame retardant characteristics(HB, as per UL 94-Tests for Flammability of Plastic materials) & preferably made up of ASA (Achylonitrile Styrene Acrylate).
- Cable Grommets : Ethylene-Propylene Rubber :
- Safety Key : PA 6.6 (Nylon).
- Safety Screw : Stainless Steel or Plating Finished steel.
- Insulation protection as per IP 44.
- Bus bars or Terminal Blocks : PA 6.6 (Nylon), Stainless Steel & Copper.
- Button & Cable Holder : PA 6.6 (Nylon) with 50% Glass Fibre.
- Busbar Insulation :Polymide.

#### **10.7 Locking System**

The boxes should consist of Special type Lock & Key arrangement as well as provision for sealing for complete protection of the service connection contacts.

#### **11.0 G.A. DRAWINGS ETC.**

**11.1** A drawing / picture clearly showing principal parts & dimensions for all products should be submitted along with the offer.

**11.2** The principal outer dimensions of each item, l x b x w in mm and weight in gms should be submitted along with the offer.

**11.3** The Employer may call for samples for verification & evaluation purposes.

**12.0 GENERAL CONDITIONS OF MANUFACTURE**

**13.0 GTP**

The Guaranteed Technical Particulars should be filled up in the given format of GTP.

**14.0 TESTING STANDARD – Given in Annexure 2 & 3.**

Note : 1) Any specific meteorological data other than those listed above applicable for a particular equipment/item will be available in the technical specification for that equipment/item.

2) When values specified above contradicts with respective equipment TS, the later will prevail for that equipment.

3) The atmosphere in the area is laden with industrial and town gases and smoke with dust in suspension during the dry months and subject to tough colder months.

4) Heavy lightning is usual in the area during the months from May to November.

**ANNEXURE-1**

**GENERAL CONDITIONS FOR MANUFACTURE**

The products shall be in accordance recognized standards used in L.T. ABC or equivalent I.S., if any.

- |              |   |   |
|--------------|---|---|
| Marking      | : | Each product shall be clearly identified with manufacturer name or trade mark, reference and capacity of the item and batch no.                             |
| Packaging    | : | Manufacturer shall mention the packaging of each item. Installation instruction should be included in packaging.  |
| Type test    | : | Each supplier should provide type test reports with the offer, carried out in accordance with one of the reference standards in NABL Accredited Laboratory. |
| Routine test | : | Supplier shall provide a control plan, which will be implemented on each item. Routine test reports should be submitted by the                              |

manufacturer with inspection call.

Quality : All suppliers should preferably be ISO-9000 certified.

Anchoring and suspension clamps should be installable on existing poles using appropriate devices (hooks, pigtails, brackets etc.).

All crimped connectors should be installed with mechanical or hydraulic hand crimping tools.

**ANNEXURE – 2****TESTING STANDARDS :**

The Insulating Piercing Connector should conform to following std. :

<b>Tests</b>	<b>Tests Standard / Test Procedure</b>
Corrosion  Qualification Test	<p>As per NF C 33-020 (Jun '98), or equivalent I.S., if any.</p> <p>Exposure in Saline Environment : The exposure should be carried out as per NF en 60068-2-11 (Aug. '99) std. requirement. The concentration of Saline solution must be of <math>5\% \pm 1\%</math> in mass, &amp; the temperature of the test chamber must be maintained at <math>35^{\circ}\text{C} \pm 2^{\circ}\text{C}</math>.</p> <p>Exposure in Sulphur environment saturated of humidity – The exposure should be carried out as per NF T 30-055 (Mar. '74) std. requirement. <math>\text{SO}_2</math> concentration in the chamber should be 0.067% in volume. The temperature of the test chamber should be increased to <math>40^{\circ}\text{C} \pm 3^{\circ}\text{C}</math>.</p> <p>The total test should include four identical periods of 14 days, in which 7 days of exposure in Saline environment &amp; in other 7 days – 8 hrs. cycles in <math>\text{SO}_2</math> environment &amp; 16 hrs. in laboratory environment.</p>
Electrical Ageing Test	<p>As per NF C 33-020 &amp; NF C 33-004 (Jun '98) or equivalent I.S., if any.</p> <p>Total no. of cycles 200, Heating time -60 mins., Cooling time -45 mins., Pause time – 2 mins.</p>
Dielectric Investigation Test in water	<p>As per NF C 33-020 (Jun '98) or equivalent I.S., if any. <math>15^{\circ}\text{C}</math> &amp; <math>30^{\circ}\text{C}</math> &amp; relative humidity between 25% &amp; 75%. The tightening of the connectors should be at minimal value of the torque indicated by the manufacturer. The sample should be placed in tank full of water on 30 cm height, after an immersion length of 30 mins. The set is subjected to a dielectric test under a voltage of 6 KV at industrial frequency during 1 min. No flashover / breakdown should occur at 6 KV during 1 min.</p>



Tests	Tests Standard / Test Procedure
Tests	Tests Standard / Test Procedure
Mechanical Tests	As per NF C 33-020 (Jun '98) or equivalent I.S., if any. For checking electrical continuity, shear heads & mechanical behaviour of the connector's suitable tests as per the above specification have to conduct.

### Capacity needed :

For ABC 16 to 95 mm<sup>2</sup>

Model 1 for customer service

Main 16 to 95 mm<sup>2</sup>

Tap 2.5 to 10 mm<sup>2</sup> (For Street lighting/service connection)

Design as per furnished drawing

Model 2 for customer service

Main 16 to 95 mm<sup>2</sup>

Tap 04 to 35 mm<sup>2</sup> (for distribution box charging)

Design as per furnished drawing

Model 3 for customer service

Main 25 to 95 mm<sup>2</sup>

Tap 25 to 95 mm<sup>2</sup> (For ABC to ABC Tee Joint)

Design as per furnished drawing.

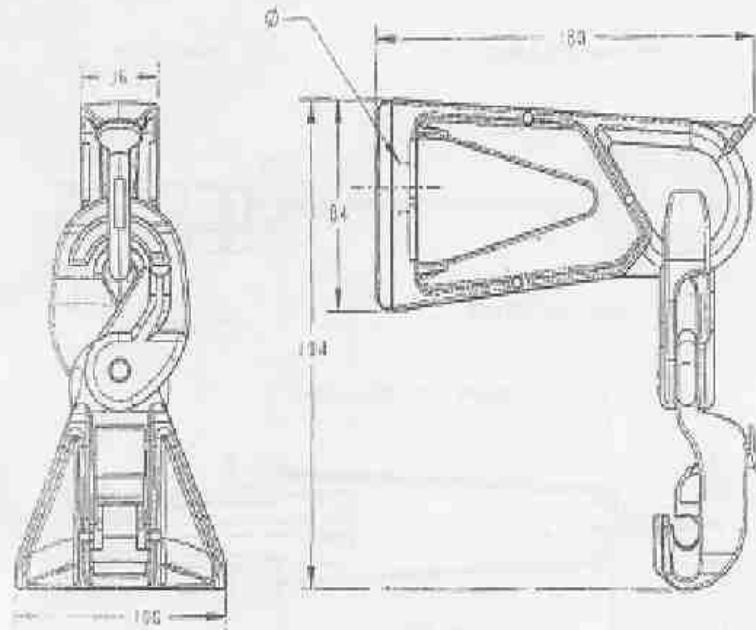
**ANNEXURE – 3****TESTING STANDARDS**

Impact Resistance should be according to UL 746C. Insulation Protection should be as per IP 44. The Outer Plastic box should conform to following std. –

<b>Test / Standard</b>	<b>Requirements</b>	<b>Test Procedures</b>
Degree of Protection IEC 60529	IP 44 – Protected against the penetration of solid objects exceeding 1.0mm in diameter and against penetration of water jets that may affect the product operation.	First Digit : A 1.0mm diameter test wire should not penetrate in any apparent opening (force = 1 N $\pm$ 10%)  Second Digit : A spray nozzle is used to spread a water jet in all possible directions.
Impact Resistance UL 746-C	After the test the product should not show any evidence of : - Live electrical parts accessible to the test probe, as described in this test specification. - Any results, which may affect the mechanical performance of the product. - Any results, which may increase the probability of electrical shocks.	The impact should be generated by dropping a steel ball – with a diameter of 50.8 mm and a mass of 0.535 kg – from a specified height sufficient to produce an impact energy of 6.8 J (0.69 13 kg.m.)
UV Resistance  UL 746-C	The sample physical properties average value after an accelerated aging with UV	According to ASTM G26, Exposure Method 1, Xenon Arc Lamp Type B or

Test / Standard	Requirements	Test Procedures
	radiation – should not be lower than 70% of its initial value,	ASTM G 155, Exposure Cycle I, with continuous
	without aging, that is, a variation of + 30% is allowed.	exposure to light and intermittent exposure to water jets, with programmed cycles of 120 minutes, consisting of a 102 minutes light-only exposure
		and a 18 minutes exposure to light and water jets.
Withstanding Voltage UL 746-C	Product should withstand the specified voltage	A 5 kV voltage should be applied to the samples after the 40 hours conditioning cycle at $23 \pm 2^{\circ}\text{C}$ and $50 \pm 5\%$ relative humidity plus 96 hours at $35 \pm 2^{\circ}\text{C}$ and $90 \pm 5\%$ relative humidity.
Flammability  UL 94	After the UV radiation accelerated aging, the material should maintain the same original flammability level (HB).	The test can be applied to test samples molded with the same material used for the base and the cap of the box or taking a piece of these components.
Flexural Strength  ASTM D790  UL 746-C	After UV radiation accelerated aging, the average value for this test should not be lower than 70% of the original value, that is, a maximum variation of 30% is allowed.	A group of test samples without aging should be tested and the average values calculated. Another group should be aged under UV radiation then it should be tested and the new average should be calculated and compared to the initial average value.

<b>Test / Standard</b>	<b>Requirements</b>	<b>Test Procedures</b>
Tensile Strength	After aging with UV	One of the test bodies must be tested without being
ASTM D638	Radiation, the average value	submitted to accelerated
UL 746-C	should not be lower than 70% of the initial values, that is, a maximum variation of 30% is allowed.	aging and is computed over mean values. Another group is submitted to the radiation induced aging and then tested and the new mean value is computed and compared to the first computed mean value.

**ANNEXURE-A**

Standard : As per NF C 33040

UTS : 4.3KN

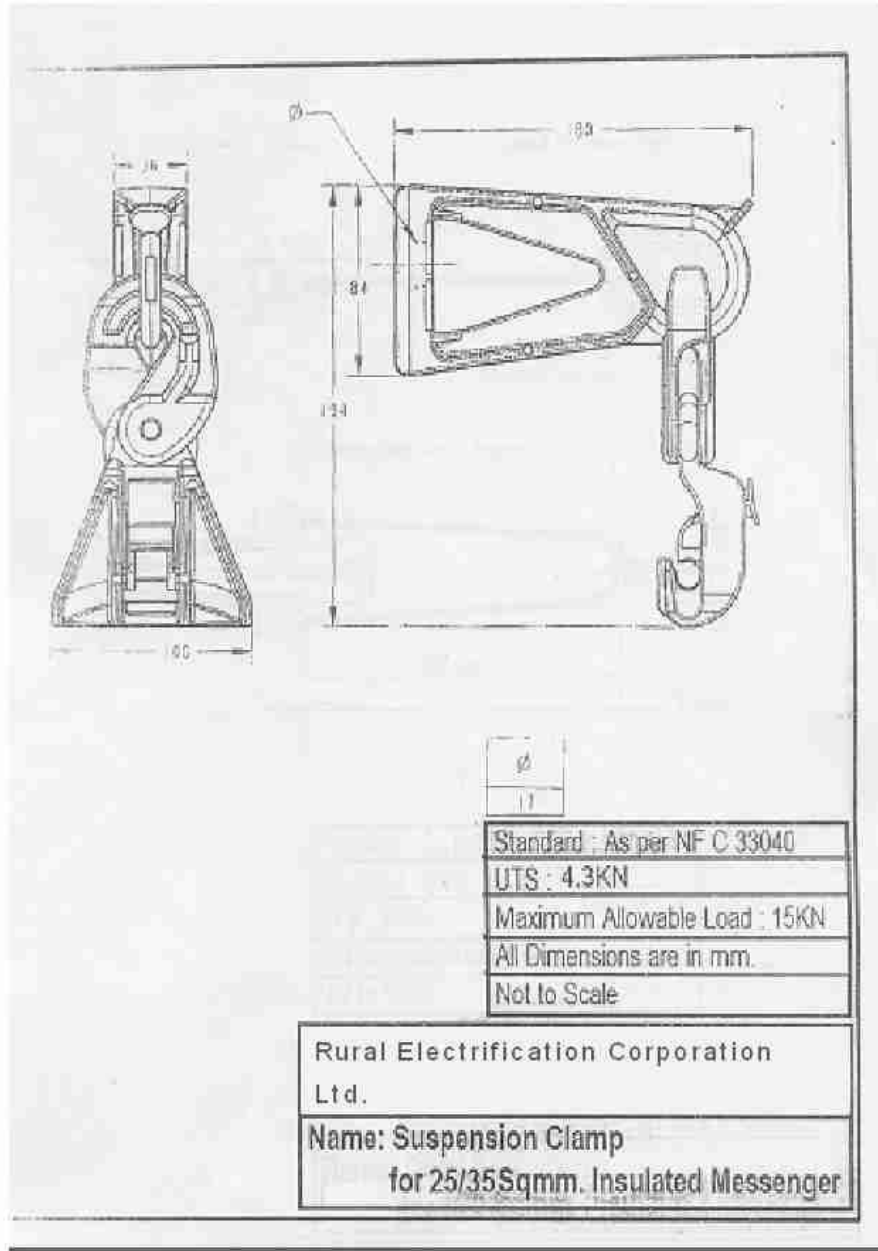
Maximum Allowable Load : 15KN

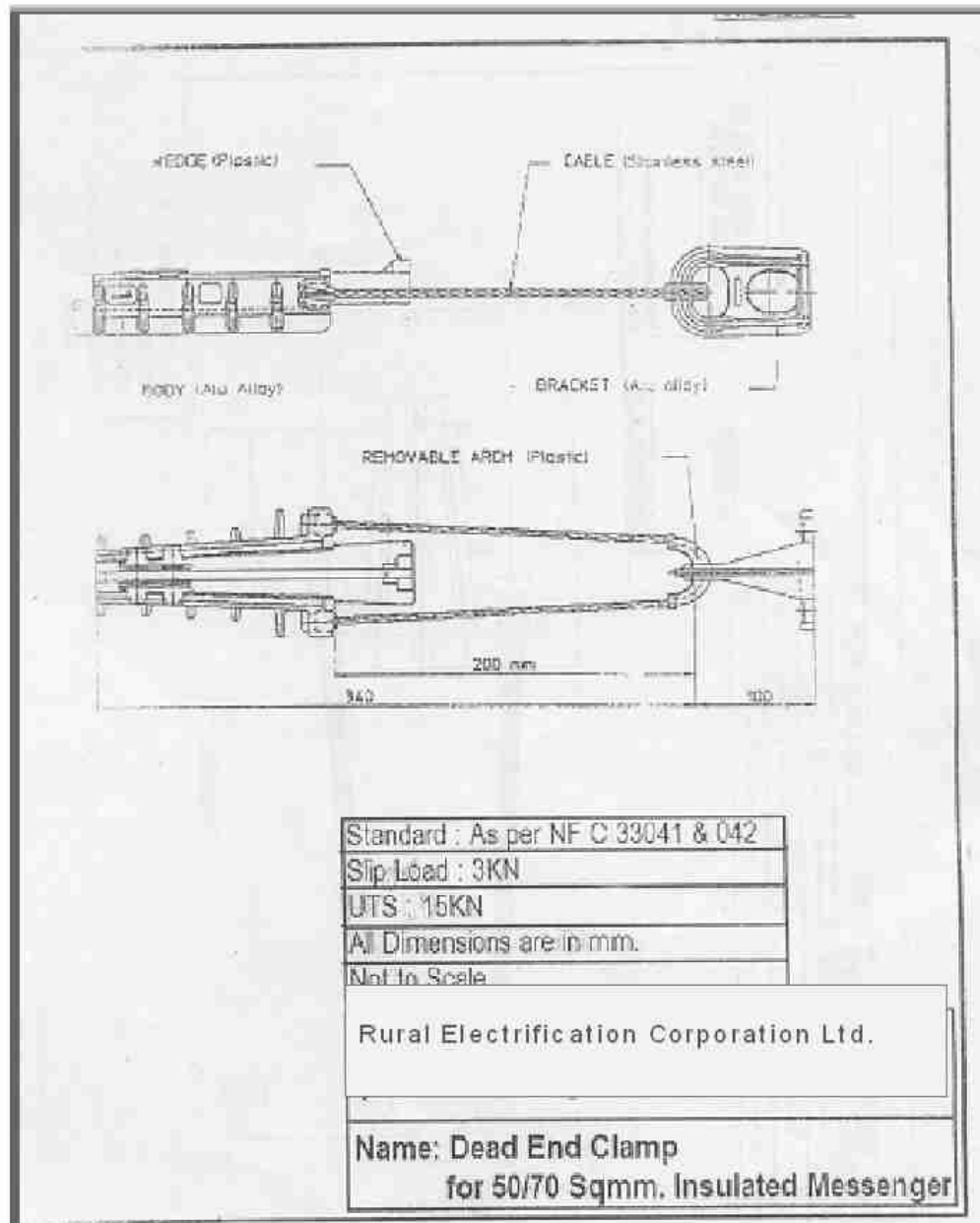
All Dimensions are in mm.

Not to Scale

Rural Electrification Corporation Ltd.

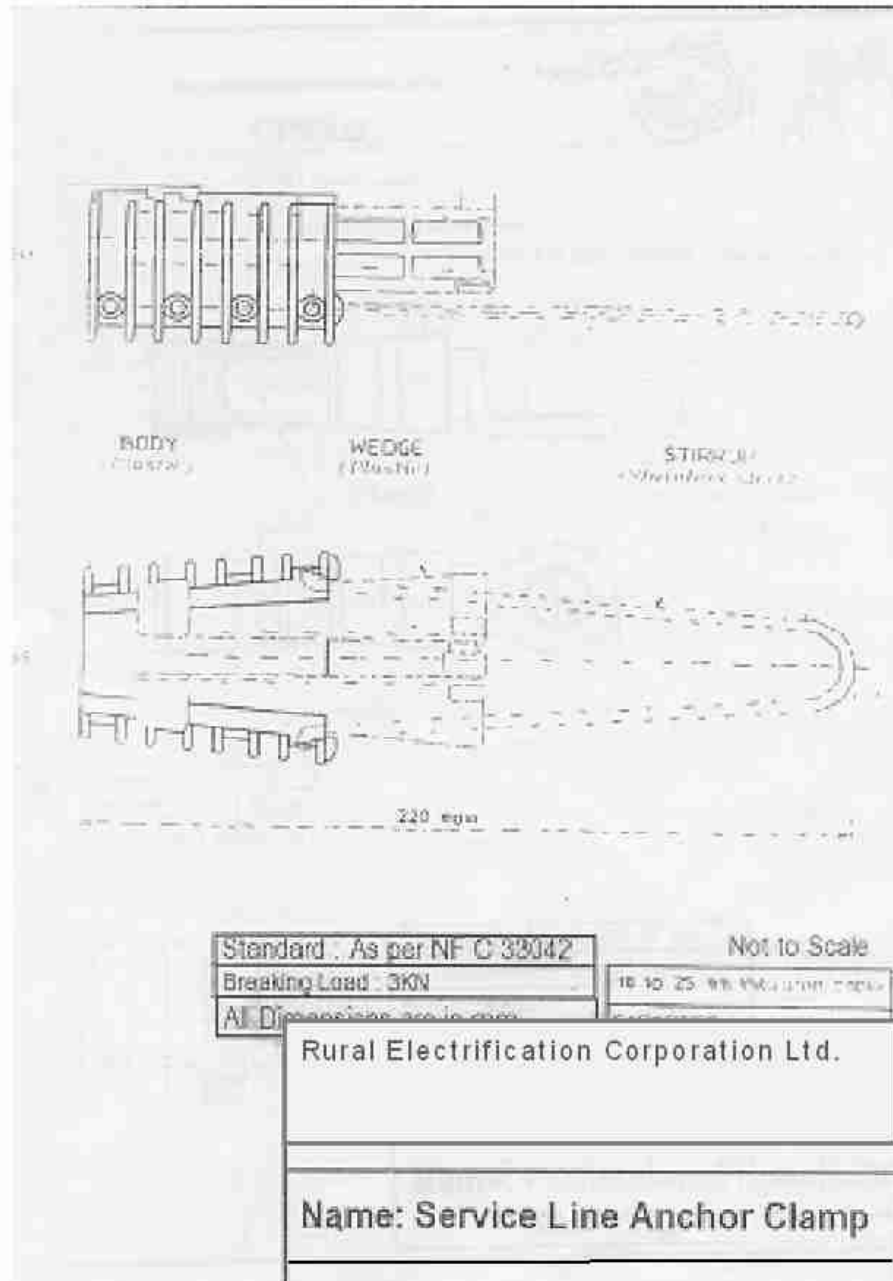
**Name: Suspension Clamp  
for 25/35 Sqmm. Insulated Messenger**

**ANNEXURE-B**

**ANNEXURE-C**

[illegible]



**ANNEXURE-E**

Technical drawing of a Preinsulated Bimetallic Socket. The drawing includes a side view and an end view. Labels indicate the following components: RING (elastomeric), SLEEVE (aluminium), INSULATED COVER (thermo-plastic), Greased, and PALM (copper). Dimensions are provided for various parts, including diameters (ø12, ø14, ø16, ø18, ø20, ø22, ø24, ø26, ø28, ø30, ø32, ø34, ø36, ø38, ø40, ø42, ø44, ø46, ø48, ø50, ø52, ø54, ø56, ø58, ø60, ø62, ø64, ø66, ø68, ø70, ø72, ø74, ø76, ø78, ø80, ø82, ø84, ø86, ø88, ø90, ø92, ø94, ø96, ø98, ø100) and lengths (L, L1, L2, L3, L4, L5, L6, L7, L8, L9, L10, L11, L12, L13, L14, L15, L16, L17, L18, L19, L20, L21, L22, L23, L24, L25, L26, L27, L28, L29, L30, L31, L32, L33, L34, L35, L36, L37, L38, L39, L40, L41, L42, L43, L44, L45, L46, L47, L48, L49, L50, L51, L52, L53, L54, L55, L56, L57, L58, L59, L60, L61, L62, L63, L64, L65, L66, L67, L68, L69, L70, L71, L72, L73, L74, L75, L76, L77, L78, L79, L80, L81, L82, L83, L84, L85, L86, L87, L88, L89, L90, L91, L92, L93, L94, L95, L96, L97, L98, L99, L100).

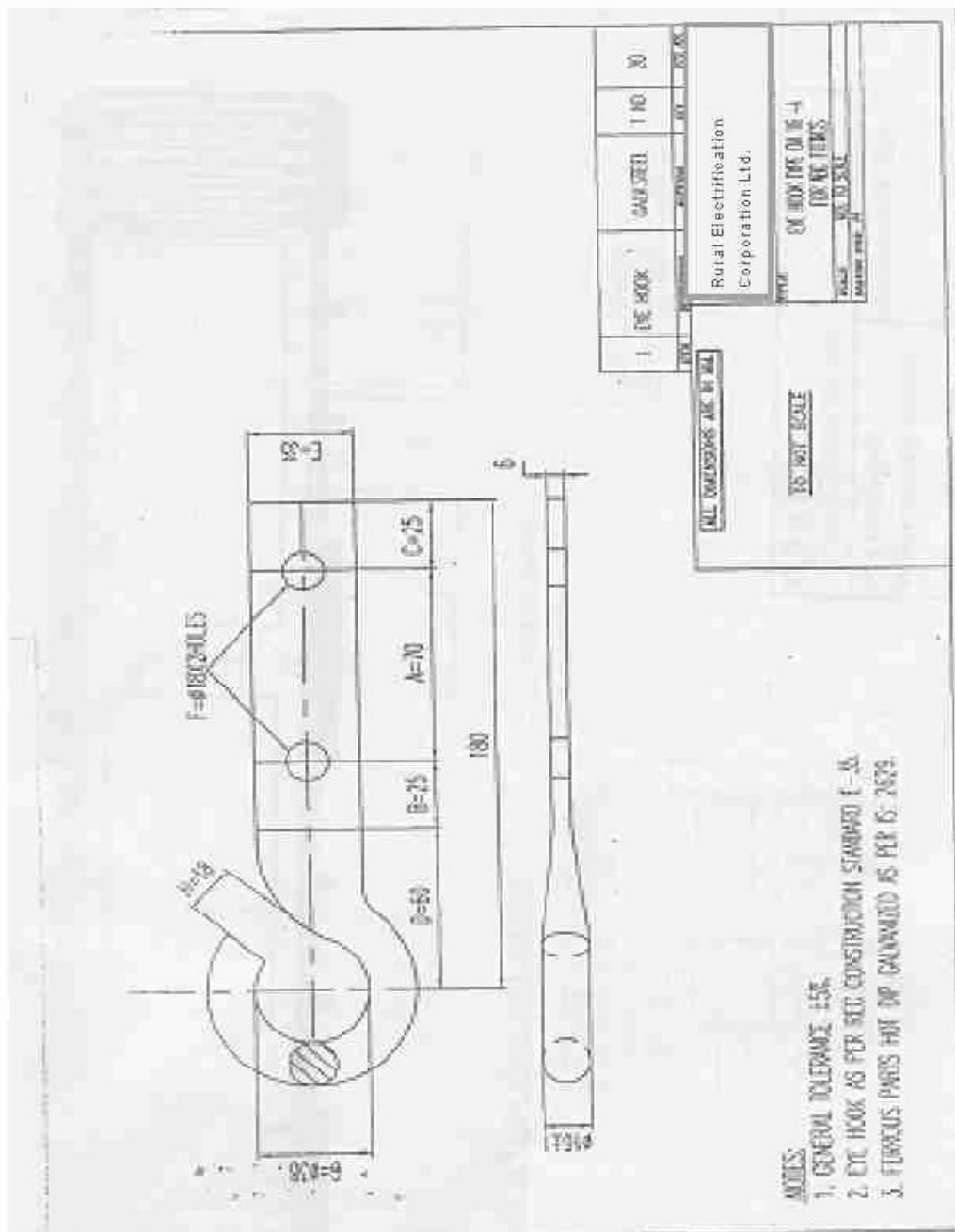
Code	Designation	Material	Dimensions (mm)
1	RING	elastomeric	ø12, ø14, ø16, ø18, ø20, ø22, ø24, ø26, ø28, ø30, ø32, ø34, ø36, ø38, ø40, ø42, ø44, ø46, ø48, ø50, ø52, ø54, ø56, ø58, ø60, ø62, ø64, ø66, ø68, ø70, ø72, ø74, ø76, ø78, ø80, ø82, ø84, ø86, ø88, ø90, ø92, ø94, ø96, ø98, ø100
2	SLEEVE	aluminium	ø12, ø14, ø16, ø18, ø20, ø22, ø24, ø26, ø28, ø30, ø32, ø34, ø36, ø38, ø40, ø42, ø44, ø46, ø48, ø50, ø52, ø54, ø56, ø58, ø60, ø62, ø64, ø66, ø68, ø70, ø72, ø74, ø76, ø78, ø80, ø82, ø84, ø86, ø88, ø90, ø92, ø94, ø96, ø98, ø100
3	INSULATED COVER	thermo-plastic	ø12, ø14, ø16, ø18, ø20, ø22, ø24, ø26, ø28, ø30, ø32, ø34, ø36, ø38, ø40, ø42, ø44, ø46, ø48, ø50, ø52, ø54, ø56, ø58, ø60, ø62, ø64, ø66, ø68, ø70, ø72, ø74, ø76, ø78, ø80, ø82, ø84, ø86, ø88, ø90, ø92, ø94, ø96, ø98, ø100
4	Greased	-	ø12, ø14, ø16, ø18, ø20, ø22, ø24, ø26, ø28, ø30, ø32, ø34, ø36, ø38, ø40, ø42, ø44, ø46, ø48, ø50, ø52, ø54, ø56, ø58, ø60, ø62, ø64, ø66, ø68, ø70, ø72, ø74, ø76, ø78, ø80, ø82, ø84, ø86, ø88, ø90, ø92, ø94, ø96, ø98, ø100
5	PALM	copper	ø12, ø14, ø16, ø18, ø20, ø22, ø24, ø26, ø28, ø30, ø32, ø34, ø36, ø38, ø40, ø42, ø44, ø46, ø48, ø50, ø52, ø54, ø56, ø58, ø60, ø62, ø64, ø66, ø68, ø70, ø72, ø74, ø76, ø78, ø80, ø82, ø84, ø86, ø88, ø90, ø92, ø94, ø96, ø98, ø100

Standard : As per NF C 33021  
 All Dimensions are in mm  
 Not to Scale

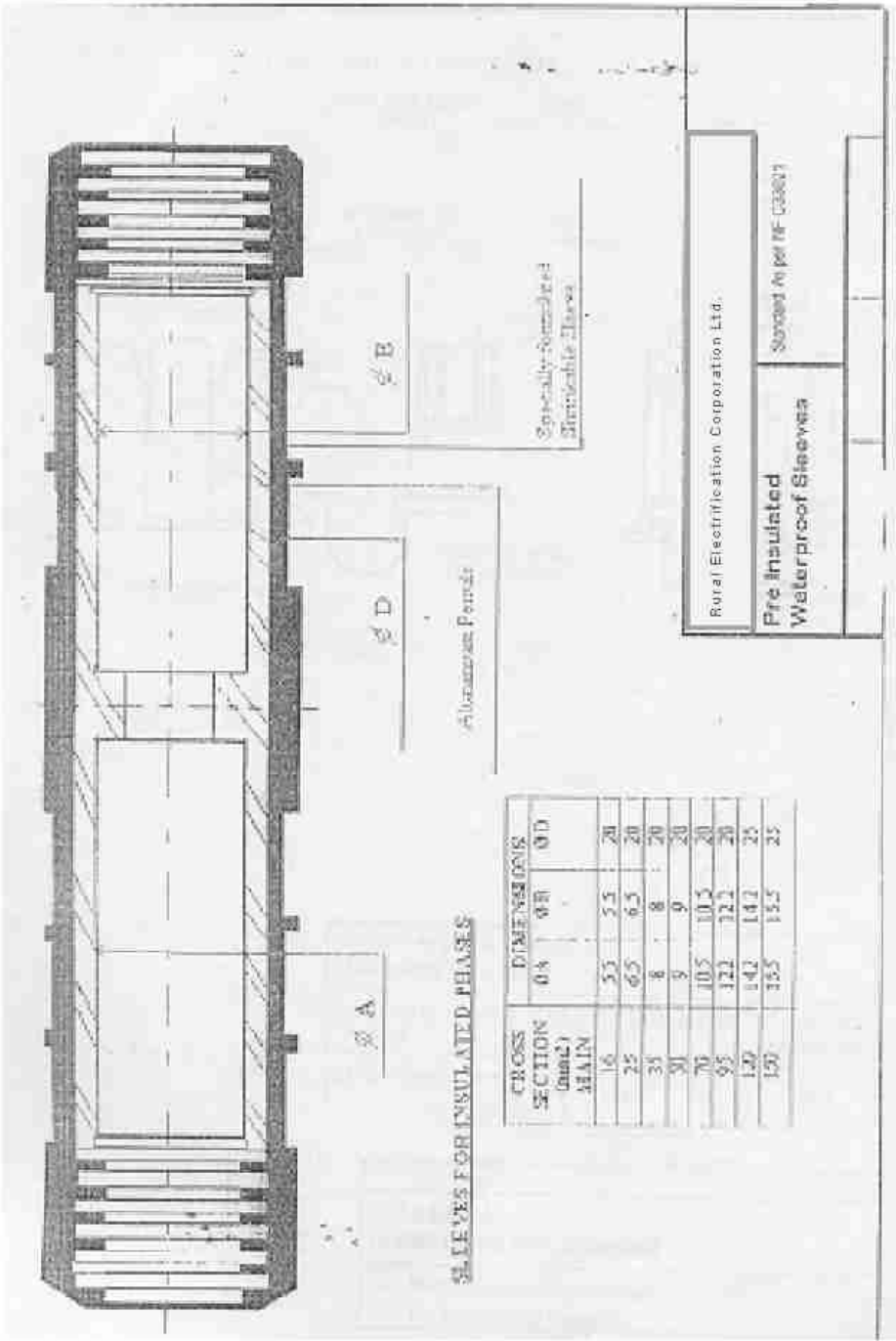
Rural Electrification Corporation Ltd.

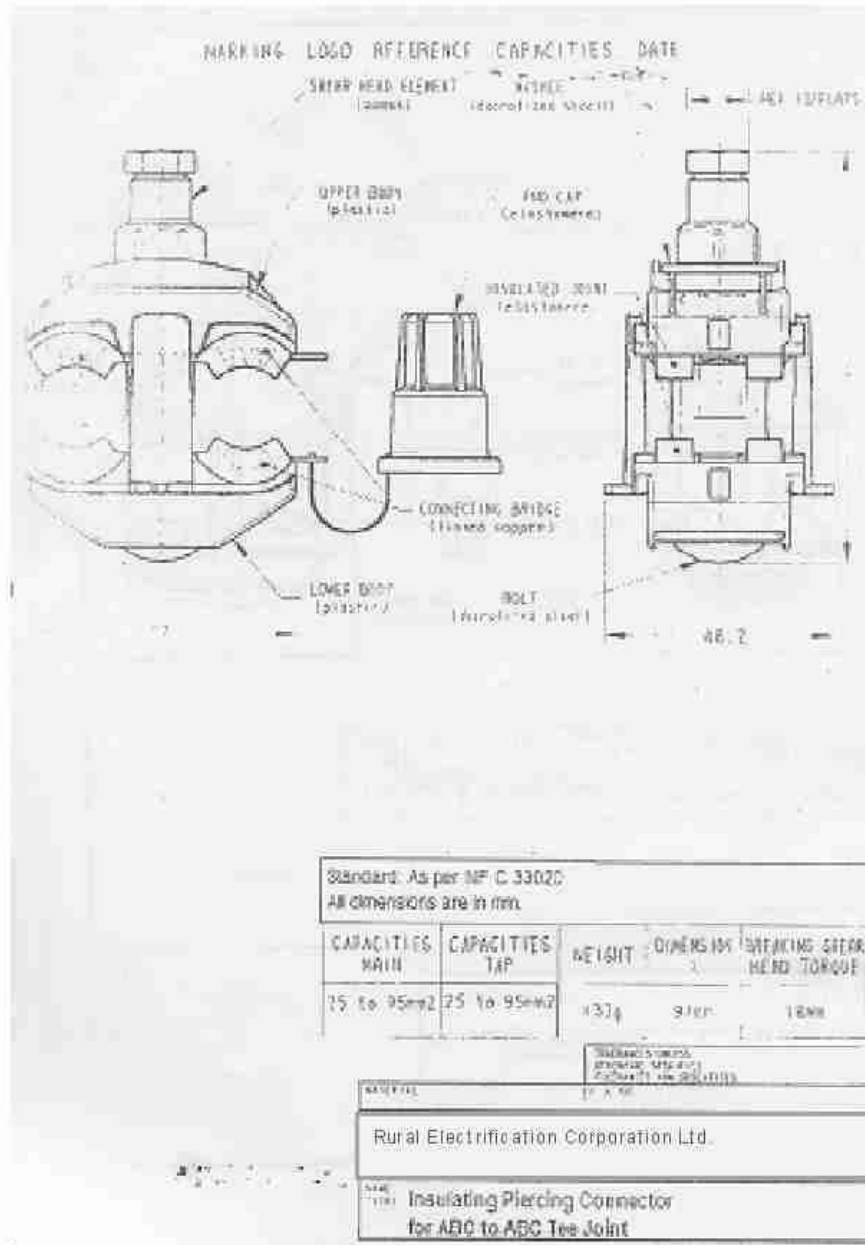
Name: Preinsulated Bimetallic Socket. (For Transformer Switching)

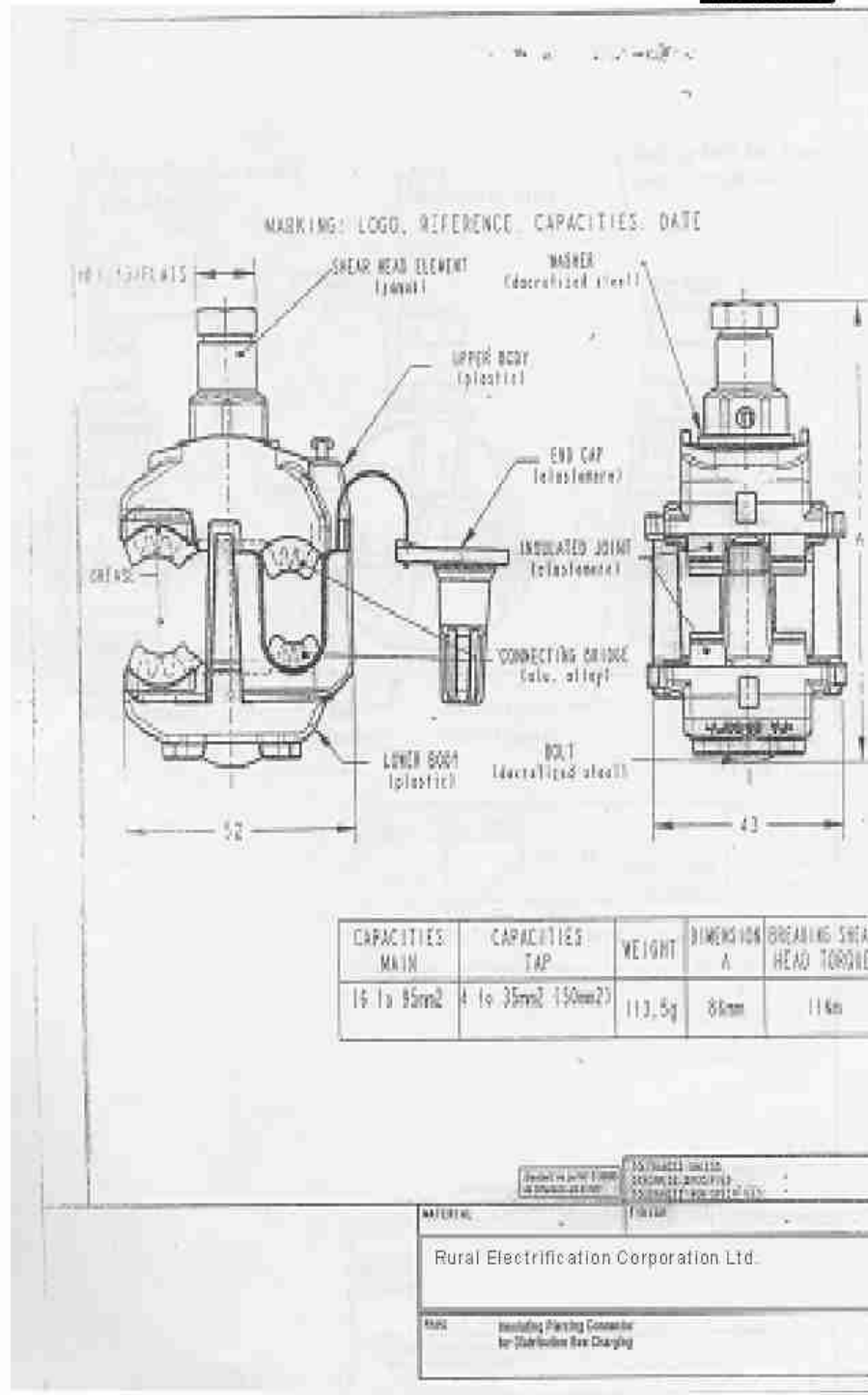
**ANNEXURE-G**



ANNEXURE-H



**ANNEXURE-I**

**ANNEXURE-J**



**23. 11 kV Drop Out Fuse Cut Outs****1. SCOPE**

This specification covers outdoor, open, drop-out expulsion type Fuse Cutouts suitable for installation in 50 Hz, 11 KV distribution system.

**2. APPLICATION**

The distribution fuse cutouts are intended for use in distribution transformers and have no inherent load break capacity.

**3. APPLICABLE STANDARD**

Unless otherwise modified in this specification, the cutout shall conform to IS:9385 (Part-I to III) as amended from time to time.

**4. RATED VOLTAGE**

The rated voltage shall be 12 KV.

**5. RATED CURRENT**

The rated current shall be 100 A.

**6. RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE VALUES FOR THE FUSE BASE**

The rated lightning impulse withstand voltages both for positive and negative polarities shall be as given below:

- |   |              |
|---|--------------|
| a) To earth and between poles                 | 75 KV (Peak) |
| b) Across the isolating distance of fuse base | 85 KV (Peak) |

**7. RATED ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE (DRY & WET) VALUES FOR THE FUSE BASE**

- |                                  |             |
|----------------------------------|-------------|
| a) To earth and between poles    | 28 KV (rms) |
| b) Across the isolating distance | 32 KV (rms) |

**8. TEMPERATURE RISE LIMIT (In Air)**

- |  |      |
|--|------|
| a) Copper contacts silver faced  | 65°C |
| b) Terminals   | 50°C |
| c) Metal parts acting as springs. - The temp. shall not reach such a value that elasticity of metal is changed |      |



## **9. RATED BREAKING CAPACITY**

The rated breaking capacity shall be 8 KA (Asymmetrical).

## **10. GENERAL REQUIREMENTS/CONSTRUCTIONAL DETAILS**

**10.1** The cutouts shall be of single vent type (downward) having a front connected fuse carrier suitable for angle mounting.

**10.2** All ferrous parts shall be hot dip galvanised in accordance with the latest version of IS:2633. Nuts and bolts shall conform to IS:1364. Spring washers shall be electro-galvanised.

**10.3** Typical constructional details of the fuse cutout are shown in Fig. 1

## **11. FUSE BASE TOP ASSEMBLY**

**11.1** The top current carrying parts shall be made of a highly conductive copper alloy and the contact portion shall be silver plated for corrosion resistance and efficient current flow. The contact shall have a socket cavity for latching and holding firmly the fuse carrier until the fault interruption is completed within the fuse.

**11.2** The top contact shall be actuated by a strong steel spring which keeps it under sufficient pressure to maintain a firm contact with the fuse carrier during all operating conditions. The spring shall also provide flexibility and absorbs most of the stresses when the fuse carrier is pushed into the closing position.

**11.3** The current carrying parts of the assembly shall be protected from water and dust formation by a stainless steel top cover.

**11.4** The top contact assembly shall have a robust galvanised steel hook to align and guide the fuse carrier into the socket latch even when the fuse carrier is closed at an off-centre angle.

**11.5** The top assembly shall have an aluminum alloy terminal connector (refer clause 19).

**11.6** The top assembly shall be robust enough to absorb bulk of the forces during the fuse carrier closing and opening operations and shall not over-stress the spring contact. It shall also prohibit accidental opening of the fuse carrier due to vibrations or impact.

## **12. FUSE BASE BOTTOM ASSEMBLY**

**12.1** The conducting parts shall be made of high strength highly conductive copper alloy and the contact portion shall be silver plated for corrosion resistance and

shall provide a low resistance current path from the bottom fuse carrier contacts to the bottom terminal connector.

- 12.2** The bottom assembly shall have hinge contacts made from highly conductive, anti-corrosive copper alloy and shall accommodate and make a firm contact with the fuse carrier bottom assembly. The fuse carrier shall be placed easily in or lifted from The hinges without any maneuvering. In addition, the bottom assembly shall perform the following functions :-

- i) When opened manually or after fault interruption the fuse carrier shall swing through 180° to the vertical and its further travel shall be prevented by the fuse base bottom assembly.
- ii) The fuse carrier shall be prevented from slipping out of the self locking hinges during all operating conditions and only when the fuse carrier has reached its fully open position can it be removed from the hinge support.

- 12.3** The assembly shall have an aluminium alloy terminal connector (refer clause 19).

### **13. FUSE CARRIER TOP ASSEMBLY**

- 13.1** The fuse carrier top contact shall have a solid replaceable cap made from highly conductive, anti-corrosive copper alloy and the contact portion shall be silver plated to provide a low resistance current path from the Fuse Base Top Contact to the Fuse Link. It shall make a firm contact with the button head of the fuse link and shall provide a protective enclosure to the fuse link to check spreading of arc during fault interruptions.

- 13.2** The fuse carrier shall be provided with a cast bronze opening eye (pull ring) suitable for operation with a hook stick from the ground level to pull-out or close-in the fuse carrier by manual operation.

### **14. FUSE CARRIER BOTTOM ASSEMBLY**

- 14.1** The fuse carrier bottom assembly shall be made of bronze castings with silver plating at the contact points to efficiently transfer current to fuse base. It shall make smooth contact with the fuse base bottom assembly during closing operation.

- 14.2** The bottom assembly shall have a lifting eye for the hook stick for removing or replacing the fuse carrier.

- 14.3** The bottom assembly shall have a suitable ejector which shall perform the following functions :

- i) It shall keep the fuse link in the centre of fuse tube and keep it tensioned under all operating conditions.

ii) It shall be capable of absorbing the shock when the fuse carrier is pushed into the closed position and shall not allow the fuse link to be damaged. This is specially important when the fuse link is of low-ampere rating.

iii) The ejector at the instant of interruption shall retain the fuse carrier in the closed position long enough to ensure that the arc is extinguished within the fuse tube thereby excluding the possibility of arcing and subsequent damage at the contact surfaces.

iv) The ejector shall help the fuse link separation after fault interruption, allowing the fuse carrier to drop out and clearing the pigtail of the blown fuse link through the bore of fuse tube.

#### **15. FUSE BASE (PORCELAIN)**

The fuse base shall be a bird-proof, single unit porcelain insulator with a creepage distance (to earth) not less than 320mm. The top and bottom assemblies as also the middle clamping hardware shall be either embedded in the porcelain insulator with sulphur cement or suitably clamped in position. For embedded components, the pull out strength should be such as to result in breaking of the porcelain before pull out occurs in a test. For porcelain insulators, the beam strength shall not be less than 1000 Kg.

#### **16. FUSE TUBE**

The fuse tube shall be made of fibre glass coated with ultraviolet inhibitor on the outer surface and having arc quenching bone fibre liner inside. The tube shall have high bursting strength to sustain high pressure of the gases during fault interruption. The inside diameter of the fuse tube shall be 17.5mm. The

solid cap of the fuse carrier shall clamp the button head of the fuse link, closing the top end of the fuse tube and allowing only the downward venting during fault interruption.

#### **17. TYPE TESTS**

The cutout shall be subjected to the following type tests :

i) Dielectric tests (rated impulse withstands and rated one minute power frequency with stand test voltages)

ii) Temperature rise test

The above tests shall be carried out in accordance with IS:9385 Part I & II.

**For Porcelain Fuse Base only.**

- iii) Pull out test for embedded components of the fuse base
- iv) Beam strength of porcelain base

## **18. MOUNTING ARRANGEMENT**

- 18.1** The cutouts shall be provided with a suitable arrangement for mounting these on 75x40mm or 100x50mm channel cross arm in such a way that the centre line of the fuse base is at an angle of 15° to 20° from the vertical and shall provide the necessary clearances from the support. Mounting arrangement shall be made of high strength galvanised steel flat and shall be robust enough to sustain the various stresses encountered during all operating conditions of the cutout. For more details see enclosed figure 2.
- 18.2** Strength of the component marked 1 (see figure) shall be determined by clamping the member with the shorter leg at the top to a rigid support by M-10 carriage bolts. A downward force shall be applied along the axis of M-14 carriage bolt parallel to the longer leg and in the direction of longer leg of the member under test. A load of 50 Kg. shall be applied and then removed to take up any slack in the mounting arrangement before the measurement of position is taken, the permanent set measured at the axis of the M-14 carriage bolt shall not exceed 1.6mm when a load of 425 Kg. is applied and removed.
- 18.3** The strength of the M-14 bolt shall in no case be less than 1900 Kg. and the strength of M-10 bolts not less than 3500 Kg.

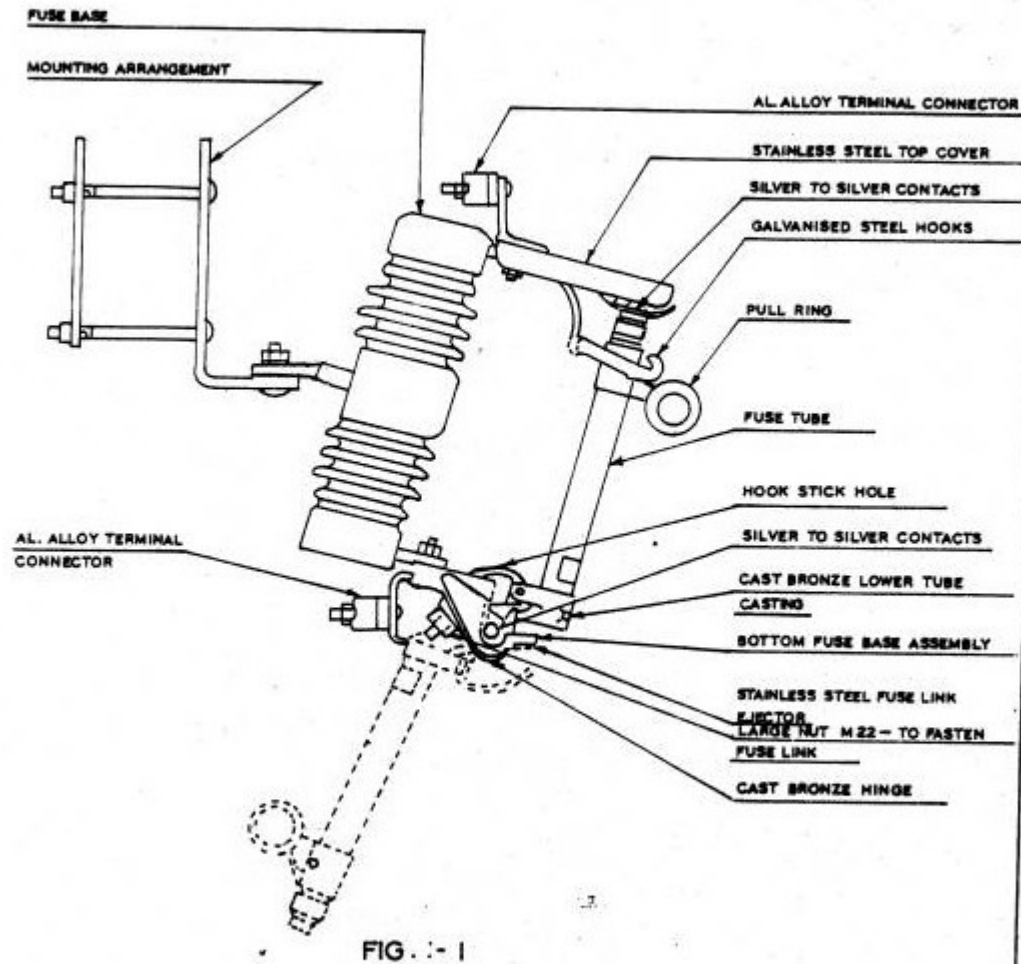
## **19. TERMINAL CONNECTIONS**

The cut-out shall be provided with two aluminium alloy (alloy designation 2280 (A-11) as per IS:617-1975) terminal connectors at top and bottom of fuse base assemblies to receive aluminium conductors of diameters between 6.3mm to 10.05mm. These terminals shall be easily accessible irrespective of the cut-out location with respect to the pole. The terminals shall meet the test requirements of REC Construction Standard.

## **20. INSPECTION**

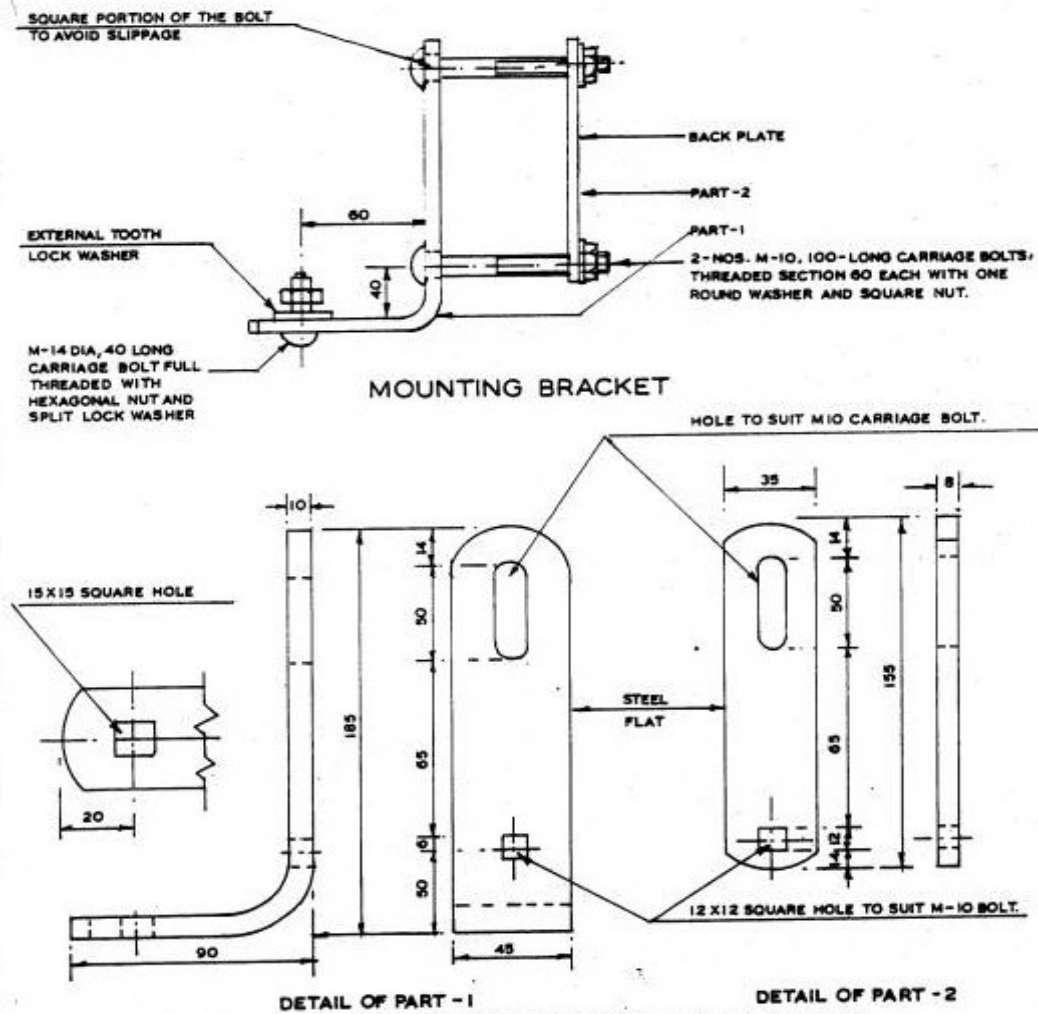
All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and the purchaser at the time to purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities without charge, to satisfy him that the material is being furnished in accordance with this specification.

The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.



११ के. वी. फ्यूज कट-आउट का प्रारूपिक निर्माण विवरण

TYPICAL CONSTRUCTIONAL DETAILS OF 11KV  
FUSE CUT-OUT



ALL DIMENSIONS ARE IN mm.

११ के.वी. ड्रॉप-आउट  
फ्यूज कटआउट  
11KV DROP-OUT FUSE  
CUTOUT

SCALE :- N.T.S

JULY, 1987

## **24. 33 & 11 kV Station Class Lightning Arrestor & 11 kV Distribution Class Surge Arrestors**

### **1. 33kV VOLTAGE CLASS SURGE ARRESTORS**

Lightning Arrestors at Grid Substation shall be of Station class only in 33 & 11 KV System.

#### **1.1. INTRODUCTION**

The section covers the specification of 33kV voltage level, 10 kA, and Station class heavy duty, gapless metal (zinc) oxide Surge Arrestors complete with insulating base, terminal clamps, complete fittings & accessories for installation on outdoor type 33kV switchgear/transmission lines / transformers.

#### **1.2. STANDARDS**

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material and processes shall conform to the latest applicable Indian/International Standards as listed hereunder:

IS:2071-1993 (Part-1)	Methods of High Voltage Testing General Definitions & Test Requirements.
IS:2071-1974(Part-2)	Test Procedures
IS:2629-1985	Recommended Practice for hot dip galvanizing on Iron & Steel
IS:2633-1986	Method for Testing uniformity of coating of zinc coated Articles.
IS:3070-1993 (Part – 3)	Specification for surge arrestor for alternating current systems. Metal-Oxide lightening Arrestors without gaps
IS:4759-1996	Specification for hot dip zinc coating on Structural Steel and Other allied products.
IS:5621-1980	Hollow Insulators for use in Electrical Equipment.
IS:6209-1982	Methods of Partial discharge measurement.
IS:6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles
ANSI/IEEE-C.62.11	Metal oxide, Surge Arrestor for AC Power Circuits.
IEC –60099-4	Surge Arrestors

The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

**1.3. GENERAL REQUIREMENT**

- 1.3.1. The metal oxide gap less Surge Arrestor without any series or shunt gap shall be suitable for protection of 33kV switchgear, transformers, associated equipment and 33 kV lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances.
- 1.3.2. The surge arrestor shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
- 1.3.3. The surge arrestor shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified creepage distance.
- 1.3.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
- 1.3.5. The surge arrestor shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrestor shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing system to the Surge Arrestor.
- 1.3.6. The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.
- 1.3.7. The surge arrestor shall be suitable for circuit breaker performing 0-0.3sec.-CO-3 min-CO- duty in the system.
- 1.3.8. Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain/silicon polymeric housing and providing path for flow of rated fault currents in the event of arrestor failure.
- 1.3.9. The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 1.3.10. The arrestors for 33 kV system shall be suitable for mounting on transformers, Bus, Line & structure as per scheme. The supplier shall furnish the drawing indicating



the dimensions, weights etc. of the surge arrestors for the design of mounting Structure.

- 1.3.11. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

#### 1.4. **ARRESTOR HOUSING**

- 1.4.1. The arrestor housing shall be made up of porcelain/**silicon polymeric** housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown (**for porcelain**)/Grey (**for silicon polymeric**) colour, free from blisters, burrs and other similar defects.

Arrestors shall be complete with fasteners for stacking units together and terminal connectors.

- 1.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrestor. The arrestors shall not fail due to contamination. The 33 kV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.

- 1.4.3. Sealed housings shall exhibit no measurable leakage.

#### 1.5. **FITTINGS & ACCESSORIES**

- 1.5.1. The surge arrestor shall be complete with fasteners for stacking units together and terminal connectors.

- 1.5.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take off.

#### 1.6. **TESTS**

##### 1.6.1. **Test on Surge Arrestors**

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS : 3070 (Part-3)/IEC-60099-4. In addition, the suitability of the surge arresters shall also be established for the followings

i) **Acceptance tests**

- a) Measurement of power frequency reference voltage of arrester units.
- b) Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)
- c) Internal ionization or partial discharge test

ii) **Special Acceptance tests**

- a) Thermal stability test (IEC 99-4 clause 7.2.2)
- b) Watt loss test.

iii) **Routine tests**

- a) Measurement of reference voltage
- b) Residual voltage test of arrester unit
- c) Internal ionization or partial discharge test
- d) Sealing test
- e) Verticality check on completely assembled surge arresters as a sample test on each lot if applicable.

iv) **Type Tests**

Following shall be type test as per IS 3070 (Part 3): 1993 or its latest amendment.

1.	Insulation Withstand test a) Lightning Impulse b) Power Frequency (Dry/Wet)
2.	Residual Voltage Test a) Steep current impulse residual voltage test b) Lightning impulse residual voltage test c) Switching Impulse Residual voltage test
3.	Long duration current impulse withstand test
4.	Switching surge operating duty test
5.	Power frequency voltage Vs. Time characteristics
6.	Accelerated Ageing test
7.	Pressure relief test a) High Current b) Low Current
8.	Artificial pollution test (for porcelain housing)
9.	Seismic Test
10.	Partial Discharge test
11.	Bending test
12.	a) Temperature cycle test (for porcelain housing) b) Porosity test (for porcelain housing)

13.	Galvanising test on metal parts
14.	Seal Leakage test (for porcelain housing)
15.	Seal leak test and operation tests ( for surge monitor)
16.	Weather ageing test (for polymer housing)

1.6.2. The maximum residual voltages corresponding to nominal discharge current of 10 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to **Annex-K of IEC-99-4**.

1.6.3. The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrestor and power frequency voltage v/s time characteristic of the surge arrestor subsequent to impulse energy consumption as per clause 6.6.7 of IS:3070 (Part-3) offered along with the GTP/Drawing.

1.6.4. The surge arrestor housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 5621.

**1.6.5. Galvanization Test**

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS:2633 & IS 6745.

**1.7. NAME PLATE**

1.7.1. The name plate attached to the arrestor shall carry the following information:

- Rated Voltage
- Continuous Operation Voltage
- Normal discharge current
- Pressure relief rated current
- Manufacturers Trade Mark
- Name of Sub-station
- Year of Manufacturer

- Name of the manufacture
- Name of Client-“ “
- Purchase Order Number along with date

#### 1.8. DRAWINGS AND INSTRUCTION MANUALS

Within 15 days of receipt of the order, the successful tenderer shall furnish to the purchaser the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrestor and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Drawings of terminal clamps.
- (iv) Arrangement of earthing lead.
- (v) Minimum air clearance to be maintained of line components to ground.
- (vi) Name plate
- (vii) Instructions manual
- (viii) Drawing showing details of pressure relief valve
- (ix) Volt-time characteristics of surge arrestors
- (x) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

#### 1.9. TECHNICAL PARTICULARS

- 1.9.1. The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

##### System Parameters:

Nominal system voltage	:	33 kV
Highest system voltage	:	36 kV
System earthing	:	Solidly earthed system
Frequency (Hz)	:	50
Lightning Impulse withstand Voltage (kVP)	:	170
Power frequency withstand Voltage (kV rms)	:	70
Connection to system	:	Phase to earth

--	--	--

### 1.9.2. Surge Arrestors

Type of Surge Arrestor	:	Gapless Metal oxide outdoor
Arrestor rating (kV rms)	:	30
Continuous Operating voltage (kV rms)	:	25
Standard Nominal Discharge Current Rating (kA) (8x20 micro impulse shape)	:	10
Line discharge class	:	2
Degree of protection	:	IP-67
Lightning Impulse at 10 kA	:	85
Partial discharge at 1.05 COV not greater than	:	50 (PC)
Energy capability corresponding to		
a) Arrestor rating (kJ/kV)	:	4.5
b) COV (kJ/kV)	:	4.9
Peak current for high current impulse operating duty of arrestor classification 10 kA	:	100

### 1.9.3. Insulator Housing

Power frequency withstand test voltage (wet) (kV rms)	:	70
Lightning impulse withstand/tests voltage (kVP)	:	170
Pressure Relief Class	:	40
Creepage distance not less than	:	900 mm

### 1.9.4. Galvanisation

<u>Fabricated Steel Aticles</u>		
-- 5 mm thick cover	:	610 g/m <sup>2</sup>
-- Under 5 mm but not less than 2 mm thickness	:	460 g/m <sup>2</sup>

-- Under 2 mm but not less than 1.2 mm thickness	:	340 g/m <sup>2</sup>
<u>Castings</u>		
-- Grey Iron, malleable iron	:	610 g/m <sup>2</sup>
<u>Threaded works other than tubes &amp; tube fittings</u>		
-- Under 10 mm dia		270 g/m <sup>2</sup>
-- 10 mm dia & above		i. m <sup>2</sup>

## 2. 11kV VOLTAGE CLASS SURGE ARRESTORS

### 2.1. INTRODUCTION

This section covers the specification of 11kV voltage station Surge Arrestors for installation on outdoor type 11kV switchgear, transmission lines, transformers etc. 11kV side of which is not enclosed in a cable box. Station class surge arrestors shall be complete with fasteners for stacking units.

### 2.2. STANDARDS

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material & processes shall conform to the latest amendments of the following:

IS:2071-1993 (Part-1)	Methods of High Voltage Testing General Definitions & Test Requirements.
IS:2071-1974 (Part-2)	Test Procedures.
IS: 2629-1985	Recommended Practice for hot dip galvanizing on Iron & Steel.
IS: 2633-1986	Method for Testing uniformity of coating of zinc coated Articles.
IS:3070-1993 (Part – 3)	Specification for surge arrestor for alternating current systems. Metal-Oxide lightning Arrestors without gaps.
IS: 4759-1996	Specification for hot dip zinc coating on structural steel and other allied products.
IS: 5621-1980	Hollow Insulators for use in Electrical Equipment.

IS: 6209-1982	Methods of Partial discharge measurement.
IS: 6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles.
ANSI/IEEE-C.62.11	Metal oxide, Surge Arrestor for AC Power Circuits.
IEC –60099-4	Surge Arrestors.

The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

### 2.3. GENERAL REQUIREMENT

- 2.3.1. The metal oxide gap less Surge Arrestor without any series or shunt gap shall be suitable for protection of 11 kV side of power transformers, associated equipment and 11kV lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances.
- 2.3.2. The surge arrestor shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
- 2.3.3. The surge arrestor shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified Creepage distance.
- 2.3.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
- 2.3.5. The surge arrestor shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrestor shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing system to the Surge Arrestor.
- 2.3.6. The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.
- 2.3.7. The surge arrestor shall be suitable for circuit breaker performing 0-0.3 min-CO-3 min-CO- duty in the system.

- 2.3.8. Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain/ silicon polymeric housing and providing path for flow of rated fault currents in the event of arrestor failure.
- 2.3.9. The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 2.3.10. The Surge Arrestor shall be thermally stable and the bidder shall furnish a copy of thermal stability test with the bid.
- 2.3.11. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.
- 2.3.12. The surge arrestor shall be provided with line and earth terminals of suitable size.

#### 2.4. **ARRESTOR HOUSING**

- 2.4.1. The arrestor housing shall be made up of porcelain/**silicon polymeric** housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform **brown (for porcelain)/Grey (for silicon polymeric)** colour, free from blisters, burrs and other similar defects.

Arrestors shall be complete with fasteners for stacking units together and terminal connectors.

- 2.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrestor. The arrestors shall not fail due to contamination. The 11kV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.
- 2.4.3. Sealed housings shall exhibit no measurable leakage.

#### 2.5. **ARRESTOR MOUNTING**

The arrestors shall be suitable for mounting on 4 pole/2 pole structure used for pole/plinth mounted transformer and for incoming and outgoing lines. Arrestor may also be required to be mounted on a bracket provided in the Transformers.

#### 2.6. **FITTINGS & ACCESSORIES**

- 2.6.1. The surge arrestor shall be complete with fasteners and terminal connectors.



- 2.6.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take off.

## 2.7. TESTS

### 2.7.1. Test on Surge Arrestors

**The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS : 3070 (Part-3)-/IEC:600994. In addition, the suitability of the surge arresters shall also be established for the followings.**

#### i) Acceptance tests

- a) Measurement of power frequency reference voltage of arrester units.
- b) Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)
- c) Internal ionization or partial discharge test

#### ii) Special Acceptance tests:

- a) Thermal stability test (IEC clause 7.2.2)
- b) Watt loss test.

#### iii) Routine tests

- a) Measurement of reference voltage
- b) Residual voltage test of arrester unit
- c) Internal ionization or partial discharge test
- d) Sealing test
- e) Verticality check on completely assembled surge arresters as a sample test on each lot if applicable.

#### iv) Type Tests

Following shall be type test as per IS 3070 (Part 3): 1993 or its latest amendment

1.	Insulation Withstand test a) Lightning Impulse b) Power Frequency (Dry/Wet)
2.	Residual Voltage Test a) Steep current impulse residual voltage test b) Lightning impulse residual voltage test

	c) Switching Impulse Residual voltage test
3.	Long duration current impulse withstand test
4.	Switching surge operating duty test
5.	Power frequency voltage Vs. Time characteristics
6.	Accelerated Ageing test
7.	Pressure relief test c) High Current d) Low Current
8.	Artificial pollution test (for porcelain housing)
9.	Seismic Test
10.	Partial Discharge test
11.	Bending test
12.	a) Temperature cycle test (for porcelain housing) b) Porosity test (for porcelain housing)
13.	Galvanising test on metal parts
14.	Seal Leakage test (for porcelain housing)
15.	Seal leak test and operation tests ( for surge monitor)
16.	Weather ageing test (for polymer housing)

- 2.7.2. The maximum residual voltages corresponding to nominal discharge current of 10 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to Annex-K of IEC-99-4.
- 2.7.3. The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrestor and power frequency voltage v/s time characteristic of the surge arrestor subsequent to impulse energy consumption as per clause 6.6 of IS:3070 (Part-3) offered alongwith the bid.
- 2.7.4. The surge arrestor housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS :5621.
- 2.7.5. **Galvanization Test**  
All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS:2633 & IS 6745.

**2.8. NAME PLATE**

**2.8.1.** The name plate attached to the arrestor shall carry the following information:

- Rated Voltage
- Continuous Operation Voltage
- Normal discharge current
- Pressure relief rated current
- Manufacturers Trade Mark
- Name of Sub-station
- Year of Manufacturer
- Name of the manufacture
- Name of Client-
- Purchase Order Number along with date

**2.9. DRAWINGS AND INSTRUCTION MANUALS**

Within 15 days of receipt of the order, the successful tenderer shall furnish to the purchaser, the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrestor and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Drawings of terminal clamps.
- (iv) Arrangement of earthing lead.
- (v) Minimum air clearance to be maintained of line components to ground.
- (vi) Name plate
- (vii) Surge monitor, if applicable.
- (viii) Instructions manual
- (ix) Drawing showing details of pressure relief valve
- (x) Volt-time characteristics of surge arrestors
- (xi) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

**2.10. TECHNICAL PARTICULARS**

- 2.10.1.** The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

**System Parameters**

i)	Nominal system voltage	11kV
ii)	Highest system voltage	12 kV
iii)	System earthing	Effectively earthed system
iv)	Frequency (Hz)	50
v)	Lightning Impulse withstand	75 Voltage (kVP)
vi)	Power frequency withstand	28 Voltage (kV rms)
vii)	Arrestor duty	
	-- Connection to system	Phase to earth
	-- Type of equipment to be protected	transformers & switchgear

**2.10.2. Surge Arrestors**

i)	Type	Gapless Metal oxide outdoor
ii)	Arrestor rating (kV rms)	9
iii)	Continuous Operating voltage	7.65 (kV rms)
iv)	Standard Nominal Discharge Current	10 Rating (kA) (8x20 micro impulse shape)
v)	Degree of protection	IP 67
vi)	Line discharge Class	2
vii)	Steep current at 10 kA	45
viii)	Lightning Impulse at 10 kA	40
ix)	Energy capability corresponding to	
	a) Arrestor rating (kj/kV)	4.5

b) COV (kj/kV) 4.9

x) Peak current for high current 100  
impulse operating duty of Standard TS for  
arrester classification 10 kA

### 2.10.3. Insulator Housing

i) Power frequency withstand test voltage (Wet) (kV rms) 28  
ii) Lightning impulse withstand/test voltage (kVP) 75

### 2.10.4. Galvanisation

i) Fabricated Steel Articles  
a) 5 mm thick cover 610 g/m<sup>2</sup>  
b) Under 5 mm but not less than 2 mm thickness 460 g/m<sup>2</sup>  
c) Under 2 mm but not less than 1.2 mm thickness 340 g/m<sup>2</sup>  
ii) Castings  
Grey Iron, malleable iron 610 g/m<sup>2</sup>  
iii) Threaded works other than tubes & tube fittings  
a) Under 10 mm dia 270 g/m<sup>2</sup>  
b) 10 mm dia & above 300 g/m<sup>2</sup>

NOTE- Surge Monitor shall have to be provided if covered in BPS.

## 3. DISTRIBUTION CLASS SURGE ARRESTORS

To be used in distribution Transformer Substations only.

### 3.1. INTRODUCTION

This section covers the specification of Distribution class Surge Arrestor for 11kV transmission lines, transformers etc.

### 3.2. STANDARDS

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material and processes shall conform to the latest applicable Indian/International Standards as listed hereunder:

IS:2071- 1993 (Part-1)	:	Methods of High Voltage Testing General Definitions & Test
IS:2071-1974 (part-2)	:	Test Procedures
IS:2629-1985	:	Recommended Practice for hot dip galvanizing on Iron & Steel

IS:2633-1986	:	Method for Testing uniformity of coating of zinc coated Articles.
IS3070-1993 (Part-3)	:	Specification for surge arrestor for alternating current systems. Metal-Oxide lightening Arrestors without gaps
IS:4759-1996	:	Specification for hot dip zinc coating on Structural Steel and Other allied products.
IS:5621-1980		Hollow Insulators for use in Electrical Equipment.
IS:6209-1982		Methods of Partial discharge measurement.
IS:6745		Method for determination of mass of zinc coating on zinc coated iron and steel articles
ANSI/IEEE-C.62.11		Metal oxide, Surge Arrestor for AC Power (1982) Circuits.
IEC –60099-4		Surge Arrestors

- 3.2.1. The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

### 3.3. GENERAL REQUIREMENT

- 3.3.1. The metal oxide gap less Surge Arrestor without any series or shunt gap shall be suitable for protection of 11 kV side of Distribution Transformers, associated equipment and 11 kV lines from voltage surges resulting from natural disturbance like lightning as well as system disturbances.
- 3.3.2. The surge arrestor shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
- 3.3.3. The surge arrestor shall consist of non-linear metal oxide resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified Creepage distance.
- 3.3.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
- 3.3.5. The surge arrestor shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrestor shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode. The contractor shall also recommend the procedure which shall be followed in providing the earthing/system to the Surge Arrestor.

- 3.3.6. The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.
- 3.3.7. The surge arrestor shall be suitable for circuit breaker performing 0-0.3 min-CO-3 min-CO- duty in the system.
- 3.3.8. The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 3.3.9. The Surge Arrestor shall be thermally stable and the contractor shall furnish a copy of thermal stability test with the bid.
- 3.3.10. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

#### 3.4. **ARRESTOR HOUSING**

- 3.4.1. The arrestor housing shall be made up of porcelain/*silicon polymeric* housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform **brown (for porcelain)/ Grey (for silicon polymeric)** colour, free from blisters, burrs and other similar defects.
- 3.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrestor. The arrestors shall not fail due to contamination.
- 3.4.3. Sealed housings shall exhibit no measurable leakage.

#### 3.5. **ARRESTOR MOUNTING**

The arrestors shall be suitable for mounting on 4 pole/2 pole structure used for pole mounted transformer and for incoming and outgoing lines.

#### 3.6. **FITTINGS & ACCESSORIES**

- 3.6.1. The surge arrestor shall be complete with disconnecter and terminal connectors and all other accessories.
- 3.6.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take off.

### 3.7. TESTS

#### 3.7.1. Test on Surge Arrestors

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS : 3070 (Part-3)-1993. In addition, the suitability of the surge arresters shall also be established for the followings

a) **Acceptance tests:**

- i) Measurement of power frequency reference voltage of arrester units.
- ii) Lightning impulse residual voltage on arrester units (IEC clause 6.3.2)
- iii) Internal ionization or partial discharge test

b) **Special Acceptance tests:**

- i) Thermal stability test (IEC clause 7.2.2)

c) **Routine tests:**

Measurement of reference voltage

- i) Residual voltage test of arrester unit
- ii) Internal ionization or partial discharge test
- iii) Sealing test
- iv) Verticality check on completely assembled surge arresters as a sample test on each lot if applicable.

d) **Type tests:** Following shall be type test As per IS 3070 (Part 3)-/IEC;60094 or its latest amendment

1.	Insulation Withstand test a) Lightning Impulse voltage test b) Power Frequency (Dry & Wet)
2.	Residual Voltage Test a) Steep current impulse residual voltage test b) Lightning Impulse Residual Voltage Test
3.	Long duration current impulse withstand test
4.	High current impulse operating duty test
5.	Power frequency voltage Vs. Time characteristics
6.	Accelerated Ageing test
7.	Artificial pollution test (for porcelain housing)



8.	Partial discharge test
9.	Visual Examination (for porcelain housing)
10.	a) Temperature cycle test (for porcelain housing)
11.	Mechanical Failing Load test (Bending Strength test)
12.	Uniformity of Zinc coating, Mass of zinc coating
13.	Time versus current curve (for disconnector)
14.	Weather ageing test (for polymer housing)

3.7.2. The maximum residual voltages corresponding to nominal discharge current of 5 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to Annex-K of IEC-99-4.

3.7.3. The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrestor and power frequency voltage v/s time characteristic of the surge arrestor subsequent to impulse energy consumption as per clause 6.6.7 of IS:3070 (Part-3) offered alongwith the GTP.

3.7.4. The surge arrestor housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 5621

**3.7.5. GALVANIZATION TEST**

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS:2633 & IS 6745.

**3.7.6. TEST ON SURGE ARRESTOR DISCONNECTORS**

The test shall be performed on surge arrestors which are fitted with arrestor disconnector or on the disconnector assembly alone if its design is such as to be unaffected by the heating of adjacent parts of the arrestor in its normally installed portion in accordance with IS:3070 (Part-3)

**3.8. NAME PLATE**

3.8.1. The name plate attached to the arrestor shall carry the following information:

- Rated Voltage

- Continuous Operation Voltage
- Normal discharge current
- Manufacturers Trade Mark
- Year of Manufacturer
- Name of the manufacture
- Name of Client-
- Purchase Order Number along with date

### **3.9. DRAWINGS AND INSTRUCTION MANUALS**

The successful bidder shall furnish to the purchaser the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrestor and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Drawings of terminal clamps.
- (iv) Arrangement of earthing lead.
- (v) Minimum air clearance to be maintained of line components to ground.
- (vi) Name plate
- (vii) Instructions manual
- (viii) Drawing showing details of pressure relief valve
- (ix) Volt-time characteristics of surge arrestors
- (x) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

### **3.10. TECHNICAL PARTICULARS**

- 3.10.1.** The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

**System Parameters**

i)	Nominal system voltage	11kV
ii)	Highest system voltage	12 kV
iii)	System earthing	Solidly earthed system
iv)	Frequency (Hz)	50
vii)	Lightning Impulse withstand	75 Voltage (kVP)
viii)	Power frequency withstand	28 Voltage (kV rms)
vii)	Arrestor duty	
--	Connection to system	Phase to earth
--	Type of equipment to be protected	11 kV transformers & switchgear

**3.10.2. Surge Arrestors**

i)	Type	Gapless Metal oxide outdoor
ii)	Arrestor rating (kV rms)	9
iii)	Continuous Operating voltage (kV rms)	7.65
v)	Nominal Discharge Current micro impulse shape)	5 Rating (kA) (8x20
v)	Long Duration discharge class	Distribution class
vi)	Maximum residual voltage (kV peak)	
a)	at 5 kA	27
vii)	Partial discharge at 1.05 COV not greater than	50 (PC)
viii)	High current impulse withstand voltage at 5 kA (kVp)	65

**3.11. INSULATOR HOUSING**

- |      |   |     |
|------|---|-----|
| i)   | Power frequency withstand test voltage (Wet) (kV rms) | 28  |
| ii)  | Lightning impulse withstand/tests voltage (kVP)       | 75  |
| iii) | Creepage distance not less than (mm)                  | 300 |

**3.12. GALVANISATION**

- |      |  |                      |
|------|--|----------------------|
| i)   | Fabricated Steel Aticles                         |                      |
|      | a) 5 mm thick cover                              | 610 g/m <sup>2</sup> |
|      | b) Under 5 mm but not less than 2 mm thickness   | 460 g/m <sup>2</sup> |
|      | c) Under 2 mm but not less than 1.2 mm thickness | 340 g/m <sup>2</sup> |
| ii)  | Castings   |                      |
|      | Grey Iron, malleable iron                        | 610 g/m <sup>2</sup> |
| iii) | Threaded works other than tubes & tube fittings  |                      |
|      | a) Under 10 mm dia                               | 270 g/m <sup>2</sup> |
|      | b) 10 mm dia & above                             | 300 g/m <sup>2</sup> |

## 25. Earthing Coil

Earthing Coils shall be fabricated from soft GI Wire Hot Dip Galvanized. The Hot Dip galvanized wire shall have clean surface and shall be free from paint enamel or any other poor conducting material. The coil shall be made as per REC constructions standard (Refer tender drawing No. REC-XI Plan-Gen-005). The Hot Dip galvanizing shall conform to IS:2629/1966, 2633/1972 and 4826/1969 with latest amendments. Galvanizing should be heavily coated and should stand for the following tests.

### Galvanizing Tests

#### i) Minimum Mass of Zinc

- a) ON GI Wire used 280 cm/m<sup>2</sup>
- b) After Coiling – 266 gm/m<sup>2</sup>. The certificate from recognized laboratory shall be submitted towards mass of zinc.

#### ii) Dip Test Shall stand 3 dips of 1 minute and one dip of ½ minute before coiling and 43 dips of 1 minute after coiling as per IS : 4826/1979.

### THE DIMENSIONAL REQUIREMENT SHALL BE AS FOLLOWS

- a) Nominal dia of GI Wire 4 mm (Tolerance  $\pm 2.5\%$ )
- b) Minimum no. of turns – 115 Nos.
- c) External dia of Coil (Min) – 50 mm
- d) Length of Coil (Min) – 460 mm
- e) Free length of GI Wire at one end coil (Min.) – 2500 mm

The turns should be closely bound. Weight of one finished Earthing Coils (min.) – 1.850 Kg.

Adhesion test – As per ISS 4826 – 1979.

**26. Earthing Conductors**

All conductors buried in earth and concrete and above ground level shall be galvanised steel. Galvanised steel shall be subject to four one minute dips in copper sulphate solution as per IS:2633.

## 27. Three Phase 4 Wire L.T. Distribution Box for Aerial Bunched Conductor

### 1 SCOPE:

- 1.1 The L.T. Distribution Box shall be used for connection through overhead conductors or ABC line and for giving connections to the consumers. This specification covers the design, manufacture, inspection, testing and supply of L.T. Distribution Box. The L.T. Distribution Box will be installed at the Poles and it shall withstand solar radiations, rain, wind pressure and pollution.

### 2 CONSTRUCTIONAL AND TECHNICAL PARTICULARS:

- 2.1 The Distribution Box shall be made from 20 SWG CRCA MS sheet by **Deep Drawn/Sheet Bending process\*Method with Powder Coating**. Size of the box shall be 418mm x 300mm x 120mm as shown in drawing. There shall not be any welding joint to make base and cover of the Distribution box. Roof of the box shall be tapered on both sides to drain the rain water.
- \* Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017.
- 2.2 Distribution box shall have Insulated Multiple Outgoing Connectors for R, Y, B Phases and Neutral. Distribution box shall have arrangement for one incoming cable of three phase of size up to 4core 35mm<sup>2</sup>. Arrangement for four outgoing cables of size up to 4core 16mm<sup>2</sup> for three phase connection shall be provided in the distribution box. Each Incoming & outgoing cable shall be fixed inside the connection terminals by two screws of size not less than M8. The connection terminals shall be such that the outgoing cables can be fixed or removed easily without disconnecting the power supply. No current carrying part shall be approachable by hand or finger. Any current carrying part should be at a minimum distance of 5mm from the outer edge of the insulation. Insulation shall be Fire retardant.
- 2.3 Connection terminals for R, Y, and B Phases shall be mounted horizontally in a single line and Neutral shall be mounted parallel to R, Y, and B Phases in stepped pattern. Mounting arrangement shall be such that minimum clearance of 40mm is maintained between each phase and neutral. Fixing of connection terminals with the distribution box shall be preferably non-removable type to avoid theft of connection terminals.
- 2.4 Box shall be provided with U-latch sealing arrangement. A hole of 8mm & 2.5mm shall be provided in the U-latch to provide a padlock & sealing of the box respectively. U-latch shall be joined with stainless steel rivet. Box should be duly powder coated after 7-tank Phosphating process. Box should be of Light Admiralty Grey color (IS-5:1993, COLOUR NO-697). The L.T. Distribution box shall be powder coated only. The facility for 7-Tank Phosphating and powder coating shall be in-house of the tenderer to ensure proper quality, since these boxes are for outdoor applications.

- 2.5 4 Holes for incoming cables and 4 Nos. holes for outgoing cables shall be provided on the lower wall of the box. Cable holes shall be provided with rubber / plastic glands duly pasted with the box. Incoming and outgoing cable gland shall have internal diameter of 20mm. Cable Glands shall be made such that internal diameter of glands provided for cables should be closed with the film of minimum 1mm thickness. Cable will go through the cable glands by piercing the film of the glands. Gap of minimum 100mm shall be maintained between the lower wall and neutral mounted inside the distribution box for easy handling of incoming and outgoing cables.
- 2.6 **MARKING:** Following shall be provided on the cover of box.
- a) Manufacturers name duly embossed
  - b) Utility name duly embossed
  - c) Name of scheme duly embossed
  - d) Danger marking in red color.
- 2.7 M.S. Earthing Screw of diameter 6mm with washer shall be provided in the threads of the earth clamp welded to the main body of the box.
- 2.8 The box shall comply with the requirement of IP54. The box shall be fully type tested along with dimensional details as per the requirement of relevant Indian Standard (latest edition) IS13947: Part-I and latest amendments. Tests shall be carried out from laboratories which are accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India to prove that the complete box meet the requirement of IP54. The tests report shall be submitted along with the tender failing which the tender of the firm shall not be opened. Government approved laboratories should be accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India. The type test reports shall not be older than 5 years.
- 2.9 Distribution Box shall be duly packed in 3Ply corrugated box. The tolerance permissible on the overall dimensions of the MMB shall be ( $\pm$ ) 3%.

### **3.0 TESTS:**

Following tests shall be performed on the box during inspection:

#### **3.1 Visual Examination:**

The L.T. Distribution box will be inspected visually, externally and internally for proper Powder Coating layer, fitting of all the components in accordance with technical Specification.

#### **3.2 Verification of dimensions:**

Verification of dimensions, external / internal clearances will be carried out as per technical specifications.



- 3.3 **Verification of fittings:** Components like insulated connection terminals, screws etc will be verified as per technical specification.
- 3.4 **High voltage withstand test at 2.5KV:**  
The A.C. voltage of 2.5KV, 50HZ shall be applied for one minute as follows:
- a) Between each Phase
  - b) Between each Phase and earth screw
  - c) On the insulation of connection terminals
- There shall not be any puncture or flash over during this test.
- 3.5 **Current Carrying Capacity:** The Current of 200 AMP shall be applied for 30 minutes through high current source on the each Phase. There shall not be overheating of the terminals during this test.

## **28. Single Phase L.T. Distribution Box for Aerial Bunched Conductor**

### **1 SCOPE:**

The LT Distribution box for ABC single phase is used for Connection through overhead conductors or ABC line and for giving connections to the consumers. This specification covers the design, manufacture, inspection, testing and supply of the LT Distribution box. The LT Distribution box suited for ABC single phase cable will be installed at the Poles and it shall withstand solar radiations, rain, wind pressure and pollution.

### **2 CONSTRUCTIONAL AND TECHNICAL PARTICULARS:**

- 2.1 The Distribution Box shall be made from 20 SWG CRCA MS sheet **with Powder Coating**. Internal size of the box shall be 225mm x 285mm x 120mm as shown in drawing. There shall not be any welding joint to make base and cover of the Distribution Box. Roof of the box shall be tapered on both sides to drain the rain water.
- 2.2 Distribution Box shall have insulated Multiple Outgoing Connector for Phase and Neutral. Each Multiple Outgoing Connector shall have arrangement for one incoming cable of Single phase of size up to 25mm<sup>2</sup> and 8 outgoing cables of single phase of size up to 2core 10mm<sup>2</sup>. Each Incoming & outgoing cable shall be fixed inside the Multiple Outgoing Connector by two screws of size not less than M6. The Multiple Outgoing connector shall be such that the outgoing cables can be fixed or removed easily without disconnecting the power supply. No current carrying part shall be approachable by hand or finger. Any current carrying part should be at a minimum distance of 5mm from the outer edge of the insulation. Insulation shall be Fire retardant.
- 2.3 Multiple Outgoing Connectors shall be mounted horizontally. Mounting arrangement shall be such that minimum clearance of 40mm is maintained between phase and neutral. Fixing of Multiple Outgoing Connectors preferably shall be non-removable type to avoid theft of connectors.
- 2.4 Box shall be provided with U-latch sealing arrangement. A hole of 8mm & 2.5mm shall be provided in the U-latch to provide a padlock & sealing of the box respectively. U-latch shall be joined with stainless steel rivet. Box should be duly powder coated after 7-tank Phosphating process. Box should be of Light Admiralty Grey color (IS-5:1993, COLOUR NO-697). The LT Distribution box for ABC single phase shall be powder coated only. The facility for 7-Tank Phosphating and powder coating shall be in-house of the tenderer / manufacturer to ensure proper quality, since these boxes are for outdoor applications.

2.5 One Hole for incoming cable and 8 Nos. holes for outgoing cables shall be provided on the lower wall of the box. Cable holes shall be provided with rubber / plastic glands duly pasted with the box. Incoming and outgoing cable gland shall have internal diameter of 30mm & 15mm respectively. Cable Glands shall be made such that internal diameter of glands provided for cables should be closed with the film of minimum 1mm thickness. Cable will go through the cable glands by piercing the film of the glands. Gap of minimum 100mm shall be maintained between the lower wall and neutral mounted inside the Distribution Box for easy handling of incoming and outgoing cables.

2.6 **MARKING:** Following shall be provided on the cover of box.

- a) Manufacturers name duly embossed
- b) Utility name duly embossed
- c) Name of the scheme
- d) Danger marking in red color.

2.7 M.S. Earthing screw of diameter 6mm with washer shall be provided in the threads of the earth clamp welded to the main body of the box.

\* Amendment issued vide letter No. REC/DDUGJY/SBD/2017-18/1122 dated 15.05.2017.

The box shall comply with the requirement of IP54. The box shall be fully type tested along with dimensional drawings as per the requirement of relevant Indian Standard (latest edition) IS13947: Part-I and latest amendments. Tests shall be carried out from laboratories which are accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India to prove that the complete box meet the requirement of IP54. The tests report shall be submitted along with the tender failing which the tender of the firm shall not be opened. Government approved laboratories should be accredited by the National Board of Testing & Calibration Laboratories (NABL) of Govt. of India. The type test reports shall not be older than 5 years. In case order is placed on a firm, no change in design / manufacturer of LT Distribution box shall be allowed in supplies.

2.8 Box shall be duly packed in 3Ply corrugated box. The tolerance permissible on the overall dimensions shall be ( $\pm$ ) 3%.

### 3 TESTS:

Following tests shall be performed on the box during inspection:

#### 3.1 Visual Examination: -

The LT Distribution box for ABC single phase will be inspected visually, externally and internally for proper Powder Coating layer, fitting of all the components in accordance with technical Specification.

#### 3.2 Verification of dimensions: -

Verification of dimensions, external / internal clearances will be carried out as per technical specifications.

**3.3 Verification of fittings: -**

Components like insulated Multiple Outgoing Connectors, screws etc will be verified as per technical specification.

**3.4 High voltage withstand test at 2.5KV: -**

The A.C. voltage of 2.5KV, 50HZ shall be applied for one minute as follows:

- a) Between Phase & Neutral
- b) Between Phase and earth screw
- c) On the insulation of Multiple Outgoing Connectors.

There shall not be any puncture or flash over during this test.

**3.5 Current Carrying Capacity: -**

The Current of 200 AMP shall be applied for 30 minutes through high current source on each Multiple Outgoing Connector. There shall not be overheating of the terminals during this test.

## 29. Earthing

(AS PER IS 3043-1987)

Earthing shall generally be carried out in accordance with the requirements of Indian Electricity Rules 2003 amended from time to time and relevant regulations under Electricity Supply Authority concerned.

In case of high and extra high voltages, the neutral points shall be earthed by not less than two separate distinct connections with earth, each having its own electrodes sub-station and will be earthed at any other point provided no interference is caused by such earthing. If necessary, the neutral may be earthed through suitable impedance.

As far as possible, all earth connections should be visible for inspection. Each earthing system shall be so designed, that, the testing of individual earth electrodes is possible. It is recommended that the value of any earth system resistance shall be such as to conform to the degree of shock protection desired.

It is recommended, that a drawing showing the main earth connections and earth electrodes be prepared for each installation and submitted to Employer.

No addition to the current carrying system, either temporary or permanent, shall be made which will increase the maximum available fault current on its duration until it has been ascertained that the existing arrangement of earth electrodes, earth bus-bar etc., are capable of carrying the new value of earth fault current which may be obtained by this addition.

All materials, fittings etc., used in earthing shall conform to Indian Standard Specifications, wherever they exist.

### **GENERAL REQUIREMENTS AND PROCEDURES FOR EARTHING AT SUB-STATIONS.**

The ground resistance for sub-stations should not exceed a value 2(two) ohms. The joints/connections in the earthing system shall be welded only, except the connections, which require opening for testing/maintenance. Such connections should be bolted tightly, using spring and ring washers for proper contact pressure. The G.S. flats to be provided for the horizontally laid earth grid should have overlap welded joints, with length of welding at least twice the width of the flat, e.g., 100 MM for 50x6 MM G.S. flats. There should not be any dirt, grease, oil, enamel, paint or any such non-conductive coatings on the surfaces being joined/connected. Only the finished joints/connections above ground may be provided with red-oxide or any other protective coating. Underground earth electrodes and earth grid elements, when laid, should have a clean metallic surface, free from paint, enamel, grease or any such non-conductive coatings.

As far as possible, all earth connections should be accessible for visual inspection. No cut-outs, links or switches, other than linked switches arranged to operate simultaneously on the earthed or earthed neutral conductor and the live wire shall be inserted in the supply system. Earth electrodes or mate should not be installed in close proximity to metal fence to avoid possibility of fence becoming live. Separate

earth electrodes, isolated from the earth grid, are to be provided for grounding the fence wires.

Pipes or rods used as electrodes should be in one piece, as far as possible, with a minimum allowable length of 3 mtrs. Except where rock or hard stratum is encountered, the pipe/rod electrodes should be driven into the ground to a minimum depth of 3 mtrs. The strip electrodes, forming the horizontal grid, should be buried underground to a minimum depth of 0.5 mtrs. The path of earth wire should be out of normal reach of any person, as far as possible.

For high resistivity soils, above 100 Ohm-mtrs., attempts should be made to bring the soil resistivity in the range of 50 to 60 Ohm-mtrs. By digging and treating the soil mass around the earth grid/electrodes with a mixture of salt and charcoal.

In case of rocky top soil and sub-stratum, having very high resistivity, with no scope of improvement by other means, the procedure given below should be followed:

1. At least two bores of diameter little less than 40 mm, with a minimum distance of 10 mtrs. between them, should be made in the ground at suitable locations inside the S/S yard. The boring should be done until soil sub-stratum rich in moisture and low in resistivity is encountered. G.I. pipes of 40 MM dia. should be descended in each bore, such that, the soil mass around the pipes grips them tightly, Back – filling of bores, if required, with wet soil/clay may be done to ensure this condition. The G.I. pipes in these deep bores should be interconnected with the main earthing grid of the S/S through 50x6 mm G.S. flat, with all the joints/connections and terminations being either fully welded, or clamped/bolted and welded simultaneously. The G.I. pipes in the bores should also be interconnected with each other. In extreme cases, the bores may have to be made at remote locations i.e. outside the S/S yard, with inter-connections, through 50x6 MM flats, as explained before.
2. The procedures to be observed stringently for making connections and joints between various elements of the earthing system are as follows:
  - a. G.S. flat to Structure/flat - The G.S. flat should be welded to the metallic portion (leg) of the structure after thoroughly cleaning the surfaces to be welded. The length of the welding should be at least twice the width of the G.S. flat, e.g.-minimum 100 mm for 50x6 mm G.S. flat. Exactly similar procedure is to be adopted for joints between two G.S. flats.
  - b. G.I. wire to structure. The G.I. wire should be bolted to the structure after making an eye formation and kept tight with the help of spring and ring washer. Then, the entire arrangement should be welded.
  - c. G.I. wire to G.S. flat- The G.I. wire should be bolted and then welded to G.S. flat, as explained above.

- d. G.I. rod to G.S. flat- The G.I. rod should be securely clamped to the G.S. flat with the help of bolts and washers and the entire arrangement should then be welded.
- e. G.I. wire to G.I. pipe – GI wire should be bolted to the G.I. pipe and then welded, keeping in view the relevant precautions, mentioned before.
- f. G.I. flat to G.I pipe – The GI flat should be bolted tightly to the G.I. pipe and then the connection should be welded.

Before making connections and joints, it should be ensured that, the elements to be joined have a clean metallic contact surface without any non-conductive coating.

### **EARTH GRID SYSTEM**

Grid system of interconnected conductors forming a closed loop mesh is to be installed using 75x8 mm MS flat for peripheral and branch conductors. Interconnections are made by welding them. This earth grid will be laid at a depth of about 0.5 mtr. bonded to general mass of the earth by 3 mtrs. long earth electrode of solid MS rod (or pipe) of dia 25mm. The G.I. pipe 40 mm. dia 3 mtrs. long in the earthing pits, driven vertically.

It is to this earth grid that the transformer neutral, apparatus, frame work and other non-current carrying metal work associated like transformer tank, switchgear frame etc. are to be connected. All these connections should be made in such a way that reliable and good electrical connection is ensured. Aluminum/ other paint, enamel, grease and scale should be removed from the point of contact before connections are made. No part of the ground connection leads should be embedded in concrete.

Arrangement of connection of earth connection shall be as follow:

#### **1. STRUCTURES:**

Structures including frames, metal supports within the substation grid at least two legs, preferably diagonally opposite (where more than two legs are provided) on each metal structure shall be connected to earth grid with GI wire of 4mm dia or 6 mm dia.

#### **2. ISOLATORS/ SWITCHES:**

The operating handle shall be connected to earth grid independent of the structure earthing or through the steel mounting structure, through 4 mm dia G.I. wire.

#### **3. LIGHTNING ARRESTOR:**

The bases of lightning arrestors shall be directly connected to the earth electrodes by 4 or 6 SWG G.I. wires as short and as straight as practicable, to ensure minimum impedance. Separate earth leads should be used for L.A. in each phase. In addition there shall be as direct connections as practicable

from the earthed side of the lightning arrestors to the frame of the apparatus being protected. Surge counters, could also be inserted in the circuit where lightning incidences are high, but in such cases, the lightning arrestor should be mounted on insulated base. Invariably, earth connections for lightning arrestors should be separate, and in no case should they be joined looped or meshed with other conductors. For lightning arrestors mounted near transformers, earthing connections shall be done with the earthing pits and earthing leads shall be laid clear of the tank and collars in order to avoid possible oil leakage caused by arcing. The earth connection should not pass through iron pipes, as it would increase the reactive impedance of the connection.

**4. POWER TRANSFORMER:**

- The tank of the transformer shall be directly connected to the main earth grid. In addition there shall be a separate and as direct a connection as practicable from the tank to the earth side of protecting LA using 4 or 6 SWG GI wire.
- The earthing of the neutral shall be by two separate, distinct and direct connections of 50x6 mm GS flat to earth pits, which form a part of the earth grid, and shall be run clear of the tank and collars.
- The transformer track rails shall be connected to earth

**5. OUT DOOR VCB:**

At least two legs, preferably diagonally opposite of the supporting structure frame work of each circuit breaker unit shall be connected to the earth grid, through 50x6 mm G.S. flats.

**6. FENCING:**

Fencing and gate should be earthed separately.

**7. CURRENT TRANSFORMERS / POTENTIAL TRANSFORMERS:**

The bases of the current transformers should be directly connected to the earth grid through 4 or 6 SWG G.I. wires. The base (neural side) of the P.Ts. should be directly connected to the earth grid through 4 or 6 SWG G.I. wires. Separate earth leads should be used for P.Ts. in each phase. The termination of leads on the P.T. neutral should be bolted/clamped and not welded, to facilitate opening of the earth connection for testing purposes. In



addition, all bolted cover plates to which bushings are attached, should be connected to the earth grid, both in case of C.Ts. and P.Ts.

8. Armoring of armored metal-sheathed cables within the station grid area shall be connected to the earth grid.
9. Substation L.T. Supply Transformer: Same as above except that the neutral earthing conductor used shall be 4 or 6 SWG G.I. wire.

### **30. GI Earthing Pipe**

Earthing pipe should be made of 40 mm diameter ISI marked B class GI Pipe. 12 mm dia suitable holes on its circumference shall be made as per approved drawing. The pipe should be in one piece. No joints or welding would be allowed on its length. Clamps made of 50x6mm GI flat duly drilled with 12 mm size holes should be welded at the top end for connection of earth conductor.

Pipe used shall be 40mm NB diameter, ISI marked Galvanized Mild Steel Tubes continuously welded Electric Resistance Welded ERW/High Frequency Induction welded (HFIW)/Hot finished welded (HFW) type, conforming to IS-554-1985 with latest amendment of MEDIUM quality (Class B).

#### **1. MANUFACTURE:**

GI earth pipe (40 mm diameter & 3 metre long) shall be made of tubes which shall be made from tested quality steel manufactured by any approved process as follows:

- a) Electric Resistance Welded (ERW).
- b) High Frequency Induction Welded (HFIW) and
- c) Hot finished Welded (HFW).

Tubes made by manual welding are not acceptable.

#### **2. DIMENSIONS:**

The dimensions and weights of tubes shall be in accordance with Table-I and Table-II of IS: 1239 (Part-I)/1990 with latest amendments, subject to tolerance permitted therein. Necessary 12 mm diameter holes across the circumference shall be provided as per approved drawing. Drawings shall be approved by the owner before start of the manufacturing work. The tube, earthing pipe shall be provided with 50x6mm GS clamps on one end, one clamp is to be welded with the pipe and another is removable to enable measurement of earth resistance of the pit. Other end of the earth pipe should be cut half in slop to make it a sharp.

#### **3. GALVANIZING:**

Tubes shall be galvanized in accordance with IS-4736-1986 with latest amendment for not dip zinc coating of Mild Steel Tubes. The minimum mass of zinc coating on the tubes shall be in accordance with clause 5.1 of IS-4736-1986 (specification for hot dip zinc) and when determined on a 100mm long test piece in accordance with IS: 6745:1972 shall be 400 g/m<sup>2</sup>. The zinc coating shall be uniform adherent reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rust, stains, bulky white deposits and blisters.

#### **4. HYDRAULIC TEST:**

(Before applying holes) Each tube shall withstand a test pressure of 5 M Pa maintained for at least 3 seconds without showing defects of any kind. The pressure shall be applied by approved means and maintained sufficiently long for proof and inspection. The testing apparatus shall be fitted with an accurate pressure indicator

**5. TEST ON FINISHED TUBES AND SOCKETS:**

The following tests shall be conducted by the manufacturer of finished tubes and sockets.

- a) The tensile strength of length of strip cut from selected tubes when tested in accordance with IS-1894-1972, (Method for tensile testing of steel tubes), shall be at least 320N/mm<sup>2</sup>.
- b) The elongation percentage on a gauge length of 5.65/so (where so is the original cross-sectional area of test specimen) shall not be less than 20%.
- c) When tested in accordance with IS-2329-1985 (Method for Bend test on Metallic tubes) the finished tube shall be capable of with standing the bend test without showing any sign of fracture or failure. Welded tubes shall be bent with the weld at 90 degree to the plane of bending. The tubes shall not be filled for this test.
- d) Galvanized tubes shall be capable of being bent cold without cracking of the steel, through 90 degree round a former having a radius at the bottom of the groove equal to 8 times the outside diameter of tube.
- e) Flattening Test on Tubes above 50 mm Nominal Bore: Rings not less than 40 mm in length cut from the ends of selected tubes shall be flattered between parallel plates with the weld, if any, at 90 degree (point of maximum bending) in accordance with IS-2328-1983. No opening should occur by fracture in the weld unless the distance between the plate is less than 75 percent of the original outside diameter of the pipe and no cracks or breaks in the metal elsewhere than in the weld shall occur, unless the distance between the plates is less than 60% of the original outside diameter. The test rings may have the inner and outer edges rounded.
- f) GALVANISHING TEST:
  - Weight of zinc Coating: For tubes thickness upto 6 mm the minimum weight of zinc coating, when determined on a 100 mm long test piece in accordance with IS-4736-1986 shall be 400 grm/m<sup>2</sup>.

- The weight of the coating expressed in gram/m<sup>2</sup> shall be calculated by dividing the total weight of the zinc (inside plus outside) by the total area (inside plus outside) of the coated surface.
  - Test specimen for this test shall be cut approximately 100 mm in length from opposite ends of the length of tubes selected for testing. Before cutting the test specimen, 50 mm from both ends of the samples shall be discarded.
- g) Free Bore Test: A rod 230mm long and of appropriate diameter shall be passed through relevant nominal bore of the sample tubes to ensure a free bore.
- h) Uniformity of Galvanized Coating: The galvanized coating when determined on a 100 mm long test piece [see V (a) (iii)] in accordance with IS-2633-1986 (Method for testing uniformity of coating on zinc coated articles) shall with stand 4 one minute dips.

## **6. WORKMANSHIP:**

The tubes shall be cleanly finished and reasonably free from injurious defects. They shall be reasonably straight, free from cracks, surface flaws, laminations, and other defects, both internally and externally. The screw tubes and sockets shall be clean and well-cut. The ends shall be cut cleanly and square with the axis of tube.

## **7. MARKING:**

The medium class of tubes shall be distinguished by Blue colour bands which shall be applied before the tubes leaves the manufacturers' works. Tubes shall be marked with the standard mark.

**31. GS Stay Sets (16 mm AND 20 mm)****1. 16MM DIA STAY SETS (GALVANIZED)**

The stay sets (Line Guy set) will consist of the following components:-

- a) **ANCHOR ROD WITH ONE WASHER AND NUT:** Overall length of rod should be 1800 mm to be made out of 16 mm dia GS Rod, one end threaded upto 40mm length with a pitch of 5 threads per cm and provided with one square GS washer of size 40x40x1.6mm and one GS hexagonal nut conforming to IS:1367:1967 & IS:1363:1967. Both washer and nut to suit threaded rod of 16mm dia. The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality welding.
- b) **ANCHOR PLATE SIZE 200x200x6MM:** To be made out of GS plate of 6mm thickness. The anchor plate should have at its centre 18mm dia hole.
- c) **TURN BUCKLE & EYE BOLT WITH 2 NUTS:** To be made of 16mm dia GS Rod having an overall length of 450 mm, one end of the rod to be threaded upto 300 mm length with a pitch of 5 threads per cm and provided with two GS Hexagonal nuts of suitable size conforming to IS:1363:1967 & IS:1367:1967. The other end of rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality welding.
- d) **BOW WITH WELDED ANGLE:** To be made out of 16mm dia GS rod. The finished bow shall have an overall length of 995mm and height of 450 mm, the apex or top of the bow shall be bent at an angle of 10 R. The other end shall be welded with proper and good quality welding to a GS angle 180mm long having a dimension of 50x50x6mm. The angle shall have 3 holes of 18mm dia each.
- e) **THIMBLE:** To be made on 1.5 mm thick GS sheet into a size of 75x22x40mm and shape as per standard shall be supplied.
- f) **Galvanizing:** The complete assembly shall be hot dip galvanized.
- g) **WELDING:** The minimum strength of welding provided on various components of 16mm dia stay sets shall be 3100 kg. Minimum 6 mm fillet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS: 823/1964 or its latest amendment. Minimum length of weld to be provided at various places in the stay sets shall be indicated by the bidder. Welding if, found short in lengths as per final approved drawings shall be rejected.

- h) **THREADING:** The threads on the Anchor Rod, Eye Bolt & Nuts shall be as per specification IS: 4218:1967 (ISO Metric Screw Threads). The nuts shall be conforming to the requirement of IS: 1367:1967 & have dimensions as per IS: 163:1967. The mechanical property requirement of fasteners shall conform to property clause 4.6 each for anchor rod & Eye bolt and property clause 4 for nuts as per IS: 1367:1967.

AVERAGE WEIGHT OF FINISHED 16MM STAY SETS 7.702 KG.  
(MINIMUM) (EXCLUDING NUTS THIMBLES AND WASHERS) 8.445 KG.  
(MAXIMUM)

**2. 20 MM DIA STAYS SETS FOR 33KV LINES (GALVANIZED)**

THE STAY SET (LINE GUY SET) WILL CONSIST OF THE FOLLOWING COMPONENTS:

- a) **ANCHOR ROD WITH ONE WASHER AND NUT:** Overall length of Rod should be 1800mm to be made out of 20mm dia GS Rod, one end threaded upto 40mm length with a pitch of a threads per cm. And provided with one square G.S. Washer of Size 50x50x1.6mm and one GS Hexagonal nut conforming to IS:1367:1967 & IS:1363:1967. Both washer & nut to suit the threaded rod of 20mm. The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality welding. Dimensional and other details are indicated and submitted by bidders for owner's approval before start of manufacturing.
- b) **ANCHOR PLATE:** Size 300x300x8mm: To be made out of G.S. Plate of 8mm thickness. The anchor plate to have at its centre 22mm dia hole.
- c) **TURN BUCKLE, EYE BOLT WITH 2 NUTS:** To be made of 20mm dia G.S. Rod having an overall length of 450 mm. One end of the rod to be threaded upto 300mm length with a pitch of 4 threads per cm. The 20mm dia bolt so made shall be provided with two G.S. Hexagonal nuts of suitable size conforming to IS:1637/1967 & IS:1363/1967.

The other end of the rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality of welding. Welding details are to be indicated by the bidder separately for approval.

- d) **BOW WITH WELDED CHANNEL:** To be made out of 16mm dia G.S. Rod. The finished bow shall have an overall length of 995 mm and height of 450 mm. The apex or top of the bow shall be bent at an angle of 10°. The other end shall be welded with proper and good quality welding to a G.S. Channel 200mm long having a dimension of 100x50x4.7 mm. The Channel shall have 2 holes of 18 mm dia and 22 mm dia hole at its centre.

- e) **THIMBLE 2 Nos.:** To be made of 1.5mm thick G.S. sheet into a size of 75x22x40mm and shape as per standard.
- f) **GALVANISING:** The complete assembly shall be hot dip galvanised.
- g) **WELDING:** The minimum strength of welding provided on various components of 20mm dia stay sets shall be 4900 kg. Minimum 6mm fillet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS: 823/1964 or its latest amendment.
- h) **THREADING:** The threads on the Anchor Rods, Eye Bolts and Nuts shall be as per specification IS: 4218:1967 (ISO Metric Screw Threads). The Nuts shall be conforming to the requirements of IS: 1367:1967 and have dimension as per IS 1363:1967. The mechanical property requirement of fasteners shall confirm to the properly clause 4.6 each for anchor rods and Eye bolt and property clause 4 for nuts as per IS: 1367:1967.

AVERAGE WEIGHT OF FINISHED 20MM STAYS SET: 14.523 KG. (MIN.)  
(EXCLUDING NUTS THIMBLE & WASHER): 15.569 KG. (MAX.)

3. **TEST CERTIFICATE:** The contractor shall be required to conduct testing of materials at Govt./Recognized testing laboratory during pre – dispatch inspection for Tensile Load of 3100 Kg/4900 Kg. applied for one minute on the welding & maintained for one minute for 16 mm and 20 mm dia stay sets respectively.
4. **IDENTIFICATION MARK:** All stay sets should carry the identification mark of word PVVNL and size of the stay set. This should be engraved on the stay plate and on stay rods to ensure proper identification of the materials.

The nuts should be of a size compatible with threaded portion of rods and there should be no play or slippage of nuts.

Welding wherever required should be perfect and should not give way after erection.

5. **TOLERANCES:** The tolerances for various components of the stay sets are indicated below subject to the condition that the average weight of finished stay sets of 16mm dia excluding nuts, thimbles and washers shall not be less than the weight specified above :-

No. Item	Section Tolerances	Fabrication Tolerances	Material
1 Anchor	6mm thick +	200x200mm + 1%	GS plate 6mm

Plate	12.5% - 5%		thick
	8mm thick + 12.5% - 5%	300x300mm + 1%	GS plate 8mm thick
2 Anchor Rod	16mm dia + 5%- 3%	Length 1800mm + 0.5%	GS Round 16mm dia
		Rounded Eye 40 mm inside dia + 3%. Threading 40mm+11% - 5	GS Round 16mm dia
	20mm dia + 3%- 2%	Length 1800mm + 0.5%	GS Round 20mm dia
		Round Eye 40mm inside dia + 3%. Threading 40mm +11% -5%	GS Found 20mm dia
3 Turn Buckle Bow	16 mm dia + 5%- 3%	Length 995mm + 1% 16mm dia	GS Round 16mm dia
		Length 180mm + 1% 50x50x6mm	GS Angle
		Channel length 200mm + 1%	GS Channel 100x50x4.7m m
4 Eye Bolt Rod	16mm dia + 5%- 3%	Length 450mm + 1% Threading 300mm + 1% Round Eye 40mm inside dia + 3%	GS Round 16mm dia
	20mm dia + 3%- 2%	Length 450mm + 1% Threading 300mm + 1% Round Eye 40mm inside dia + 3%	GS Round 20mm dia



## **32. GI Stay Wires**

### **1. SCOPE**

This Specification covers details of G.I. stranded stay wires for use in rural distribution system.

### **2. APPLICABLE STANDARDS**

Except when they conflict with the specific requirements of this specification, the G.I. Stranded Wires shall comply with the specific requirements of IS:2141-1979, IS:4826-1979 & IS:6594-1974 or the latest versions thereof.

### **3. APPLICATION AND SIZES**

**3.1** The G.I. stranded wires covered in this Specification are intended for use on the overhead power line poles, distribution transformer structures etc.

**3.2** The G.I. stranded wires shall be of 7/2.5mm, 7/3.15mm and 7/4.0mm standard sizes.

### **4. MATERIAL**

The wires shall be drawn from steel made by the open hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and have the properties and characteristics as specified in this specification. The wires shall not contain sulphur and phosphorus exceeding 0.060% each.

### **5. TENSILE GRADE**

The wires shall be of tensile grade 4, having minimum tensile strength of 700 N/mm<sup>2</sup> conforming to IS:2141.

### **6. GENERAL REQUIREMENTS**

**6.1** The outer wire of strands shall have a right-hand lay.

**6.2** The lay length of wire strands shall be 12 to 18 times the strand diameter.

## 7. MINIMUM BREAKING LOAD

The minimum breaking load of the wires before and after stranding shall be as follows :

No. of wires & const.	Wire dia (mm)	Min. breaking load of Single wire before stranding (KN)	Min. breaking load of the standard wire (KN)
7(6/1)	2.5	3.44	22.86
7(6/1)	3.15	5.45	36.26
7(6/1)	4.0	8.79	58.45

## 8. CONSTRUCTION

- 8.1** The galvanised stay wire shall be of 7-wire construction. The wires shall be so stranded together that when an evenly distributed pull is applied at the ends of completed strand, each wire shall take an equal share of the pull.
- 8.2** Joints are permitted in the individual wires during stranding but such joints shall not be less than 15 metres apart in the finished strands.
- 8.3** The wire shall be circular and free from scale, irregularities, imperfection, flaws, splits and other defects.

## 9. TOLERANCES

A tolerance of ( $\pm$ )2.5% on the diameter of wires before stranding shall be permitted.

## 9. SAMPLING CRITERIA

The sampling criteria shall be in accordance with IS:2141.

## 11. TESTS ON WIRES BEFORE MANUFACTURE

The wires shall be subjected to the following tests in accordance with IS:2141.

- i) Ductility Test
- ii) Tolerance on Wire Diameter

## 12. TESTS ON COMPLETED STRAND

The completed strand shall be tested for the following tests in accordance with IS:2141.

a) Tensile and Elongation Test :

The percentage elongation of the stranded wire shall not be less than 6%.

b) Chemical analysis

c) Galvanising Test :

The Zinc Coating shall conform to “Heavy Coating” as laid down in IS:4826

### **13. MARKING**

Each coil shall carry a metallic tag, securely attached to the inner part of the coil, bearing the following information:

- a) Manufacturers’ name or trade mark
- b) Lot number and coil number
- c) Size
- d) Construction
- e) Tensile Designation
- f) Lay
- g) Coating
- h) Length
- i) Mass
- j) ISI certification mark, if any

### **14. PACKING**

The wires shall be supplied in 75-100 Kg. coils. The packing should be done in accordance with the provisions of IS:6594.

**33. MCCB**

The MCCBs provided in these boxes shall conform in all respects to the relevant IS: 2516 (Pt-I&II)/1977 or its latest revision as applicable.

**REQUIREMENT OF MCCBs:**

The moulded case circuit breakers should comprise of a switching mechanism, an effective extinguishing device and a tripping unit contained in a compact moulded case cover made of high strength, heat resistance and flame retardant thermo-insulating materials. They should comprise of a spring assisted quick make/quick break type independent manual trip free mechanism rendering it easy to manually operate the MCCBs and capable of clearly indicating “TRIPPED”, “ON” AND “OFF” positions from the position of the operating handle. The contact tips should be made of a suitable alloy having high arc resistance and a long electrical and mechanical life needing no replacement. The breakers should be designed with a common trip bar to break and make all the three phase together even when fault occurs on any of the phases. The breakers should provide protection against sustained overloads and short circuits through thermal-magnetic/fully magnetic releases. These MCCBs along with terminal blocks are intended to be housed in the distribution boxes made out of sheet steel of 2mm gauge. The assembly of the MCCBs and the terminal blocks should be compact, reliable from operation point of view and safe to the operating personnel. As already mentioned earlier, the MCCBs should be fully maintenance free.

**TECHNICAL PARTICULARS OF MCCBs:**

The LT MCCBs should have inverse current/time characteristics suitable for protection of 63KVA, 100KVA, 200KVA & 315KVA 11.0.4KV Distribution Transformers against sustained over-loads and short circuits for following operating conditions:-

i	Rated Operating Voltage	3 Phase 415 Volts AC 50 cycles with neutral solidly grounded system
ii	Standard rated current ratings for MCCBs to be used with different sizes of transformers will be as follows:-	
a)	For 63KVA 11/0.4KV Dist. Transformer	90 Amps
b)	For 100KVA 11/0.4KV Dist. Transformer	140 Amps
c)	For 200KVA 11/0.4KV Dist. Transformer	300 Amps

d)	For 315KVA 11/0.4KV Dist. Transformer	450 Amps
iii	No. of Poles	3
iv	Duty	Un-interrupted
v	Maximum ambient temperature	47°C in shade
vi	Minimum ambient temperature	4°C in shade
vii	Average altitude	A maximum of 1000 meter
viii	Maximum humidity	Frequently approaches saturation point

#### **TIME/CURRENT CHARACTERISTICS:**

The circuit breakers shall have time/current characteristics suitable for following operating conditions :-

Multiple of normal current rating	Tripping time
1.1 times	After 4 hours
1.2 times	Less than 50 minutes
1.3 times	Less than 30 minutes
1.4 times	Less than 10 minutes
2.5 times	Less than 1 minute
6 times	Less than 40 mili-seconds
12 times	Less than 40 mili-seconds

Time/Current characteristic of the Circuit Breaker (MCCB) shall be tested in accordance with Clause-7.7.2.3 (b) (2) of IS:2516-(Pt-I&II) Sec.I/1977 and the test shall be made with all the three phases loaded.

For time/current characteristic, the reference calibration temperature of the MCCBs shall be 40°C and durance, if any, upto 50°C operating temperature in the enclosure shall not exceed 10% of the value indicated above in Clause (I) above.

The MCCBs shall be calibrated and adjusted in the factory itself for the desired time/current characteristic.

The MCCB should have the following maximum resetting time under overload & short circuit conditions :-

Overload conditions	-	3 minutes
Short Circuit conditions	-	Instantaneous

#### **RATED SHORT CIRCUIT BREAKING CAPACITY:**

The rated short circuit breaking capacity of the MCCBs shall be as follows: -

Transformer rating(KVA)	Rated short circuit breaking capacity of the breaker in Kilo-Amps
63 KVA	A minimum of 3 Kilo-Amps
100 KVA	A minimum of 5 Kilo-Amps
200KVA	A minimum of 10 Kilo-Amps
315KVA	A minimum of 15 Kilo-Amps

The short circuit breaking capacity test as specified above shall be based on short circuit tests carried out at 0.4 Power Factor (lagging). For the purpose of these tests, the following operating sequence shall be followed: -

Break-3 minutes interval-Make-Break-3 minutes interval-Make-Break.

### 34. H.R.C. Fuse

The H.R.C. fuse links of 100 Amp, 200 Amp, 300 Amp ratings, should be ISI marked & conforming to ISS: 9224-1979 with latest amendment and to be supplied with suitable base of bakelite on DMC. The knife contact should be made of tinned/silver plated copper complete with extension strips. The extension strips should be made of copper. The thickness of the cooper strips should be 2mm for 100 Amp and 200 Amp, 3.0mm for 300 Amp. The strips should be in one piece. The HRC Fuse units should also be supplied with suitable lugs for 3 core 95 sq.mm, 120 sqmm and 300 sq.mm. cables for 100, 200 and 300 Amps ratings respectively. The dimension of the lugs should be as under

S.No	Ratings of HRC Fuse unit	Cable sizes	Minimum thickness of lugs Flat (mm) / Rounded (mm)	Minimum total length of lugs (mm)
1	100 Amp	95 sq.mm	4.2 / 2.1	64
2	200 Amp	120 sq.mm	4.6 / 2.3	73
3	300 Amp	300 sq.mm	7.0 / 3.5	15

The knife contact should have pressure springs to hold the fuse links. The extension strips shall be provided with GI nut & bolts and plain and spring washer to both the end. The DMC or bakelite base should be provided with suitable fixing alignment.

The following test certificates should invariably to be performed on the HRC Fuse Units.

1. Test for temperature rise at rated current
2. Current time characteristics
3. Determination of minimum fusing current and minimum non-fusing current
4. Test for duty

The breaking capacity of HRC Fuse Units should not be less than 80 KA.

The following tests shall be performed during pre-despatch inspection at manufacturer's works: -

1. Insulation resistance test
2. Temperature rise test
3. High Voltage test

Marking on the fuse base and on the fuse links :

1. Name of the manufacturer
2. Rated current
3. Rated voltage
4. ISI marking and reference of 185 No. (only on fuse links)
5. Rated Power loss
6. Name of the Employer



### **35. Triple Pole Switch Fuse Units with Neutral Links (200A, 320A & 400A/415 VOLTS RATINGS)**

This specification covers manufacture, testing before dispatch and delivery of Triple Pole Switch Fuse Units with neutral Link and HRC cartridge type fuses suitable for AC 3 Phase 4 wire 415 V with neutral solidly grounded system. The working conditions and technical requirements are as under:-

#### **TECHNICAL REQUIREMENTS**

- a) Rated Current : 200 Amps, 320 Amps & 400 Amps
  - b) I) Rated Operational Voltage : 3 Phase 4 Wire, 415 Volts AC 50 Hz  
with solidly earthed neutral
  - II) Highest System Voltage : 415V + 10%
  - c) Type of Fuse to be used : Non-deteriorating quick arcing type  
ISI marked
- HRC Cartridge fuse Links suitable for Class-1 category of duty of IS:13703(Part-I). The temperature rise shall be in accordance with IS:13703 (Part-I) (with latest amendments) over and above the ambient temperature of 45°C. It shall be used for protecting the distribution circuits and distribution transformers and shall be capable of carrying continuously the above stated rated current safely.
- d) Number of Poles : Three
  - e) Neutral Link : One
  - f) Duty : Un-interrupted duty
  - g) Rated fused short circuit current capacity at 415V : 40KA for 1 second. withstands
  - h) Utilization category as : AC-23 (B) as defined in IS: 13947 (Pt-III)/ 1993

## **GENERAL**

### **1. CONTACTS AND BLADES & OPERATING MECHANISM**

The switch shall be a combination of double break per pole AB switch with HRC fuses in all the three phases. The switch shall be spring assisted, quick make and quick break type having operating mechanism independent of the speed of the operator to minimize the arcing. If required, additional contact springs shall be provided to maintain correct contact pressures throughout operating life of the switches. The switch shall be so constructed that the alignment of its contacts & blades, which will be made of silver plated electrolytic copper/tinned copper, is maintained under asymmetrical fault conditions also. The tenders should furnish in their offers about the details of switching mechanism and the contacts. The switch shall have positive break feature such that it is possible to make it OFF even if the quick action spring fails due to ageing or other causes. The switch fuse unit shall be provided with double break per pole to ensure complete isolation of HRC Fuses from both incoming and outgoing circuits when the switch is in OFF position, in order to minimize the damage to the maintenance personnel. Ample flash over distances shall be provided so as to make the unit suitable for controlling highly inductive loads.

### **2. ENCLOSURES**

The Triple Pole Switch fuse units shall be totally enclosed in robust enclosures made out of 16 gauge/1.5 mm pressed steel sheet (conforming to relevant ISS for M.S. sheet) designed to withstand humid and hot weather conditions. The enclosures should have adequate strength and rigidity to withstand rough usage without fracture or permanent distortion. Suitable mounting arrangement shall be provided on the enclosures for mounting the units on a supporting structure.

### **3. INTER LOCK**

It should not be possible to open the switch cover when the switch is in 'ON' position and also it should not be possible to operate the switch 'ON' when the switch cover is open.

### **4. PAINTING**

The inside and outside of the enclosure should be painted with a grey paint. Before painting the surface, the same should be chemically cleaned for removing rust, grease etc. Then it should be given phosphate coating, followed by two coats of anti-rust primer (i.e. Red zinc Chrome Primer), after which two coats of synthetic paint of light grey colour shall be applied on internal and external surfaces of the

enclosures with a spray gun. The enclosures shall then be baked in oven so as to give an elegant and durable finish.

## **5. EARTHING**

The enclosure shall be provided with earthing arrangements at two places.

## **6. TERMINAL CONNECTIONS**

The switch shall be provided with aluminium lugs for termination of PVC coated aluminium cables of following sizes: -

S.No.	Capacity of TPN Switches	Size of Cable	No. of cable sockets required
1	200 Amps	150 sq.mm. 3.5 Core stranded aluminium cable	8 Nos. (3 Nos. phase leads and 1 natural lead for incoming and also 3 Nos. phase leads and 1 neutral for outgoing connections)
2	320 Amps	300 sq.mm. 3.5 Core stranded aluminium cable	-do-
3	400 Amps	300 sq.mm. 3.5 Core stranded aluminium cable	-do-

7. All the surface contacts (e.g. lugs, connectors, fixed contacts, moving contacts etc.) should be fitted with GI nuts & bolts having yellowish OR whitish passivation with good finish.

## **8. TESTING & TEST CERTIFICATES FOR SWITCHES**

The performance of the switch should conform to IS:10027/1981 with latest amendments. Accordingly, certificates from reputed laboratories such as CPRI, ERDA, IITs, for the type tests in accordance with IS:10027/1981 with latest amendment would necessarily be furnished by the tenderers along with offer.

## **9. USE OF ISI MARK HRC FUSES**

The HRC Fuses with ISI mark only should be used. These HRC fuses should conform to IS:13703 (Part-I)/1993 or as per its latest revision. The rated current of HRC fuses must be 200 Amps for 200 Amps Switches, 315 Amps for 320 Amps Switches and 400 Amps for 400 Amps Switches.

**10. IMPORTANT NOTE**

The firms must consider supply of 'ISI' certificate (valid on date) products on their offer in the tender, Other certification such as ISO:9001 & 9002 shall be given due weightage while considering their offer, however, the attested photo copies of such certification must be enclosed with the offer.

**11. INSULATION FOR LIVE PARTS**

All live parts shall be fully shielded with bakelite shrouds.

### 36. Clamps & Connectors

CLAMPS & CONNECTORS: Clamps & connectors shall conform to IS: 5561. The clamps and connectors shall be made of materials listed below:

For connecting ACSR conductors	Aluminium alloy casting, conforming to designation A6 of IS: 617 and shall be tested for all tests as per IS: 617
For connecting equipment terminals made of copper with ACSR conductor	Bimetallic connectors made from aluminium alloy casting conforming to designation A6 of IS:617 with 2mm thick Bimetallic liner and shall be tested as per IS:617
For connecting GS shield wire	Galvanised mild steel
Bolts, Nuts & plain washers	Hot dip galvanised mild steel for sizes M12 and above, and electro-galvanised for sizes below M12
Spring washers for items 'a' to 'c'	Electro-galvanised mild steel suitable for at least service condition 4 as per IS:1573

All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

No current carrying part of a clamp or connector shall be less than 10 mm thick. They shall be designed and manufactured to have minimum contact resistance.

For Bimetallic clamps or connectors, copper alloy liner of minimum 2 mm thickness shall be provided.

Flexible connectors, braids or laminated strips made up of copper/ aluminium for the terminal clamps for equipment shall be suitable for both expansion or through (fixed/ sliding) type connection of IPS Aluminium tube as required. In both the cases the clamp height (top of the mounting pad to center line of the tube) should be same.

Size of the terminal/conductor for which the clamp/connector is suitable shall be embossed/punched (i.e. indelibly marked) on each components of the clamp/connector, except on the hardware.

Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/ connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

Clamps and connector shall be designed corona controlled.

Clamps & connectors shall conform to type tests and shall be subjected to routine and acceptance tests on minimum 3 samples per lot as per IS: 5561. Type tests report for all clamps and connectors for temperature rise test, tensile test, shall be furnished by the Contractor.

### 37. Epoxy Based Protective Paint

#### 1. SCOPE

This specification covers the requirement of self-priming epoxy-based protective paint both for new and old steel structures such as poles, sub-station structures etc.

#### 2. COMPOSITION

The paint shall be epoxy-based with metallic zinc as an essential component. The paint shall be supplied in two components and shall be suitable for a single coat application. It shall have such composition as to satisfy the requirements of this standard. The mixing ratio (base-to-accelerator) shall be specified by the manufacturer.

#### 3. REQUIREMENTS

3.1	Volume Solids	85% ( $\pm$ )3%
3.2	Theoretical covering Capacity	6.5 sq. mtrs. per litre at 125 microns dry film thickness
3.3	Weight per 10 litres of mixed paint	14 to 15 Kg. ( $\pm$ ) 0.3 kg
3.4	Drying time (at 30 OC) dry	Surface : Not more than 4 hours Hard Dry : 16-18 hours Recoating Time: 16-18 hours Curing time : 7 days
3.5	Scratch hardness (with 1.5 kg.load)	No such scratch as to show the base metal
3.6	Finish	Smooth and semi-glossy
3.7	Colour	Ash Grey or Aluminium (as required)
3.8	Dry Film Thickness	The paint shall develop a dry film of minimum 100-125 microns in a single coat(measured by Elcometer)
3.9	Flash point	Not below 40 OC
3.10	Flexibility and adhesion	The paint shall not show damage, detachment or cracking.
3.11	Resistance to humidity	Shall pass 1000 hours (minimum) at 125 microns D.F.T
3.12	Resistance to lubricating oil petroleum, hydrocarbon solvent,petrol and heat	Shall show no sign of permanent injury

**4. STORAGE LIFE & POT LIFE**

4.1	Storage life	Minimum 6 months from the date of manufacture in original sealed container under normal covered storage conditions
4.2	Pot life (at 30OC)	Not less than 4 hours

**5. DURABILITY**

Under severe surface conditions, paint shall protect the substrate at least for 5 years, if it is wire-brushed/power tool cleaned and 7 years for commercially grit-blasted steel sub-strate.

**6. SURFACE PREPARATION**

If possible, the surface on which the paint has to be applied shall be cleaned by grit blasting, otherwise manual wire brushing or power tool cleaning process may be used as convenient.

**7. METHOD OF APPLICATION**

Brushing, rollers or spraying.

**8. TESTS**

The following tests shall be carried out in accordance with the procedure given in the Indian Standard quoted against each, except requirements stipulated in clauses 3.1 and 3.2 which shall be tested in accordance with the procedure indicated in Annexure-II; preparation of painted panels for conducting different tests shall be done as given in Annexure-I.

- 8.1** Requirement stipulated in clauses 3.3 to 3.12 - **IS:101**
- 8.2** **Resistance to Salt Spray**  
Shall pass 1000 hours (minimum with 200 microns D.F.T.) - **IS:2074**
- 8.3** **Chemical Resistance**  
Shall be resistant to acid/alkaline chemicals or solvents - **IS:8662**

**9. PACKAGE**

Unless otherwise specified by the purchaser, the paint shall be normally supplied in 2 litre packs.



**Annexure – I****DETAILS OF PREPARATION OF PAINTED PANELS FOR TESTING EPOXY BASED****PROTECTIVE PAINT ( TWO PACKS)**

S. N .	Test	Type of Metal	Size in mm	Painting Details	Dry Film Thickness	Method of Application	Duration of air drying before commencement of test	Special Instructions
1	2	3	4	5	6	7	8	9
1	Drying Time	Mild Steel	150x100x1.25	One coat of Epoxy based protective paint	100□	Brush /Spray	-	-
2	Finish		-do-		-do -	-do -	48 hours	
3	Colour	-do -	-do -	-do -	-do-	-do -	24 hours	-
4	Dry Film Thickness	-do -	-do -	-do -	-do -	-do -	24 hours	-
5	Flexibility and adhesion	-do -	150x150x0.315	-do-	-do-	-do-	7 days	-
6	Scratch Hardness	Tinned	-do -	-do -	-do -	-do -	-do -	-
7	Resistance to Salt Spray	-do -	150x150x1.25	-do-	200□	-do -	7 days	Apply a load of 1.5 Kgs. Instead of 1 kg.
8	Protection against corrosion under conditions of condensation	Mild Steel	- do -	-do-	125□	- do -	- do -	As specified in Col.15.1 of IS: 101 – 64

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## ANNEXURE-II

### Procedure for determining volume solids

#### 1. Scope :

This method is applicable to the determination of the volume non-volatile matter of paint coatings.

#### 2. Significance :

This method is intended to provide a measure of the volume of dry coating obtainable from a given volume of liquid coating. This volume is considered to be the most equitable means of comparing the coverage (square metre of surface covered at a specific film thickness per unit volume) and also for calculating the wet film thickness of the given paint.

#### 3. Apparatus

- i) Analytical Balance
- ii) Steel disc : Preferably stainless steel, 60mm dia, and 0.70mm thickness with a small hole 2 to 3mm from the edge. A fine wire such as chromel is attached through the hole and made of the appropriate length for suspending the disc in a liquid.
- iii) Weight Box
- iv) Beaker : 1 litre for weighing the disc in liquid.
- v) Weight per litre cup for determining the specific gravity of the paint material and of the suspending liquid if not known.
- vi) Oven

#### 4. Procedure

- i) Dry the disk in an oven at 105<sup>0C</sup> for 10 minutes and cool.
- ii) Weigh the disk in air, let it be W1 grams.
- iii) Suspend the disk in water and weigh again. Let it be W2 grams.
- iv) Calculate the volume of disk 'V' as follows:

$V = W1 - W2 / d$  where 'd' is the density of the water at room temperature

- v) Determine the weight of non-volatile content per gram of the liquid coating material by drying a known amount of paint at 105<sup>0</sup>C for 3 hours. Let it be 'W' grams.
- vi) Determine the specific gravity of the paint to the nearest 0.001 g/ml. by using weight per liter cup. Let it be 'p'.
- vii) Dip the disk in the paint sample for 10 minutes, and take out the disc and allow the excess coating material to drain off. Blot the coating material off the bottom edge of the disc so that beads or drops do not dry on the bottom edge of the disc.
- viii) Dry the disc in oven for 3 hours at 105<sup>0</sup> C and cool.
- ix) Weigh the coated disc in air. Let it be W3 grams.
- x) Suspend the coated disc in water and weigh it. Let it be W4 grams.
- xi) Calculate the volume of the coated disc as follows:

$V1 = W3 - W4/d$ , where 'd' is the density of the water at room temperature.

- xii) Calculate the volume of the dried coating as follows:

Volume of dried coating ( $V_d$ ) =  $V1 - V$

- xiii) Calculate the volume of the wet coating as follows:

$V_w = W3 - W1/W \times P$ , where W = grams of non volatile matter in one gram of wet coating

P= Specific gravity of the paint.

- xiv) Calculate the percentage volume solids of the paints as follows:

$$= \frac{V1 - V \times 100}{V_w} \quad \text{or} \quad \frac{V_d \times 100}{V_w}$$

The volume of non volatile matter or the percentage volume solids of a paint is related to the covering capacity and film thickness in the following manner:

- a) Theoretical Coverage ( $m^2/l$ ) =  $\frac{\% \text{ volume solids} \times 10}{\text{Dry film thickness (in microns)}}$
- b) Wet film thickness (in microns) =  $\frac{\text{Dry Film thickness} \times 100}{\% \text{ volume solids}}$

% volume solids.

### **38. Mid Span Compression Joint and Repair Sleeve**

#### **1.0 Mid Span Compression Joint**

- 1.1** Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistivity less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.
- 1.2** In ACSR conductors, the joint shall be made of steel and Aluminium for jointing the steel core and Aluminium respectively. The steel sleeve should not crack or fail during compression. The Brinell Hardness of steel sleeve shall not exceed 200. The steel sleeve shall be hot dip galvanised. The Aluminium shall have Aluminium/alloy. Aluminium plugs shall also be provided on the line of demarcation between compression and non compression zone.

#### **2.0 Repair Sleeve**

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from Aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during **installation**.

#### **3.0 Material and Workmanship**

- 3.1** All the equipment shall be of the latest proven design and conform to the best modern practices adopted in the power line field. The Supplier shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 11/33 kV transmission line application and will give continued good performance.
- 3.2** The design, manufacturing process and quality control of all the materials shall be such as to achieve requisite factor of safety for maximum working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.
- 3.3** All ferrous parts shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanized as per grade 4 of IS-1573-1970. The bolt threads shall be undercut to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS:2629-1985 / IS-1367 (Part-13) and satisfy the tests mentioned in IS-2633-1986. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall have a minimum over range coating of Zinc equivalent to 600 gm/sq.m and shall be guaranteed to withstand at least six dips each lasting one minute under the standard Peerce test for galvanising unless otherwise specified.

- 3.4 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn.99.95 as per IS:209.
- 3.5 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc.
- 3.6 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum and localised heating phenomenon is averted.
- 3.7 No equipment shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all service conditions.
- 3.8 Particular care shall be taken during manufacture and subsequent handling to ensure smooth surface free from abrasion or cuts.
- 3.9 The fasteners shall conform to the requirements of IS:6639-1972. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

#### **4.0 Compression Markings**

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

#### **5.0 Drawings**

- 5.1 The Supplier shall furnish detailed dimensioned drawings of the equipments and all component parts. Each drawing shall be identified by a drawing number and Contract number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions and dimensional tolerances shall be mentioned in mm.
- 5.2 The drawings shall include
- (i) Dimensions and dimensional tolerances

(ii) Material. Fabrication details including any weld details and any specified finishes and coatings. Regarding material, designations and reference of standards are to be indicated.

(iii) Catalogue No.

(iv) Marking

(v) Weight of assembly

(vi) Installation instructions

(vii) Design installation torque for the bolt or cap screw

(viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts

(ix) The compression die number with recommended compression pressure.

(x) All other relevant technical details

**5.3** The above drawings shall be submitted in 3 copies with all the details as stated above along with the bid document. After the placement of award. The Contractor shall again submit the drawings in four copies to the Owner for approval. After Owner's approval and successful completion of all type tests, 10 more sets of drawings shall be submitted to Owner for further distribution and field use at Owner's end.

## **6.0 Tests**

### **6.1 Type Tests**

#### **6.1.1 Mid Span Compression Joint for Conductor**

(a) Chemical analysis of materials ( as per Annexure – A)

(b) Electrical resistance test

(c) Heating cycle test

(d) Slip strength test

#### **6.1.2 Repair Sleeve for Conductor**

(a) Chemical analysis of materials

#### **6.1.3 Flexible Copper Bond**

(a) Slip Strength Test ( as per Annexure – A)

### **6.2 Acceptance Tests**

#### **6.2.1 Mid Span Compression Joint for Conductor and Earthwire**

(a) Visual examination and dimensional verification

(b) Galvanising test

(c) Hardness test

### **6.2.2 Repair Sleeve for Conductor**

(a) Visual examination and dimensional verification

### **6.2.3 Flexible Copper Bond**

(a) Visual examination and dimensional verification

(b) Slip strength test

### **6.3 Routine Tests**

(a) Visual examination and dimensional verification

### **6.4 Tests During Manufacture**

On all components as applicable

(a) Chemical analysis of Zinc used for )  
galvanising )

(b) Chemical analysis mechanical metallo- )  
graphic test and magnetic particle ) As per Annexure-A  
inspection for malleable castings )

(c) Chemical analysis, hardness tests and )  
magnetic particle inspection for forgings )

## **7.0 Tests and Standards**

### **7.1 Testing Expenses**

**7.1.1** Supplier shall indicate the laboratories in which they proposes to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

**7.1.2** The Contractor shall intimate the Owner about carrying out of the type tests alongwith detailed testing programme at least 3 weeks in advance of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

### **8.0 Sample Batch For Type Testing**

**8.1** The Contractor shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Owner. The Contractor shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be

manufactured strictly in accordance with the Quality Assurance Programme approved by the Owner.

- 8.2** Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

**9.0 Schedule of Testing and Additional Tests**

- 9.1** The Supplier has to indicate the schedule of following activities

- (a) Submission of drawing for approval.
- (b) Submission of Quality Assurance programme for approval.
- (c) Offering of material for sample selection for type tests.
- (d) Type testing.

- 9.2** The Owner reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Contractor's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications.

- 9.3** The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items, all without any extra cost to the Owner.

**10 Test Reports**

- 10.1** Copies of type test reports shall be furnished in atleast six copies alongwith one original. One copy shall be returned duly certified by the Owner, only after which the commercial production of the concerned material shall start.

- 10.2** Copies of acceptance test report shall be furnished in atleast six copies. One copy shall be returned, duly certified by the Owner, only after which the materials will be despatched.

- 10.3** Record of routine test report shall be maintained by the Contractor at his works for periodic inspection by the Owner's representative.

- 10.4** Test certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

**11.0 Inspection**

- 11.1** The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub-Contractor's works raw materials.



manufacturer's of all the material and for conducting necessary tests as detailed herein.

- 11.2** The material for final inspection shall be offered by the Contractor only under packed condition. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.
- 11.3** The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.
- 11.4** Material shall not be despatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be despatched only after all tests specified herein have been satisfactorily completed.
- 11.5** The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such material are later found to be defective.

#### **12.0 Packing and Marking**

- 12.1** All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 50 Kg to avoid handling problems.
- 12.2** The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 12.3** Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 12.4** Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.
- 12.5** Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture.
- 12.6** All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly despatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stencilled on it in indelible ink.

#### **13.0 Standards**

- 13.1** The Hardware fittings, conductor and earthwire accessories shall conform Indian/International Standards which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

## **ANNEXURE – A**

### **1.0 TESTS ON HARDWARE FITTINGS**

#### **1.1 Galvanising/Electroplating Test**

The test shall be carried out as per Clause no. 5.9 of IS:2486-(Part-1) - 1972 except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

#### **1.2 Mechanical Strength Test of Each Component**

Each component shall be subjected to a load equal to the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached and the value recorded.

#### **1.3 Mechanical Strength Test of Welded Joint**

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ ultrasonic test. There shall not be any crack at the welded portion.

#### **1.4 Clamp Slip Strength Vs Torque Test for Suspension Clamp**

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of Conductor shall be fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be more than 12.5% but less than 20% of conductor rated strength.

### **2.0 TESTS ON CONDUCTOR AND EARTHWIRE ACCESSORIES**

#### **2.1 Mid Span Compression Joint for Conductor and Earthwire**

##### **(a) Slip Strength Test**

The fitting compressed on conductor/earthwire shall not be less than one metre in length. The test shall be carried out as per IS:2121 (Part-II)- clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/earthwire and retained for one minute at this load. There shall be no movement of the conductor/ earthwire relative to the fittings and no failure of the fittings during this one minute period.

**(b) Hardness Test**

The Brinnel hardness at various points on the steel sleeve of conductor core and of the earthwire compression joint and tension clamp shall be measured.

**2.2 Flexible Copper Bond****a) Slip Strength Test**

On applying a load of 3 kN between the two ends, stranded flexible copper cable shall not come out of the connecting lugs and none of its strands shall be damaged. After the test, the lugs shall be cut open to ascertain that the gripping of cable has not been affected.

**2.3 Chemical Analysis Test**

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

**3.0 TESTS ON ALL COMPONENTS (AS APPLICABLE)****3.1 Chemical Analysis of Zinc used for Galvanizing**

Samples taken from the zinc ingot shall be chemically analysed as per IS-209. The purity of zinc shall not be less than 99.95%.

**3.2 Tests for Forgings**

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognised procedures for these tests. The, sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

**3.3 Tests on Castings**

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Pro

### 39. Terminal Block

All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of cabinet, junction box, terminal box and marshalling box.

The terminal blocks shall be made of moulded, non-inflammable thermosetting plastic. The material of terminal block moulding shall not deteriorate because of varied conditions of heat, cold humidity, dryness etc. that would be anticipated at the location where the equipment is proposed to be installed.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CAT-M4.

The conducting part in contact with cable shall be tinned or silver plated. The terminal blocks shall be of extensible design. The terminal blocks shall be of 1100 V grade and shall be rated to carry continuously the maximum current that is expected to be carried by the terminals.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deterioration type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

The terminals shall be provided with the marking tags for wiring identification.

The blocks shall be provided with 20% spare terminals unless otherwise specified. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT/VT      Minimum of two 2.5 sq.mm copper flexible

All CT/VT circuits      Minimum of 4 nos. of 2.5 sq.mm copper flexible

AC/DC Power supply circuit      One of 16 sq. mm. Aluminium.

There shall be a minimum clearance of 250 mm between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. Cabinet wiring should be suitable for 60°C as the space heaters will keep the temperature 10°C higher than the ambient.

For the Control and Relay Panels the terminal blocks for current transformer and voltage transformer secondary lead shall be provided with test links and isolating facilities. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

#### 40. Wiring

All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:

1. All circuits except CT circuits 2.5 sq.mm
2. CT circuits 2.5 sq. mm (minimum number of strands shall be 3 per conductor).

All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.

All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Inter-pole cabling for all equipment's shall be carried out by the Contractor.

## **41 Equipment Erection Notes**

All support insulators, circuit breaker and other fragile equipment shall preferably be handled with cranes with suitable booms and handling capacity.

The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

For cleaning the inside and outside of Hollow insulators only muslin or leather cloth shall be used.

Handling equipment, sling ropes etc. should be tested before erection and periodically for strength.

Bending of compressed air piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

Cutting of the pipes wherever required shall be such as to avoid flaring of the ends, and only a proper pipe cutting tool shall be used. Hack-saw shall not be used.

The Contractor shall arrange at site all the equipments, instruments and auxiliaries required for testing and commissioning of equipment.

### **STORAGE OF EQUIPMENTS**

The Contractor shall provide and construct adequate storage shed for proper storage of equipments. Weather sensitive equipment shall be stored indoor. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instruction of the equipment manufacturer/Owner shall be strictly adhered to.

## **42 Danger Notice Plates**

### **1. SCOPE**

This Specification covers Danger Notice Plates to be displayed in accordance with rule No. 35 of Indian Electricity Rules, 2003.

### **2. APPLICABLE STANDARDS**

Unless otherwise modified in this specification, the Danger Notice Plates shall comply with IS:2551-1982 or the latest version thereof.

### **3. DIMENSIONS**

#### **3.1** Two sizes of Danger Notice Plates as follows are recommended:

- a) For display at 415 V installations - 200x150mm
- b) For display at 11 KV (or higher voltages) installations - 250x200mm

#### **3.2** The corners of the plate shall be rounded off.

#### **3.3** The location of fixing holes as shown in Figs. 1 to 4 is provisional and can be modified to suit the requirements of the purchaser.

### **4. LETTERINGS**

All letterings shall be centrally spaced. The dimensions of the letters, figures and their respective position shall be as shown in figs. 1 to 4. The size of letters in the words in each language and spacing between them shall be so chosen that these are uniformly written in the space earmarked for them.

### **5. LANGUAGES**

#### **5.1** Under Rule No. 35 of Indian Electricity Rules, 2003, the owner of every medium, high and extra high voltage installation is required to affix permanently in a conspicuous position a danger notice in Hindi or English and, in addition, in the local language, with the sign of skull and bones.

#### **5.2** The type and size of lettering to be done in Hindi is indicated in the specimen danger notice plates shown in Fig. 2 and 4 and those in English are shown in Figs. 1 and 3.

#### **5.3** Adequate space has been provided in the specimen danger notice plates for having the letterings in local language for the equivalent of 'Danger', '415' '11000' and 'Volts'.

**6. MATERIAL AND FINISH**

The plate shall be made from mild steel sheet of at least 1.6mm thick and vitreous enameled white, with letters, figures and the conventional skull and cross-bones in signal red colour (refer IS:5-1978) on the front side. The rear side of the plate shall also be enamelled.

**7. TESTS**

The following tests shall be carried out :

- i) Visual examination as per IS:2551-1982
- ii) Dimensional check as per IS:2551-1982
- iii) Test for weather proofness as per IS:8709-1977 (or its latest version)

**8. MARKING**

Maker's name and trade mark and the purchaser's name shall be marked in such a manner and position on the plates that it does not interfere with the other information.

**9. PACKING**

The plates shall be packed in wooden crates suitable for rough handling and acceptable for rail/road transport.



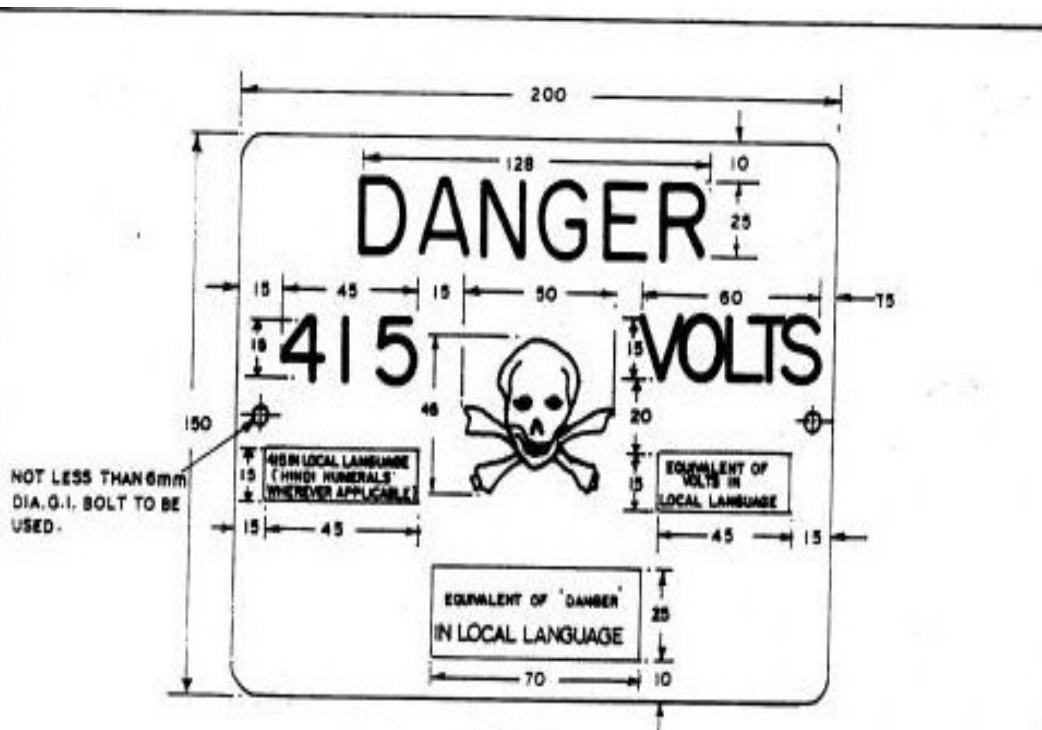


FIG. - 1

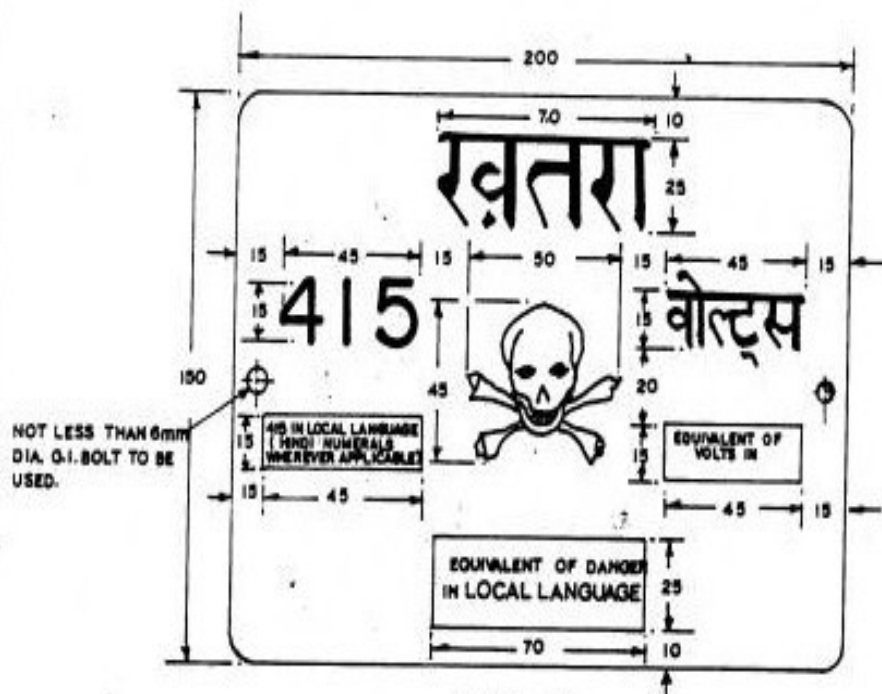
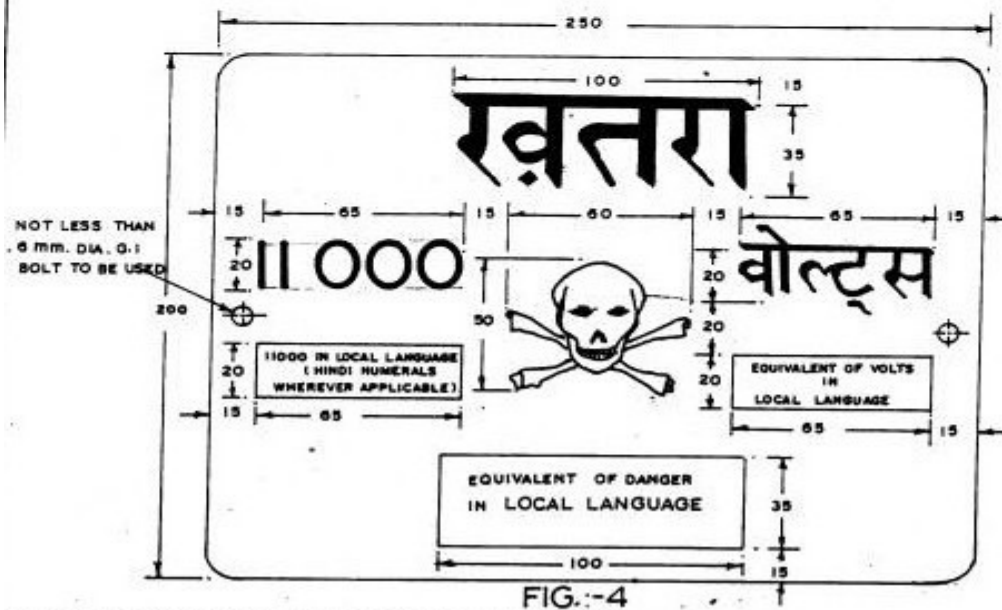
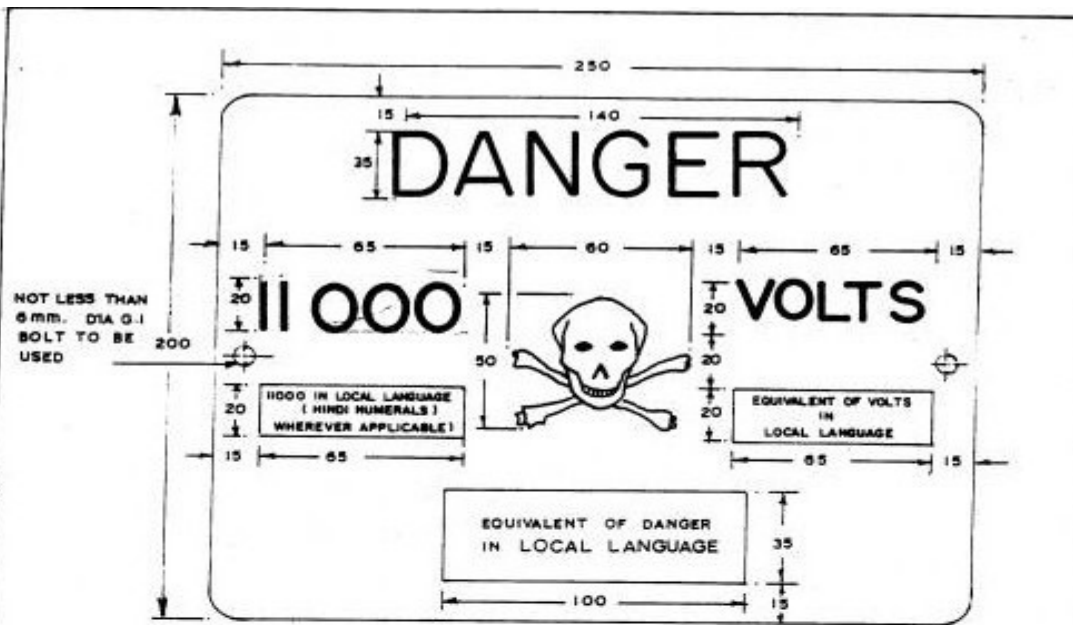


FIG. - 2

ALL DIMENSIONS ARE IN mm.



NOTE: 11000 SHALL BE REPLACED BY 33000, 66000 ETC. AS REQUIRED.

ALL DIMENSIONS ARE IN MM.

### 43 Number Plate (Support)

Weather proof number plate shall have unique name are to be installed on the pole support. The plate shall be made from mild steel sheet of at least 1.6mm thick and vitreous enameled white, with letters in signal red color (refer IS: 5-1978) on the front side. The rear side of the plate shall also be enameled. The digits shall be as under:

**110121**

**000001**

**226**

Digits shall be displayed as detailed above having at-least 25mm height. The over all size of the plate shall be 200x250mmx1.6mm. The corners of the plate shall be rounded off. All lettering shall be centrally spaced. The dimensions of the letters, figures and their respective position shall be as shown above. The size of digits and spacing between them shall be so chosen that these are uniformly written in the space earmarked for them. The type and size of digits to be written in English as indicated above. The plate should be provided with 6mm dia holes in horizontal alignment for fixing to the pole by means of Galvanized MS flat clamp of 25x3 mm size. The nut & bolts used for fixing of plate should be of galvanized and washers of electro-plated. The bolt should be used of at-least 6mm diameter.

TESTS: The following tests shall be carried out:

- i) Visual examination as per IS:2551-1982
- ii) Dimensional check as per IS:2551-1982
- iii) Test for weather proof-ness as per IS 8709-1977 (or its latest version).

### **Numbering Transformer/ Feeders/ Equipments ( in Grid Sub-Station ):**

All augmented/ new power transformer, Breakers, Outgoing feeders, respective control panels, Kiosks are to be named. Base should be painted with yellow paint and black digits should be displayed of at-least 25mm height. Experienced painter should be used to provide this work. LT and HT bushing should be colour coded, CT and PT panels are to be named. The Yellow base plate should be encircled by a black strip. Naming shall be in the local as well as English language.

### **Numbering of control panel:**

Name of Feeder should be displayed on front end and at rear end along with serial number of the panel. Yellow base paint and 25mm high black digits are to be used for this purpose. The base paint should be encircled by a black strip. Naming shall be in the local as well as English language.

Strip  
25mm Height



#### **44 Cable Glands and Lugs**

Cable glands shall be Double compression type, tinned/Nickel plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.

The cable glands shall be tested as per BS: 6121. The cable glands shall also be duly tested for dust proof and weather proof termination.

Cables lugs shall be tinned copper solder less crimping type conforming to IS: 8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

## **45.0 Cables Tags and Markers**

Each cable and conduit run shall be tagged with numbers that appear in the cables and conduit schedule.

The tag shall be of aluminum with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS: 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate.

Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint".

The marker shall project 150 mm above ground and shall be spaced at analysis interval 30 meters and at every change in direction. They shall also be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing and on each duct/conduit entry. Cable tags shall be provided inside the switchgear, motor control centers, control and relay panels, etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/ conduits quoted by the contractor.

Specific requirements for cabling for cabling, wiring, ferrules as covered in respective equipment section shall also be complied with.

### **CABLE GLANDS**

Double compression type cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof termination. Required number of packing glands to close unused openings in gland plates shall also be provided.

### **CABLE LUGS**

Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided. Crimping tool used shall be of approved design and make.

Storage and handling of cable drums

Cable drums shall be unloaded, handled and stored in an approved manner. Rolling of drums shall be avoided as far as practicable. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication the drums may be rolled in the same direction it was rolled during taking up the cables.

## **CABLE SUPPORTS AND CABLE TRAY MOUNTING ARRANGEMENTS**

Cable trenches in the control room are normally provided with embedded steel inserts on concrete floors/ walls. The Contractor shall secure supports by welding to these inserts or available building steel structures.

Insert plates will be provided at an interval of 600 mm wherever cables are to be supported without the use of cable trays, while at all other places these will be at an interval of 2000 mm.

## **CABLE TERMINATIONS AND CONNECTIONS**

The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/ or as directed by the Owner.

The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

The equipment will be generally provided with un-drilled gland plates for cables/ conduit entry. The Contractor shall be responsible for drilling of gland plates, painting, and touching up. Holes shall not be made by gas cutting.

The Contractor shall tag/ferrule the control cable cores at all terminations, as instructed by the Owner. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well. Spare cores shall be similarly tagged with cable numbers and coiled up.

Control cables shall have stranded copper conductor. Bare portion of the solid conductors shall be tinned after removing the insulation and shall be terminated directly without using cable lugs.

All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor with the approval of the Owner.

## **DIRECTLY BURIED CABLES**

The Contractor shall construct the cable trenches required for directly buried cables. The scope of work and unit rates for construction of cable trenches for cables shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective cover, back filling and reaming, supply and installation of route markers and joint markers. The Contractor/Supplier shall ascertain the soil conditions prevailing at site, before quoting the unit rates. Laying the cable and providing protective covering shall be as per approved drawing.

**Installation of cables**

Power and control cables shall be laid in separate tiers. The order of laying of various cables shall be as follows:

- Power cables on top tiers.
- Control, instrumentation and other service cables in bottom tiers.

Single core cable in trefoil formation shall be laid with a distance of three times the diameter of cables between trefoil center lines. All power cables shall be laid with a minimum center to center distance equal to twice the diameter of the cable.

Power and control cables shall be securely fixed to the trays/ supports. Trefoil clamps for single core cables shall be pressure die-cast aluminum (LM-6). Nylon-6 or fiber glass and shall include necessary fixing nuts, bolts, washer, etc. These are required at every 2 meter of cable run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminum strip clamps at every 2 m. Horizontal runs in cable trays and trenches shall be secured using 4 mm nylon cord at every 2 m.

Cables shall not be bent below the minimum permissible limit. The minimum bending radius of power cables shall be 12D and that of control cables shall be 10D, where D is overall diameter of cable.

Where cables cross roads, drains and rail tracks, the cables shall be laid in reinforced spun concrete or steel pipes, buried at not less than one meter depth.

In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T. cables) straight through joints to be made, should the cable develop fault at a later date.

Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Owner.

Control cable terminations inside equipment enclosures shall have sufficient lengths so that switching of termination in terminal blocks can be done without requiring any splicing.

Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required.

Rollers shall be used at intervals of about 2.0 meters, while pulling cables.

All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kink, sharp bends, etc.

Cable ends shall be kept sealed to prevent damage.

Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard codes or practices.

Wherever cables pass through floor or through wall openings or other partitions, wall sleeves with bushes having a smooth curved internal surface so as not to damage the cables shall be supplied, installed and properly sealed at no extra charges.



The erection work shall be carried out in a neat workmanlike manner and the areas of work shall be cleaned of all scrap materials after the completion of work in each area every day. Contractor shall remove the RCC/steel trench covers before taking up the work and shall replace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.

Contractor shall furnish three copies of the report on work carried out in a particular week, such as cable numbers and a date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever the modifications are made.

In case the outer sheath of a cable is damaged during handling/ installation, the Contractor shall repair it at his own cost, and to the satisfaction of the Engineer-in-Charge. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Contractor shall not be paid for supply, installation and removal of the damaged cable.

All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating type, sleeve or paint.

## **46.0 Earth Knobs for LT Lines**

### **1. SCOPE**

This standard covers the requirements of knobs for supporting the neutral-cum-earth wire used for earthing of metal parts of supporting structures of overhead power lines with a nominal voltage upto 1000V (refer Construction Standard B-3 & B-4).

### **2. APPLICABLE STANDARDS**

Except when they conflict with the specific requirements of this specification, the earth knobs shall conform to the latest version of IS:9511-1980.

### **3. MATERIALS**

Earth knobs shall be made of cast iron.

### **4. GENERAL REQUIREMENTS**

Earth knobs shall not have blow holes, shrinkage and other casting defects. The top and bottom flat portion of earth knob shall be smooth and plain.

### **5. SHAPE AND DIMENSIONS**

The shape and dimensions of earth knob shall conform to Fig. 1.

### **6. ACCEPTANCE TESTS**

The following acceptance tests shall be carried out atleast on one knob for every 1000 nos.

#### **6.1 Electrical Resistance**

**6.1.1** The electrical resistance of the earth knob shall be measured using a Kelvin bridge. Adequate electrical contact shall be ensured against the two surfaces of the knob preferably by using brass washers, soldered to the leads going to the bridge circuit. The washers shall be of adequate size to ensure sufficient area of contact.

**6.1.2** The electrical resistance of the earth knob, measured as given in 6.1.1 between the two flat portions, shall not exceed 200 m ohms.

#### **6.2 Mechanical Strength**

The breaking strength at the neck of the earth knob shall not be less than 11,500 kg. when force is applied in the direction shown in Fig. 2.

## 7. MARKING

Each earth knob shall be marked with the name of the manufacturer or his trade mark.

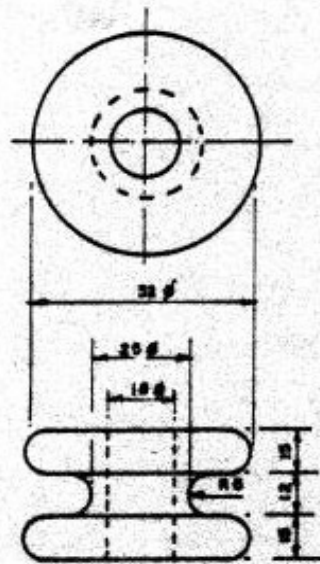


FIG. 1

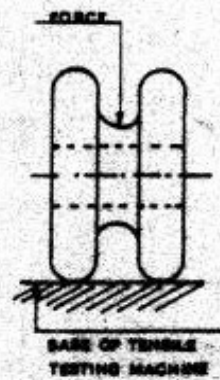


FIG. 2

एल. टी. लाइनों के लिए अर्थनाब  
EARTH KNOB FOR LT. LINES

## 47.0 GI Wires

### 1. SCOPE

This specification covers details of solid G.I. Wires for use in rural distribution system.

### 2. APPLICABLE STANDARDS

Except when they conflict with the specific requirements of this specification, the G.I. wires shall comply with the provisions of IS:280-1978 and IS:7887-1975 or the latest version thereof.

### 3. APPLICATION & SIZES

G.I. wires covered in this Specification are intended for the following applications :

Application	Sizes (nominal dia)
Bearer wire for service	3.15mm (for single phase cables services ) 4 mm ( for three phase services)
Earthing of Transformers, poles & Fittings.	4 mm
Continuous Earthwire for. 11 KV lines	4 mm
Protective guarding at the crossing of overhead power lines with roads, railway tracts and telecommunication lines	3.15, 4 and 5 mm

### 4. MATERIAL

- 4.1** The wires shall be drawn from the wire rods conforming to IS:7887-1975 or the latest version thereof.
- 4.2** The requirements for chemical composition for the wires shall conform to IS:7887.
- 4.3** The wires shall be sound, free from split surface flaws, rough jagged and imperfect edges and other detrimental defects on the surface of the wires.

### 5. GALVANISING

The wires shall be galvanised with 'Heavy Coating' as per IS:4826-1979 or the latest version thereof.

## 6. GRADES

GI wires shall be classified into two grades based on their tensile strength :

Grade	Tensile Strength (MPa)
Annealed	300-550
Hard	550-900

## 7. TOLERANCE IN DIAMETER

The tolerance on nominal diameter at any section of wire shall not exceed ( $\pm$ )2.5%. Further, the maximum difference between the diameters at any two cross-sections of wires shall not exceed 2.5%.

## 8. TESTS

The following tests shall be carried out in accordance with IS:280-1978 or the latest version thereof as per sampling criteria stipulated therein :

- i) Dimensional check (dia) - refer clause 7 above.
- ii) Visual inspection regarding freedom from defects refer clause 4.3 above.
- iii) Tensile test
- iv) Wrapping test (for wire diameters smaller than 5mm)
- v) Bend test (for wire diameters 5mm only)
- vi) Coating test - refer clause 5 above
- vii) Chemical composition

## 9. PACKING

The wires shall be supplied in 50-70 kg. coils, each coil having single continuous length. Each coil of wire shall be suitably bound and fastened compactly and shall be protected by suitable wrapping.

## 10. MARKING

Each coil shall be provided with a label fixed firmly on the inner part of the coil bearing the following information :

- a) Manufacturer's name or trade mark
- b) Lot number and coil number
- c) Size
- d) Grade (Annealed or Hard)
- e) Mass
- f) Length
- g) ISI Certification mark, if any

**48.0 Hot Dip Galvanised GS Solid Wire**

The hot dip galvanized MS Solid wire of sizes 5 mm, 4 mm and 3.15 mm diameters shall conform to the relevant ISS specification, briefed here below: -

**1) MATERIAL**

The Mild Steel wire shall have the chemical composition maximum sulfur - .055%, Phosphorus – 0.055%, Carbon 0.25%. Zinc shall conform to grade Zen 98 specified in IS 209-1966 & IS: 4826-1979 with up to date amendments.

**2) ZINC COATING**

Zinc coating shall be in accordance with IS: 4826-1979 (Col.4.2.1) for heavily coated hard quality.

**3) GALVANISING**

Galvanizing shall be as per IS 2629-1966, IS: 4826-1979 with up to date amendments.

**4) UNIFORMITY OF ZINC COATING**

Uniformity of Zinc coating shall be as per IS 2633-1972 (Col.4.2.1 to 4.2.3) with up to date amendments.

**5) TENSILE PROPERTIES**

The tensile strength of the wire after, galvanizing shall be between 55-95 Kg/Sq.mm (heavily coated Hard as per IS: 4826-1979 Tables-1) ensuring MS wire Mechanical properties as per IS-28-1972 8.1 to 8.3.

**6) FREEDOM FROM DEFECTS**

As per IS 2629-1966 (Cl.6.1) & 4826-1979 (Col.4.3) & with up to date amendments, be ensured.

**7) TESTS**

During the process of manufacture/ fabrication and finish all tests for chemical, mechanical, galvanizing as per IS-280-1979, IS: 1521-1972, IS1755-1961, IS: 6745-1972 & 4826-1979 be carried out. Test certificate towards, chemical composition (as per above) shall be submitted for each lot offered for inspection.

The following tests shall be conducted in presence of owner's representative.

1. Visual Physical inspection and measurement of specified dimensions.
2. Coating test as per IS-1755-1961, IS: 2629-1966, IS: 2633-1972, IS: 4826-1969 & 1979 – IS: 6745-1972.
3. Adhesion test as per IS: 1755-1961, IS: 2629-1966, IS: 2633-1972, IS: 4826-1969 & 1979 – IS: 6745-1972.
4. Tensile strength and breaking load and elongation determined as per IS 1521-1972 with up to date amendments.

**8) PACKING**

Packing shall be as per IS 280-1979 (Col.3.1) and each coil shall be between 50-100 Kg.

**9) MARKING**

As per IS: 280-1972 (Col.14.1 & 14.1.1) is required.



**49.0 Material Properties and Other Technical Requirements for Heat Shrinkable Cable Terminations and Joints Suitable for XLPE Cables.**

- 1) GENERAL:** The term heat shrink refers to extruded or moulded polymeric materials which are cross linked to develop elastic memory and supplied in expanded or deformed size or shape.
- 2) QUALIFYING EXPERIENCE:** The kits should have satisfactory performance record in India in excess of 5 years supported with proof of customers having had satisfactory use of these kits in excess of 5 years.
- 3) TYPE TEST REPORTS:** The Joints and terminations should have been type tested and type test reports made available.
- 4) KITS CONTENTS :** The Kits should generally consist of:
  - (a)** Heat shrinkable clear insulating tubes
  - (b)** stress control tubing where necessary,
  - (c)** Ferrule insulating tubing for joints,
  - (d)** Conductive cable break outs for terminations, non tracking, erosion and weather resistant tubing both outer / inner
  - (e)** non tracking erosions and weather resistant outdoor sheds in case of terminations
  - (f)** high permittivity mastic wedge
  - (g)** Insulating mastic.
  - (h)** Aluminium crimping lugs of ISI specification.
  - (i)** Tinned copper braids
  - (j)** Wrap around mechanical protection for joints.
  - (k)** Cleaning solvents, abrasive strips.
  - (l)** Plumbing metal.
  - (m)** Binding wire etc. adequate in quantity and dimensions to meet the service and test conditions.

**The kit shall have installation instructions and shall be properly packed with shelf life of over 3 years.**

## **50.0 Installation**

### **1. Earthing**

The earthing shall be done in accordance with requirements. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.

### **2. Civil Works**

The civil works shall be done in accordance with requirements stipulated under Section-17 of this specification.

### **3. Structural Steel Works**

The structural steel works shall be done in accordance with requirements stipulated under Section-17 of this specification.

### **4. Bay Equipment**

4.1 The disposition of equipment to be supplied is shown in enclosed single line diagrams and layout drawings.

4.2 The Bidder shall prepare layout drawings and submit the same for approval of the EMPLOYER. The approval of drg. shall not absolve Bidder from his responsibility regarding designing & engineering of Sub-Station and Bidder shall be fully responsible for all works covered in the scope of this specification.

### **5. Lightning Protection**

Detailed drawings shall be submitted for approved locations on Sub-Station towers provision of lightning rod electrode at suitable Location.

5.1 Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which they shall be directly connected to rod electrode.

5.2 Every down conductor shall be provided with a test joint at about 150 mm above ground level. The test joint shall be directly connected to the earthing system.

5.3 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

## **6. Equipment Erection Notes**

a. All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity.

b. Where, assemblies are supplied in more than one section, Bidder shall make all necessary mechanical and electrical connections between sections including the connection between buses. Bidder shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Bidder at his own expense. The Bidder shall strictly follow manufacturer's recommendations for handling and erection of equipment.

c. The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength.

d. Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.

e. Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.

f. For cleaning the inside and outside of hollow insulators only Muslin or leather cloth shall be used.

## **7. Storage Of Equipment**

Bidder is responsible for the proper storage and maintenance of all materials/equipment to be supplied by him for the work. The Bidder shall provide & construct adequate storage shed for proper storage of equipment. Sensitive equipment shall be stored indoors. All equipment during storage shall be protected against damage due to acts of nature or accidents. Bidder shall take all required steps to carryout subsequent inspection of materials/equipment stored as well as erected until the same is taken over by the EMPLOYER. The storage instruction of the equipment manufacturers/ Engineer-in-Charge shall be strictly adhered to.

## **8. Cabling**

8.1 Cabling shall be in trenches, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc.

8.2 Cables inside the Sub-Station shall be laid on angle supports at 600mm spacing with separate tiers for control and power cables.

8.3 All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm.

## **9. Conduits, Pipes And Accessories**

9.1 The bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushings, reducers, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes etc. The size of the conduit/pipe shall be selected on the basis of maximum 40% fill criterion. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner, to prevent damage to threaded portion and entrance of moisture and foreign material.

9.2 Rigid conduits shall be flow-coat metal conduits of XXX (name) Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate coatings. The inner surface shall have silicone

epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/pipes shall be of a reputed make.

9.3 The hume pipes and accessories shall be of reinforced concrete conforming to class NP2 of IS: 458. All tests on hume pipes shall be conducted as per IS: 458.

## **10. Cable Tags And Marker**

10.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

10.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

10.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.

10.4 The marker shall project 150mm above ground and shall be spaced at an interval 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

10.5 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate.

10.6 Specific requirements for cabling, wiring ferrules as covered in respective equipment section shall also be complied with.

## **11. Storage And Handling Of Cable Drums**

Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as practicable. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as

marked on the drum. In absence of any indication the drums may be rolled in the same direction it was rolled during taking up the cables.

## **12. Cable Supports And Cable Tray Mounting Arrangements**

12.1 In cases where no embedded steel inserts are available, the Bidder shall have to secure the supports on wall or floors by suitable anchoring at no extra cost to the Employer. Details of fixing steel plates by anchor fasteners shall be decided during detailed engineering stage.

12.2 The cable supports shall conform to the requirements of this Specification.

12.3 Insert plates will be provided at an interval of 600mm wherever cables are to be supported without the use of cable trays, while at all other places these will be at an interval of 2000mm.

## **13. Cable Terminations And Connections**

13.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Employer.

13.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking, (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

13.3 Cost of all consumable material shall be included in the erection rates quoted.

13.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Bidder shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

13.5 The Bidder shall tag/ferrule the control cable cores at all terminations, as instructed by the Employer. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.

13.6 Spare cores shall be similarly tagged with cable numbers and coiled up.

13.7 Control cables shall have stranded copper conductor. Bare portion of the solid conductors shall be tinned after removing the insulation and shall be terminated directly without using cable lugs.

13.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

13.9 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Bidder as directed by the Employer.

#### **14. Directly Buried Cables**

The Bidder shall construct the cable trenches required for directly buried cables. The scope of work and unit rates for construction of cable trenches for cables shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and reaming, supply and installation of route markers and joint markers. The bidder shall ascertain the soil parameters prevailing at site, before quoting the unit rates. Laying the cable and providing protective covering shall be as per approved drawing.

#### **15. Installation of Cables**

15.1 Power and control cables shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.

a) Power cables on top tiers.

b) Control, instrumentation and other service cables in bottom tiers.

15.2 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable.

15.3 Power and control cables shall be securely fixed to the supports. Trefoil clamps for single core cables shall be pressure die-cast aluminium (LM-6), Nylon-6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer, etc. these are required at every 2 metre of cable runs.

15.4 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:

		Minimum bending radius
a)	Type of cable & voltage grade	
	Power	
b)	cable	12 D
	Control	
c)	cables	10 D

Where D is overall diameter of cable.

15.5 Where cables cross roads, drains and rail tracks, the cables shall be laid in reinforced spun concrete or steel pipes, buried at not less than one metre depth.

15.6 In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T cables) straight through joints to be made, should the cable develop fault at a later date.

15.7 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. In case joints are necessary the same shall be supplied by the Bidder. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Employer.

15.8 Control cable terminations inside equipment enclosures shall have sufficient lengths so that switching of termination in terminal blocks can be done without requiring any splicing.

15.9 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required.

15.10 Rollers shall be used at intervals of about 2.0 metres, while pulling cables.



15.11 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kink, sharp bends etc.

15.12 Cable ends shall be kept sealed to prevent damage.

15.13 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS: 1255 and other Indian Standard Codes of practices.

15.14 Wherever cables pass through floor or through wall openings or other partitions, wall sleeves with bushes having a smooth curved internal surface so as not to damage the cables, shall be supplied, installed and properly sealed by the Bidder at no extra charges.

15.15 The erection work shall be carried out in a neat workmanlike manner and the areas of work shall be cleaned of all scrap materials, etc. after the completion of work in each area every day. Bidder shall remove the RCC/steel bench covers before taking up the work and shall replace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.

15.16 Bidder shall furnish three copies of the report on work carried out in a particular week, such as cable numbers and a date on which laid, actual length and route, testing carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.

15.17 In case the outer sheath of a cable is damaged during handling/installation, the Bidder shall repair it at his own cost, and to the satisfaction of the Engineer-in-Charge. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Bidder shall not be paid for installation and removal of the damaged cable.

15.18 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Bidder shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

## **16. Conduits, Pipes Installation**

16.1 Bidder shall supply all conduits, pipes and ducts as specified and to be shown in detailed engineering drawing. Flexible conduit should be used between fixed conduit and equipment terminal boxes. Where vibration is anticipated, the flexible conduit shall be as per the relevant IS.

16.2 Bidder shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anti corrosive paint shall be applied at all field threaded portions. The Bidder shall supply and apply this protective material.

16.3 All conduit/pipes shall be extended on both sides of wall/floor/openings. Exposed conduits/pipes shall be adequately clamped at an interval of about 2m. The fabrication and installation of supports and the clamping shall be included in the scope of work by Bidder.

16.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on any length to facilitate easy dismantling of two conduits.

16.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. G.I. Pull wire of adequate size shall be laid in all conduits before installation.

16.6 Each conduit run shall be painted with its designation as indicated on the drawings, such that it can be identified at each end.

16.7 Embedded conduits shall have a minimum concrete cover of 50mm. Positioning and ensuring proper alignment during concrete by other agencies shall be the responsibility of the Bidder.

16.8 Conduit runs sleeves shall be provided with the bushings at each end.

16.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end. Bushings shall have rounded edges so as not to damage the cables.

16.10 Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to

represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half the arc length of the bend shall be embedded.

16.11 For underground runs, Bidder shall excavate and back fill as necessary.

## **ANNEXURE-I : Earthing Notes**

### **1. General**

1.1 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

1.2 Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules/CEA Regulations, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

1.3 Bolts and nuts required for earthing all main equipment structures and for connecting with earthing system shall be in the scope of the Bidder.

### **2. Details Of Earthing System**

<b>Item</b>	<b>Size</b>	<b>Material</b>
Main Earthing conductor	Suitable for a system current of 31.5 KA/1s as per IS	Mild Steel
Conductor above ground & earthing leads (for equipment)	To be submitted by the the vendor as per above	Galvanized Steel
Rod Electrode	Suitable for a system current of 31.5 kA/ 1s as per IS	Mild steel

G.I. Earthwire

7/8 SWG

GI

### **3. Earthing Conductor Layout**

3.1 Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise.

3.2 Minimum 3000 mm spacing between rod electrodes shall be provided unless stipulated otherwise.

3.3 Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid at least 300 mm below them and shall be re-routed in case it fouls with equipment/structure foundations.

3.4 Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid. Otherwise, “earth insert” with temporary wooden cover or “earth riser” shall be provided near the equipment foundation / pedestal for future connections to the equipment earthing terminals.

3.5 Earthing conductor along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Earthing conductors along cable trenches shall be on the wall nearer to the equipment. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.

3.6 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.

3.7 In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future, in case equipment is not available at the time of grid installations.

3.8 Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions.

3.9 Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.

#### **4. Equipment And Structure Earthing**

4.1 The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with engineer. The equipments shall be earthed at two distinctive points on panels.

4.2 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

4.3 Metallic conduits shall not be used as earth continuity conductor.

4.4 A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.

4.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

4.6 Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.

4.7 Railway tracks within Sub-Station area shall be bonded across fish plates and connected to earthing grid at several locations.

4.8 Earthing conductor shall be buried 2000mm outside the Sub-Station fence. Every post of the fence and gates shall be connected to earthing loop by one lead.

4.9 Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

## **5. Jointing**

5.1 Earthing connections with equipment earthing pads shall be of bolted type. Contact surfaces shall be free from scales, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint/compound.

5.2 Connection between equipment earthing lead and between main earthing conductors shall be welded/brazed type. For rust protections, the welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.

5.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.

5.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

5.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

5.6 Bending of large diameter rod/thick conductor shall be done preferably by gas heating.

5.7 All arc welding with large diameter conductors shall be done with low hydrogen content electrodes.

## **6. Power Cable Earthing**

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

## **7. Specific Requirement For Earthing Systems**

7.1 Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.

7.2 Earthing mat comprising of closely spaced (300mm x 300mm) conductors shall be provided below the operating handles of the isolators.

7.3 For specific requirements for earthing at panel refer to Section-Control and Relay Panel of this specification.

### **8. Specific Requirements For Lightning Protection System**

8.1 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

8.2 Down conductors shall be cleated on the structures at 2000mm interval.

8.3 Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level.

8.4 Lightning conductors shall not pass through or run inside G.I. conduits.

8.5 Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules/CEA regulations, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

### **9. Procedure For Non Destructive Testing**

#### **A) LIQUID PENETRANT EXAMINATION OF WELDED JOINTS**

a) Evaluation of indications – As per standard Test Procedure.

**B) RADIOGRAPHIC EXAMINATION OF WELDED JOINTS** to be carried out as per standard test procedure on 10% welded joint.

## **51.0 Provision for Grouting/Support for HT & LT Lines**

### **33kV Lines**

Support foundation:

Cement concrete in mixture 1 part cement, 3-part coarse sand, 6 part 40mm size aggregate stone chips (1:3:6) shall be used in all the types of 33 kV line supports.

While erecting supports (poles), shuttering must be used for concreting so that proper quantity of cement concrete mixture be used and assessed during inspection. During concreting proper compaction by means of mobile vibrator be provided. While starting work of support erection, gang wise shuttering and mobile vibrator shall be offered for inspection to Project Manager. While erecting support, mercury level gauge must be used to ensure vertical erection of support.

250mm dia X 12" inch size muffing shall be provided on steel tubular and H-Beam poles to prevent direct entry of rainwater along the poles. Cement Concrete of 1:2:4 (1 part Cement, 2 parts coarse sand and 4 parts 20mm aggregate stones chips) shall be used for individual poles.

Steel plate shall be used in steel tubular poles and cement concrete reinforced plate shall be used as base plate for PCC poles.

### **11kV Lines**

Support foundation:

Cement concrete in mixture 1 part cement, 3-part coarse sand, 6 part 40 mm size aggregate stone chips (1:3:6) shall be used in steel tubular poles and H-Beam 11 kV line supports.

In rural areas, PCC pole pit shall be refilled with 200 mm average size of bolder mixed with excavated earth. Proper ramming shall be performed for better compaction. All Double pole (DP), Triple pole (TP), cut point poles, Distribution Transformer substation poles and poles erected on water logging area shall be grouted using cement concrete mixture similar to H-Beam & Tubular poles. Prior approval of Project Manager shall be obtained for concreting of PCC poles in water logging area. While preparing route survey report, water logging areas shall be earmarked.

While erecting supports (poles), shuttering must be used for concreting so that proper quantity of cement concrete mixture be used and assessed during inspection. During concreting proper compaction by means of mobile vibrator be provided. While starting work of support erection, gang wise shuttering and mobile vibrator shall be offered for inspection to Project Manager. While erecting support, mercury level gauge must be used to ensure vertical erection of support.



250mm dia X 12" inch size muffing shall be provided on steel tubular and H-Beam poles to prevent direct entry of rainwater along the poles. Cement Concrete of 1:2:4 (1 part Cement, 2 parts coarse sand and 4 parts 20mm aggregate stones chips) shall be used for individual poles.

Steel plate shall be used in steel tubular poles and cement concrete reinforced plate shall be used as base plate for PCC poles.

### **LT Lines**

Support foundation:

Cement concrete in mixture 1 part cement, 3-part coarse sand, 6 part 40 mm size aggregate stone chips (1:3:6) shall be used in steel tubular poles and H-Beam LT line supports.

In rural areas, PCC pole pit shall be refilled with 200 mm average size of bolder mixed with excavated earth. Proper ramming shall be performed for better compaction. PCC pole at cut point and PCC poles erected on water logging area shall be grouted using cement concrete mixture similar to H-Beam & Tubular poles. Prior approval of Project Manager shall be obtained for concreting of PCC poles in water logging area. While preparing route survey report, water logging areas shall be earmarked.

While erecting supports (poles), shuttering must be used for concreting so that proper quantity of cement concrete mixture be used and assessed during inspection. During concreting proper compaction by means of mobile vibrator be provided. While starting work of support erection, gang wise shuttering and mobile vibrator shall be offered for inspection to Project Manager. While erecting support, mercury level gauge must be used to ensure vertical erection of support.

250mm dia X 12" inch size muffing shall be provided on steel tubular and H-Beam poles to prevent direct entry of rain water along the poles. Cement Concrete of 1:2:4 (1 part Cement, 2 parts coarse sand and 4 parts 20mm aggregate stones chips) shall be used for individual poles.

Steel plate shall be used in steel tubular poles and cement concrete reinforced plate shall be used as base plate for PCC poles.

## 52. 0 Ring Main Units having fully SCADA compatible as well as fully Motorized

### Scope of work

Design, Engineering, Manufacturing, assembly, inspection and testing before despatch, packing & forwarding and delivery at site/stores of outdoor type compact 11KV Ring Main Units SF6 with Load break Isolators for 11 KV Incoming & Out going cables and VCB for Distribution Transformer with future provisions for motorization and necessary take off terminal units for future SCADA automations , other accessories and auxiliaries equipments and mandatory spares, described herein and required for their satisfactory operation in various locations of the PVVNL discom.

Provision of all the RMU with necessary take off terminal units for future SCADA automations.

- 1.1 The objective of the RMUs is for extremely small construction width, Compact, maintenance free, independent of climate, easy installation, operational reliability, Safe and easy to operate, minimum construction cost, minimum site work and minimum space requirement. The dimensions of a RMU shall preferably be [as compact as possible as per configuration requirements](#).
- 1.2 The RMUs shall conform in all respects to high standards of Engineering design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the right to reject any material which in his judgment is not in full accordance therewith.
- 1.3 The type of the 11 KV circuit breaker shall be VCB and insulating medium for load break isolators, Earth switch, 11 KV Buses and other associated equipments should be SF6 gas / solid state epoxy confirming to relevant IS/IEC.
- 1.4 The complete RMU must be fully Type Tested including for Internal Arc Fault withstand for 21KA / 1 Seconds. as per latest Standard IEC 62271-100/200.
- 1.5 As the Ring Main Units will be installed mostly under existing half four pole / two pole structures, therefore RMUs having FOOT PRINTS that fits exactly underneath shall be preferred for certain specific requirements.

### 2.0 STANDARDS :

Unless otherwise specified elsewhere in this Specification, the RMU, Switchboard (Switchgear), Load break isolators, Instrument Transformers and other associated accessories shall conform to the latest revisions and amendments thereof of the following standards.

IEC 60 298/ IEC 62271-200/IS 12729:1988	General requirement for Metal Enclosed Switchgear
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IEC62271-102/ IS 9921	Alternating current Dis-connector's (Load break isolators) and Earthing switch
IEC 62271-100/ IEC 62271-200	Specification for alternating current circuit breakers.
IEC 62271-1/ IEC 60694	Panel design, Vacuum Circuit Breakers
IEC 60044-1/IEC 60185/IS 2705:1992	Current Transformer
IEC 62271-103	High voltage switches
IEC 60273/IS :2099	Dimension of Indoor & Outdoor post insulators with voltage > 1000 Volts
IEC 60529/IS 13947(Part-1)	Degree of protection provided by enclosures for low voltage switchgear and control gear
IEC 60255	Electrical Relays
IEC 60376	Filling of SF6 Gas in RMUs

The following parts of RMU shall be type tested for Degree of protection:-

- IP 67 - tank with high voltage components.
- IP 55 - front covers of the mechanism.
- IP 55 - cable connection covers.
- IP 54 - outdoor enclosure/kiosk.

Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned above shall also be acceptable. If the equipments, offered by the Bidder conform to other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail. One Hard copy of such standards with authentic English Translations shall be furnished along with the offer.

### 3.0. SERVICE CONDITIONS:

All out door Equipment / material to be supplied against this specification shall be suitable for satisfactory continuous operation under tropical conditions as specified below:-

1. Maximum ambient air temperature in shade 50<sup>0</sup>C
2. Minimum ambient temperature in shade -2.5<sup>0</sup>C
3. Maximum Relative humidity 90%
4. Minimum Relative humidity 10%

5.	Average Annual rainfall	10-100 Cm.
6.	Maximum wind pressure (Kg. Per sq. m.)	45
7.	Height above mean sea level	< 1000 Meter
8.	Dust storms are liable to occur during the period	March to July
9.	Average number of rainy days per annum	100
10.	Isoceraunic level (days / year)	40
11.	Moderately hot and humid tropical, climate, Conductive to rust and fungus growth	Yes
12.	Seismic level (horizontal acceleration)	0.08 g

Due regard should be given to the climatic/service conditions under which the equipment is to work. Ambient temperature normally vary between -02.5°C and 50 °C, although direct sun temperature may reach 55 °C. The climate is also moderately humid and rapid variations occurs, relative humidity between 70% and 90% being frequently recorded, but these values generally correspond to the lower ambient temperatures. The equipment should also be designed to prevent ingress of vermin, accidental contact with live parts and to minimize the ingress of dust and dirt. The use of materials which may be liable to attack by termites and other insects should be avoided.

#### 4.0 TECHNICAL PARAMETERS OF RMU:

##### I. 11KV Bus Bar

Type of material	: Copper
Current Carrying Capacity	: 630 Amps.
Short time rating current for 3 secs.	: 21 KA
Insulation of bus bar	: SF6/solid state epoxy
Bus bar connections	: Anti-oxide grease

##### II. Parameters for Switch Gear of DT and load break isolators

Type	: Metal enclosed
No of Phases	: 3
No. of poles	: 3
Rated voltage	:12 KV
Operating voltage	:11 KV(+10% to -20%)
Rated lightning impulse withstand voltage	:75 KV
Rated power frequency withstand voltage	:28 KV
Insulating medium	:SF6/Solid State epoxy.
Rated filling level for insulation	:0.5 bar/As Per IEC.
Max.permissible site altitude at the above gas pressures:	≤1000m
(The operating pressure has to be adjusted for greater altitudes)	
Rated short time current	:21 KA.
Rated short time	:3s
Rated peak withstand current	:52.5 KA.

Operating mechanism : Circuit breaker with spring assisted anti reflex mechanism.

Rated current (Bus): :630 A  
 Rated current Load Break Isolator: :630 A  
 Rated current (breaker) :200 A  
 Circuit Breaker interrupter :Vacuum Interrupter  
 Rated frequency : 50 Hz  
 Rated operating sequence :O-3min- CO

Number of mechanical/Remote operations for earthing & Ring switches 1000 Nos.

Number of mechanical/ remote operations for circuit breakers 2000 Nos.

Number of closing (making) operations of earth-switch:  
 5 Nos.  
 independent of breaker as per IEC-60265-1

### III. PRINCIPAL FEATURES:

S. No	DESCRIPTION	DT breaker
1	Circuit label	Yes
2	Mimic diagram	Yes
3	Supply voltage indication	Yes
4	Current Transformer	Yes
5	Self Powered based Microprocessor based IDMT Relay (3OC+1EF)	Yes
6	Anti-Reflexing Mechanism	Yes
7	Interlock to defeat the operation of the line side earthing when the line side isolator is ON.	Yes
8	Interlock to defeat the operation of the earthing when the breaker is in service position and is ON.	Yes
9	Local /Remote Switch	Yes
10	Breaker ON/OFF indication	Yes
11	Spring Charge indication / Spring assisted mechanism.	Yes
12	Fault Tripping indication	Yes
13	Bus bar end caps	Yes
14	Whether the SF6 gas pressure gauge indicator and filling arrangement.	Yes
15	Whether the spring assisted mechanism with operating handle for ON/OFF.	Yes

16	Whether the earth positions with arrangement for padlocking in each position and independent manual operation with mechanically operated indicator are provided	Yes
17	RMUs are provided with necessary take off terminals for future SCADA automation.	Yes

#### **IV.1 Load break switch(Isolators) :**

Type : SF6/solid state epoxy load breaking and fault making.  
 Rated current : 630 A  
 Fault making capacity (KA peak min.) : 52.5 KA

#### **IV.2 Earthing switch for 11 KV Line side Isolation and DT :**

Rated short time current :21 KA.  
 Rated short time :3s  
 Rated peak withstand current :52.5 KA  
 Interlocking facility: 1) Between 11 KV Line side isolator 'ON'& Earthing.  
 2) Between 11 KV DT side breaker on close condition & Earthing.

#### **IV.3 Current Transformers for breaker**

CT Type : Tape wound

CT Description :The CTs of DT breaker shall be suitable for sensing the minimum primary variable current in the order of 10-60 A and the secondary current for the CT is 1 A. The CT shall be housed in outside SF6 chamber for testing and Maintenance.

Accuracy Class : Class 10P10 protection  
 Rated burden : Suitable for Self Powered Relay.

### **5. GENERAL CONSTRUCTION FEATURE FOR RING MAIN UNIT:**

The compact RMU shall be designed to operate at the rated voltage of 12 KV. It shall include, within the same metal enclosure, earthing switches for each Load Break Switch and Circuit Breaker for earthing each of the devices. Suitable fool-proof interlocks shall be provided to these earthing switches to prevent its inadvertent or accidental closing when the circuit is live and the concerned Load Break Switch/Circuit Breaker is in closed position. The limiting dimensions shall be preferably as compact as possible as per configuration requirements for the initial two Load Break Switches and one Circuit Breaker. Provision should be made for extension of few more Circuit Breakers or Load Break Switches on a future date. The degree of protection required against environment shall be not less than IP55 of IS 12063. The Compact RMU shall have atleast an IP54 Protection Index as per IS 12063 against dust and splashing of water. The active parts of the

switchgear shall be maintenance free and the Compact RMU shall be of low-maintenance type. [Vacuum Interrupter and RMU should be of the same make.](#)

- 5.1 The Ring Main Unit shall be installed at 11 KV junction points to have continuous supply by isolating faulty sections. The RMU shall be both side extensible and consists of the combinations of load break switches and Circuit breakers for a nominal voltage of 12 KV using SF6 gas/ solid state epoxy as insulating and Vacuum as arc quenching medium.
- 5.2 The RMU and combination shall be outdoor metal enclosed type. The RMU metal parts shall be of high thickness high tensile steel which must be grit/short blasted, thermally sprayed with Zinc alloy, phosphate and subsequently painted with polyurethane based powder paint, the overall paint layer thickness shall be not less than 80 microns.
- 5.3 **Relevant IE rules for clearances, safety and operation inside the enclosure shall be applicable.** The enclosure shall be free from pollution, humidity, dust, vermin etc. IP-55 and type tested for accelerated aging & weather proof at ERDA/CPRI.
- 5.4 All high voltage live parts except for the cable connections shall be insulated with SF6 gas/solid state epoxy. The SF6 /solid state epoxy enclosure shall be made of robotically/laser / TIG/ MIG welded stainless steel/ hermetically sealed metalized cast resin tank without use of sealant, gaskets, 'O' rings, etc. and shall be type tested for IP-67 Degree of protection.
- 5.5 The cubicle shall be touch proof metallic encapsulation with a electro galvanized sheet steel of high thickness and provided with a pressure relief arrangement away from operator toward bottom (AFLR complied).
- 5.6 RMU should be suitable for motorization in future for remote operation through SCADA.
- 5.7 Any accidental over pressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the rear/top part of the enclosure. Gas will be release to the rear of the switchboard away from the operator to ensure safety of the operating personnel and all the manual operations will be carried out on the front of the switchboard.
- 5.8 The enclosure for switchgear and metallic RMU housing shall have a design such that in the event of an internal arc fault, the operator shall be safe. This should be in accordance with IEC 298 & Standard IEC 62271-100/200 and relevant TYPE TEST certificates shall be submitted.
- 5.9 The Entire units of RMU shall be in a single compact metal clad weather proof enclosure, outdoor type suitable for all weather conditions. The switchgear and bus bar shall all be filled with SF6 at 0.5 bar G/IEC/IS Standards relative pressure to ensure the insulation and breaking functions. The enclosure must be sealed for life and shall meet the "sealed pressure system" criterion in accordance with the IEC

298 & 62271-100/200 standard .The RMU must be a system for which no handling of gas is required throughout the 30 years of service life.

- 5.10 Suitable temperature rise test on the RMU with enclosure shall be carried out as per relevant IEC/IS.
- 5.11 Each switchboard shall be identified by an appropriately sized label, which clearly indicates the functional units and their electrical characteristics.
- 5.12 The switchgear and switchboard shall be designed so that the position of the different devices is visible to the operator on the front of the switchboard and operations are visible as well.
- 5.13 The entire system shall be totally encapsulated. There shall be no access to exposed conductors. In accordance with the standards in effect, the switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools.
- 5.14 The entire 11 KV RMU shall be insulated by inert gas (SF6) / solid state epoxy suitable for operating voltage up to 12 KV respectively. The 12 KV circuit breakers must be VCB. It is necessary to fit an absorption material in the tank to absorb the moisture from the SF6 gas to regenerate the SF6 gas following arc interruption. The SF6 insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a simple indication. All the combination of the RMUs should have the required SF6 insulation by providing necessary gas chamber capacity. The provision to indicate pressure of SF6 Gas on RMU Panel shall be provided.
- 5.15 The tank shall be made of suitable stainless steel of minimum thickness of 3 mm. The tank shall have SS sheet of 3 mm thickness with robotic welded and meet the “sealed pressure system” criteria in accordance with the IEC 62271-200. This is a system for which no handling/refilling of gas shall be required throughout the expected operating life i.e. 30 years. Sealed pressure system are completely assembled, filled and tested in the factory. The maximum leakage rate of SF6 gas shall be lower than 0.1% of the total initial mass of SF6 gas per annum. The filling pressure for the switchgear shall be just above the atmospheric pressure so as to reduce the tendency to leak. SF6 gas used for the filling of the RMU shall be in accordance with IEC: 376. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption.
- 5.16 The Compact RMU shall be suitable for mounting on its connecting cable trench. A suitably sized nameplate clearly indicating its functional units and their electrical characteristics shall identify each unit. The positions of the different devices shall be clearly visible to the operator on the front of the compact RMU and the operations shall be clearly visible. The compact RMUs shall be such that access to live parts shall not be possible without the use of tools.



- 5.17 The design shall incorporate such features to prevent any accidental opening of the earth switch when it is in closed position. Similarly accidental closing of Circuit Breaker or Load Break Switch shall be prevented when the same is in open position from the release of any latch or spring in tension due to vibrations caused externally or internally and shall prevent accidents.

#### FORMATION OF COMPACT RMU:

- 5.18 The compact RMU shall be of single busbar outdoor, tropicalized in accordance with the relevant clauses mentioned in these specifications. An earth fault passage indicator using a core balance Current Transformer shall be provided for the Incomers to assist in identifying the faulty cable section in order to isolate the same.
- 5.19 The Incomers & outgoing (loop-in loop-out) The Incomers panel shall comprise of, but not limited to the following:
- A triple pole Solid State epoxy /SF<sub>6</sub> Load Break Switch rated 630 Amps or higher, with a rated making capacity under fault conditions with short circuit levels of 52.5 KA or above at 11 KV
  - Core balance Current Transformer and earth fault passage indicators (The indicator flag of the relay shall be visible till such time the relay is reset manually)  
These shall not require any external Power Supply and must be suitable for unattended places.
- 5.20 The transformer loop circuit control panels shall consist of but not limited to the following:

A triple pole Vacuum Circuit Breaker rated 200 Amps or higher, with a rated making capacity under fault conditions with short circuit levels of 52.5 KA or above at 11 KV & breaking capacity of 21 kArms.

- Motorized Operating Mechanism with provision of manual operation
- Electronic relay with associated Transformers of accuracy class 10P10 and tripping mechanism. CT burden shall be as per requirement of self powered Relay.
- Mechanical "ON", "OFF" indicator
- Manual tripping device
- Mechanical "Spring Charged", "Spring Free" indicator in case of stored energy devices.
- Provision for retrofitting meters and SCADA System

#### **6. Sulphur Hexafluoride Gas (SF<sub>6</sub> GAS) :**

The SF<sub>6</sub> gas shall comply with relevant standard IEC-376, 376A & 376B and shall be suitable in all respects for use in 12 KV panels under the operating conditions. The SF<sub>6</sub> shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC-376, 376A & 376B and test certificate shall be furnished to the purchaser indicating all the tests as per IEC-376 for each Lot of SF<sub>6</sub> Gas. The metallic enclosure should be tested for leakage at site.

## 7. RMU OUTDOOR METAL CLAD:-

The RMU enclosure must be a metallic; it follows an industrialized process of manufacturing. The RMU shall be of single bus bar SF6 gas/solid state epoxy insulated outdoor, tropicalised and metal enclosed type. The RMU metal parts shall be made of high thickness high tensile steel which must be grit/short blasted, thermally sprayed with Zinc alloy, phosphate and subsequently painted with polyurethane based powder paint, the overall paint layer thickness shall be not less than 80 microns. The rating of enclosure shall be suitable for operation on three phase, three wire, 12 KV, 50 cycles, A.C. System with short-time current rating of **21KA for 3 seconds** with Panels.

### TAKE OFF TERMINAL UNITS FOR FUTURE AUTOMATION :

The RMU should be provided with necessary take off terminal units for future SCADA automations. Both the load break switches and the tee off circuit breaker shall be suitable for motorization in future.

## 8. ISOLATORS (LOAD BREAK TYPE) :

The load break isolators for Incoming and Outgoing supply must be provided and the load break isolators are fully insulated by SF6 gas/Solid State Epoxy. The load break isolators shall consist of 630 Amp fault making/load breaking spring assisted ring switches, each with integral fault making earth switches. The switch shall be naturally interlocked to prevent the main and earth switch being switched 'ON' at the same time. The selection of the main and earth switch is made by a lever on the fascia, which is allowed to move only if the main or earth switch is in the off position. The load break isolators should have the facility for future remote operation. Each load break switch shall be of the triple pole, simultaneously operated, non automatic type with quick break contacts and with integral earthing arrangement.

The earthing switch shall also be designed for rated fault making of 50KA for operator's safety reasons.

## 9. SCADA CONNECTIVITY:

Provision shall be made in all the RMUs with necessary take off terminal units for future automations / SCADA connectivity.

In-built factory integrated FRTU with RMU shall be provided.

Following signals to be provided:

### ❖ RMU Breaker (CB) Function:

- DI:
  - CB Open
  - CB Close
  - CB ES Close
  - O/C & E/F Relay Trip
  - Local/Remote
  - Voltage healthy Indication
- DO:

- CB Open
- CB Close
- Relay Reset

❖ RMU Isolator (LBS) Function:

- DI:
  - LBS Open
  - LBS Close
  - LBS ES Close
  - FPI Fault
  - Local/Remote
  - Voltage healthy Indication
  -
- DO:
  - LBS Open
  - LBS Close
  - FPI Reset

❖ Power Supply Unit Function:

- DI:
  - Battery/Charger Fail
  - AC Fail
  - DC Low
- AI:
  - DC Voltage

❖ Common Signals:

- DI:
  - SF6 Gas Low
  - RMU-FRTU Door Open
  - DO Command Feedback
  - Latching Relay Open/Close
- DO:
  - Latching Relay Open/Close
- AI:

Transformer/Panel Temperature

## 10. VACUUM CIRCUIT BREAKER :

The VCB for the controlling of Distribution Transformer must be provided inside the outdoor metal clad and insulated by SF6 gas/Solid State epoxy. The VCB circuit breaker must be a spring assisted three positions with integral fault making earth switch on line side of breaker. The selection of the main/earth switch lever on the fascia, which is

allowed to move only if the main or earth switches is in the off position. The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip; the following manual reset operation should recharge the trip spring and reset the circuit breaker mechanism in the main off position.

The circuit breaker shall be fitted with a mechanical flag, which shall operate in the event of a fault (electrical) trip occurring. The 'tripped' flag should be an unambiguous colour differing from any other flag or mimic.

Both the circuit breaker and ring switches are operated by the same unidirectional handle.

The protection on the circuit breaker shall comprise of the following components: The circuit breaker unit fitted with 3 class X protection CT's, a low burden trip coil and auxiliary switch assembly allowing the use of a self powered (No external DC or AC source required) IDMT protection relays (Numeric/Micro processor based) 3 x over current and earth fault element shall be Definite Time type relay. The protection system should be suitable for protecting transformers of rated power from 100 KVA to 1000 KVA. The relay should be housed within a pilot cable box accessible. A facility of provision for the delay of transformer in-rush current shall be provided on relay to avoid nuisance tripping. Outlived/ defective batteries wherever provided shall be replaced promptly during the Guarantee period of RMU.

#### **11. BUSHINGS :**

The units are fitted with the standardized bushings that comply with IEC standards. All the bushings are the same height from the base and are protected by a cable cover. All the bushings shall be partial discharge free and preferably Laser welded with the SS container in case of stainless steel tank type RMU. Bushing shall be replaced at factory with minimum time.

#### **12. CABLE BOXES :**

All the cable boxes shall be air insulated suitable for dry type cable terminations. The cable boxes at each of the two ring switches shall be suitable for accepting HV cables of sizes 3c x 300 / 3c x 185 sq.mm and circuit breaker cable be suitable up to 3c x 70 sq.mm.

- Necessary Right angle Boot should be supplied to the cable terminations. The type of the Right angle Boot should be cold applied insulating Boot.
- A non Ferro- magnetic cable clamp arrangement for 3 core XLPE cables must be provided for all cables terminated on the RMU. Glands in the base plate of the RMU shall be provided for proper Cable termination.
- Gromets should be provided for cable fixing & sealing & avoid entry of rodents.
- Cable compartment should have provision for terminating 2Runs of cables inside the same standard cable box for load break switch function.

#### **13. FAULT PASSAGE INDICATORS (FPI):**

This shall be integral part of the RMU and shall be provided to assist in identifying the faulty cable section in order to isolate the same. The Fault Passage Indicators (FPI) shall have automatic reset facility and shall be suitable for trouble free operation. The indicator flag of the relay shall be visible till such time the relay is reset. LED indicating bulb should be provided for better visibility particularly in day time. The relay should not require any external power supply.

**14. CABLE TESTING FACILITY :**

It shall be possible to test the cable without opening the cable boxes or 'where there is no provision for testing the cable without opening the door or cover', opening of door or cover should not be possible unless the earthing switch is closed as per IEC 298 clause 5.102.4.

The cable testing should be possible without dismantling the cable plugs but the after opening the cable covers.

**15. VOLTAGE INDICATOR LAMPS AND PHASE COMPARATORS :**

The RMU shall be equipped with a voltage indication to indicate whether or not there is voltage on the cable. There should be a facility to check the synchronization of phases with the use of external device. It shall be possible for the each of the function of the RMU to be equipped with a permanent voltage indication as per IEC 61958 High Voltage prefabricated switchgear and control gear assemblies voltage presence indicating system to indicate whether or not there is voltage on the cables. The indicating lamp shall be LED type for better visibility during day light.

**16. EXPANDABILITY :**

Each combination of RMU shall have the provision for future extension on both sides by load break isolators / Circuit breakers, with a suitable trunking chamber and accessories and necessary Bus Bar. Extensible isolator(s) and circuit breaker(s) shall be individually housed in a separate SF6 gas/Solid State epoxy enclosures. Even in case of extensible circuit breakers, the Breaker should be capable of necessary short circuit operations as per IEC at 20 KA, and the Breaker should have a rated current carrying capacity of 200 A.

**17. BUS COUPLER/ BUS BAR SECTIONALISER WITH LOAD BREAK SWITCH**

The load break switch of the Bus bar Sectionalizer shall be rated for 12 KV, 630A, 20KA for 3 secs. The LBS should be housed in a SF6/solid state epoxy Insulated stainless steel / cast resin enclosure conforming to IP-67 Degrees of protection and shall be with motorized mechanism. The sectionaliser shall be provided with all the necessary electrical and mechanical interlocks required for proper functioning with the Incomers.

**18. PADLOCKING FACILITIES**

Provision shall be made for padlocking the load break switches/ Circuit breaker, and the earthing switches in either open or closed position with lock & master key. The circuit breakers and earthing switches can be locked in the open or closed position by 1 to 3 padlocks 6 to 8 mm in diameter.

## 19. WIRING & TERMINALS:

The wiring should be of high standard and should be able to withstand the tropical weather conditions. The wiring cable must be standard single-core non-sheathed, Core marking (ferrules), stripped with non-notching tools and fitted with end sleeves, marked in accordance with the circuit diagram with printed adhesive marking strips. All wiring shall be provided with single core multi-strand copper conductor wires with P.V.C insulation and shall be flame retardant low smoke type. The wiring shall be carried out using multi-strand copper conductor super flexible PVC insulated wires of 650/1100V Grade for AC Power, DC Control and CT circuits. Suitable colored wires shall be used for phase identification and interlocking type ferrules shall be provided at both ends of the wires for wire identification. Terminal should be suitably protected to eliminate sulphating. Connections and terminal should be able to withstand vibrations. The terminal blocks should be stud type for controls and disconnecting link type terminals for CT leads with suitable spring washer and lock nuts.

Flexible wires should be used for wiring of devices on moving parts such as swinging Panels (Switch Gear) or panel doors. Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals, terminal blocks and wiring gutters. The cables should be uniformly bunched and tied by means of PVC belts and carried in a PVC carrying trough.

The position of PVC carrying trough and wires should not give any hindrance for fixing or removing relay casing, switches etc., Wire termination shall be made with solder less crimping type of tinned copper lugs. Core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted with both ends of each wire. Ferrules shall fit tightly on the wire when disconnected. The wire number shown on the wiring shall be in accordance with the IS.375.

All wires directly connected to trip circuits of breaker or devices shall be distinguished by addition of a red color unlettered ferrule.

Inter-connections to adjacent Panels (Switch Gear) shall be brought out to a separate set of Terminal blocks located near the slots or holes to be provided at the top portion of the panel. Arrangements shall be made for easy connections to adjacent Panels (Switch Gear) at site and wires for this purpose shall be provided and bunched inside the panel. The bus wire shall run at the top of the panel. Terminal block with isolating links should be provided for bus wire. At least 10% of total terminals shall be provided as spare for further connections. Wiring shall be done for all the contacts available in the relay and other equipment and brought out to the terminal blocks for spare contacts. Colour code for wiring is preferable in the following colours.

Voltage supply	: Red, Yellow, Blue for phase and Black for Neutral
CT circuits	: Similar to the above
DC circuits	: Grey for both positive and negative

*250V AC circuits : Black for both phase and neutral*

Earthing : Green

The wiring shall be in accordance to the wiring diagram for proper functioning of the connected equipment. Terminal blocks shall not be less than 650V grade and shall be piece-molded type with insulation barriers.

The terminal shall hold the wires in the tight position by bolts and nuts with lock washers. The terminal blocks shall be arranged in vertical formation at an inclined angle with sufficient space between terminal blocks for easy wiring.

The terminals are to be marked with the terminal number in accordance with the circuit diagram and terminal diagram. The terminals should not have any function designation and are of the tension spring and plug-in type.

## **20. EARTHING :**

### **EARTHING OF ISOLATORS AND DISTRIBUTION TRANSFORMER BREAKERS (EARTH SWITCH) :**

Necessary arrangements shall be made at Load break isolators / Distribution Transformer Breaker for selecting Earth position. Mechanical interlocking systems shall prevent the RMU function from being operated from the 'ON' to 'Earth On' position without going through the 'OFF' position.

The RMU outdoor metal clad, Switch Gear, Load break isolators, Distribution Transformer ,LT pillar box, & steel structure etc., shall be equipped with an earth bus securely fixed along the base of the RMU.

When several units of the RMU (Extra Isolators / Breakers) are mounted adjoining to each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. The size of the earth bus shall be made of IEC / IS standards with tinned copper flat for RMU earthing. Provision shall be made on end of RMU for connecting the earth bus to the earth grid.

All metal parts of the switchgear which do not belong to main circuit and which can collect electric charges causing dangerous effect shall be connected to the earthing conductor made of copper having Cross Sectional area of minimum 75 mm<sup>2</sup>. Each end of conductor shall be terminated by M12/equivalent quality and type of terminal for connection to earth system installation. Earth conductor location shall not obstruct access to cable terminations.

The following items are to be connected to the main earth conductor by rigid or copper conductors having a minimum cross section of 75 mm<sup>2</sup> (a) earthing switches (b) Cable sheath or screen (c) capacitors used in voltage control devices, if any.

All metallic cases of the relays, instruments and other panel mounted Equipment's shall be connected to the earth bus by independent copper wires of size shall be made of IEC/IS standards. The colour code of earthing wire shall be green. Earthing wires shall be

connected on the terminals with suitable clamp connectors only and soldering shall not be permitted.

## **21. ACCESSORIES & SPARES:**

The following spares and accessories shall be supplied along with the main equipments at free of cost:-

1. Charging lever for operating load break isolators & circuit breaker of each RMU
2. Kit for identifying SF6 gas leakage – 5 numbers
3. All pressure gauges indications – 5 numbers
4. Necessary SF6 gas filling plant with adopter and tools etc for filling SF6 gas at Site --2 Nos
5. Necessary gas cylinders with adopter ,pressure gauge for storage of SF6 gas --2 Nos
6. Any other spares & Tools, which are all essentially required at the time of emergency and routine maintenance.

The following accessories shall be supplied with each compact RMU at free of cost:

1. Pad locks for all doors with one set (3 Nos.) Master keys
2. Earth bus formed out of 30X5 mm tinned Copper flat.
3. Wire guard protective mesh on the front doors and back for prevention of pasting of papers etc.
4. Base channel with foundation bolts
5. Live part shrouds, danger plates, caution boards, name plates, rating plates etc. as per requirements
6. All other components, even though not specifically mentioned, but required for the safe operation of the unit.

## **22. GUARANTEE PERIOD:**

Guarantee Period for RMU shall be 60 months from the date of final acceptance.



**22. TESTING OF EQUIPMENT & ACCESSORIES:****22.1 INSPECTION & TESTING :**

The inspection may be carried out by the PVVNL at any stage of manufacture. The supplier shall grant free access to DISCOM's representative at any reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the DISCOM shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

The supplier shall keep the DISCOM informed in advance, about the manufacturing programme so that arrangement can be made for inspection. The PVVNL reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. The PVVNL has rights to inspect the supplier's premises for each and every consignment for type & routine test.

No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested / unless the same is waived by the PVVNL in writing.

**22.2 ACCEPTANCE AND ROUTINE TESTS :**

All acceptance and routine tests as stipulated in the latest relevant IS/IEC shall be carried out by the supplier at his works in the presence of PVVNL representative.

**22.3 ADDITIONAL TESTS :**

The DISCOM reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/laboratory or at any other recognized laboratory/research institute in addition to the above mentioned type tests, acceptance and routine tests at the cost of the DISCOM to satisfy that the material complies with the intent of this specification.

**22.4 TYPE TEST**

The Tenderers should, submit copies of all Type test certificate of their make in full shape as confirming to relevant ISS/IEC of latest issue before approval of vendor.

The above type test certificates should accompany the drawings for the materials duly signed and certified by the institution who has issued the type test certificate. The following type test certificate shall be provided:

S. No.	Name of Type Test
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01.	Short time current withstand test and peak current withstand test.
02.	Lightning Impulse voltage with-stand test
03.	Temperature rise test
04	Short Circuit current making and breaking tests <ul style="list-style-type: none"> <li>➤ CB</li> <li>➤ Isolator</li> </ul>
05.	Power frequency voltage withstand test (dry/wet)
06	Capacitive current switching test confirming to IEC
07.	Mechanical Endurance Test confirming to IEC /
08	Measurement of the resistance of the main circuit.
09	Checking of degree of protection
10	Switch, circuit breaker, earthing switch making Capacity <ul style="list-style-type: none"> <li>➤ CB</li> <li>➤ Earth Switch</li> </ul>
11	Switch, circuit breaker, earthing switch breaking Capacity <ul style="list-style-type: none"> <li>➤ CB</li> </ul>
12	Internal Arc Withstand
13	Partial Discharge test on Complete RMU
14	Other type & routine tests insists by IEC for RMU

## 22.5 PRE-COMMISSIONING TESTS :

All the pre-commissioning tests shall be carried out by PVVNL representative in the presence of the supplier's representative (if wish to present).

## 23.0. DOCUMENTATION

### 23.1DRAWINGS

The tenderer shall submit along with his tender dimensional general arrangement drawings of the equipments, illustrative and descriptive literature in triplicate for various items in the RMUs which are all essentially required for future automation.

- i) Schematic diagram of the RMU panel
- ii) Instruction manuals
- iii) Catalogues of spares recommended with drawing to indicate each items of spares
- iv) List of spares and special tools recommended by the supplier.
- v) Copies of Type Test Certificates as per latest IS/IEC.
- vi) Drawings of equipments, relays, control wiring circuit, etc.
- vii) Foundation drawings of RMU.
- viii) Dimensional drawings of each material used for item Vii.

- ix) Actual single line diagram of RMU/RMUs with or without Extra combination shall be made displayed on the front portion of the RMU so as to carry out the operations easily.

The following should be supplied to each consignee circle along with the initial supply of the equipments ordered.

5 copies of printed and bound volumes of operation, maintenance and erection manuals in English along with the copies of approved drawings and type test reports etc.

3 sets of the manuals as above shall be supplied to the Superintending Engineer(MM), PVVNL.

All drawings shall conform to relevant International Standards Organization (ISO) Specification. All drawings shall be in ink and suitable for microfilming.

- 23.1.1 All drawings submitted by the Supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, required fixing arrangement, the required dimensions for installation and any other information specifically requested in the Specification.
- 23.1.2 Each drawing submitted by the Supplier shall be clearly marked with the name of the Purchaser, the unit designation, the Specification title, the Specification number and the name of the Project. All titles, noting, markings and in writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units.
- 23.1.3 The drawings submitted by the Supplier shall be reviewed by the Purchaser as far as practicable within 15 days and shall be modified by the Supplier if any modifications and / or corrections are required by the Purchaser in compliance with the Specification. The Supplier shall incorporate such modifications and or corrections and submit the final drawings for approval. Any delays arising out of failure by the Supplier to rectify the drawings in good time shall not alter the completion date.
- 23.1.4 The drawings submitted for approval to the Purchaser shall be in quadruplicate. One print of such drawings shall be returned to the Supplier by the Purchaser marked "approved / approved with corrections". The Supplier shall thereupon furnish the Purchaser additional print as stipulated in Technical Specification along with one reproducible in original of the drawings after incorporating all corrections.
- 23.1.5 Further work by the Supplier shall be strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.
- 23.1.6 All manufacturing and fabrication work in connection with the equipment / material prior to the approval of the drawings shall be at the Supplier's risk. The Supplier may make any changes in the design, which are necessary to make the equipment

conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Supplier's drawing or work by the Purchaser shall not relieve the Supplier of any of his responsibilities and liabilities under the Contract.

- 23.1.7 All rights of the design / drawing shall be strictly reserved with the Purchaser only and any designs / drawings / data sheets submitted by the supplier from time to time shall become the property of the Purchaser. Under no circumstances, the Supplier shall be allowed to use / offer above designs / drawings / data sheets to any other authority without prior written permission of the Purchaser. Any deviation to above is not acceptable and may be a cause of rejection of the bid.

## 23.2 NAME PLATE:

Each RMU and its associated equipments shall be provided with a nameplate legible and indelibly marked with at least the following information.

- (a) Name of manufacturer
- (b) Type, design and serial number
- (c) Rated voltage and current
- (d) Rated frequency
- (e) Rated symmetrical breaking capacity
- (f) Rated making capacity
- (g) Rated short time current and its duration
- (h) Purchase Order number and date
- (i) Month and Year of supply & Expiry of Guarantee period
- (j) Rated lightning impulse withstand voltage
- (k) D.C. component of current.
- (l) Feeder name(Incoming and Out going),DTs Structure name,11000Volts Dangers etc.

NOTE:i) The word rated need not appear on the name plate.Recognized abbreviations may be used to express the above particulars.

- ii)Whether the circuit breaker is fitted with closing/tripping devices necessitating an auxiliary supply shall be stated either on the circuit breaker name plate or any other acceptable position.

## B) TECHNICAL SPECIFICATION OF RING MAIN UNITS FULLY MOTORIZED AND SCADA COMPATIBLE

PVVNL is also intend to purchase RMU fully motorized with SCADA compatiblty for which additional features shall be incorporated in addition to metioned in the above specification of RMU having provision for future motorization & SCADA compatibility to fullfill the following requirement :-

- i) Both LBS & T-off VCB shall be compatible for remote operation through SCADA.

- ii) Fault Passage Indicator (Non-communicable) shall be provided with potential free contacts for SCADA compatibility & should have provision for remote reset.
- iii) Protection & auxiliary relay should have self resetting feature as well as remote resetting feature.
- iv) status (Potential free contacts) signal to SCADA – to be wired to marshalling terminal block:
  - LBS close/open
  - LBS & CB Earth switch close/open
  - Battery Charger Fail
  - CB close/open
  - Protection relay operated
  - FPI operated
  - SF6 gas pressure low
  - Trip Coil healthy
  - Local remote
  - Spring charge
  - RMU door open
  - Power supply healthy
- v) Commands from SCADA – to be wired to marshalling terminal block: LBS close/open, CB close/open, FPI Reset etc.

**The following are the specific requirement for SCADA connectivity & motorization:**

Each RMU shall be fitted with a power supply unit, which includes 24/48 Volt DC battery & battery charger suitable for min. 5 Nos. operation on after failure of power supply. The power supply unit shall conform to following requirements:-

Input: 230 V AC / 110 V AC with a possible variation of +/- 10%.

Output: Stable 24 / 48 V DC

Battery : 24/48 V DC .

The Power supply unit shall have sufficient capacity to supply power to the following devices with a nominal backup of 4 hour:-

- RMU's motor for minimum of 5 Nos. operations.
- RMU's trip coils, close coil, FPI (in case required).

The battery charger to meet out the above requirement shall be provided.

**C) TECHNICAL SPECIFICATION OF RING MAIN UNITS FULLY MOTORIZED AND SCADA COMPATIBLE WITH PT PANEL**

**In addition to the features incorporated in the above specification of RMU fully motorized with SCADA compatibility, following shall be added in the specification for purchase of RMU fully motorized with SCADA compatibility with PT Panel:**

- i) Potential Transformers & Current Transformer with metering Core shall be provided for metering using MFT for DMS system.
- ii) 3 Nos. Current transformer shall be provided in Circuit Breaker for metering purpose in addition to 3 Nos. CT provided for protection purpose. The CT access

for maintenance or any other purpose shall be from front only. The CT shall conform to relevant Indian Standards. The design & constructions shall be sufficient robust to withstand thermal & dynamic stress during short circuit. Secondary terminal of CT shall be brought out suitable to a terminal block which shall be easily accessible for testing & terminal connections. The CT ratio shall be 100-50/1 Amp. with accuracy class 0.5 with suitable burden.

- iii) 3 Nos. single phase Potential Transformers shall be provided. These should be housed in a separate air insulated PT panel, directly connected to RMU through main bus. The burden per transformer shall not be more than 50 VA and voltage ratio shall be 11 KV/110 V. The accuracy class shall be 0.5. The PT shall have cast resin epoxy construction and shall conform to relevant Standards. Their design & construction shall be robust to withstand thermal & dynamic stress during short circuit. Provision for installation of meter shall also be kept in the panel.

**Bidder shall indicate price of RMU fully motorized with SCADA compatible**

**Schedule – I****GUARANTEED TECHNICAL PARTICULARS FOR 11 KV OUTDOOR RING MAIN UNITS****GUARANTEED TECHNICAL PARTICULARS****SCHEDULE OF GUARANTEED PARTICULARS FOR OUTDOOR METAL CLAD RMU**

01.	Manufacturer's Name and Country of origin	
02.	Manufacturer's Design / Type ref/Model.	
03.	Material used for making the body of the enclosure	
04.	Standards of manufacturing	
05.	Whether painting for RMU metal enclosure is done as per high standards.	
06.	Whether the enclosure is fire resistive, anti-corrosive	
07.	Whether the RMU metal clad is provided with sufficient space for integration of a) Minimum 2 numbers load break isolators and 1 number Vacuum Circuit breaker. b) Sufficient space for inspection, testing, etc c) Earthing arrangements d) Terminal output points for future SCADA automation e) Sufficient arrangement for future extension with Load break isolators/Breakers f) Arrangement/provision for motorization of Load break isolators/Breakers in future for SCADA automation.	
08.	Maximum temperature with stand of enclosure.	
09.	Spacing between live part to Earth	
10.	Whether the enclosure are designed to withstand the in all weather conditions (Seashore area, Chemical industries polluted area)	
11.	Period of guarantee of the RMU enclosure.	
12.	Over all dimensions of the RMU enclosure (L x B x H)	
13.	Gauge of the Material used for the fabrication of the RMU enclosure	
14.	Whether the RMU enclosure is manufactured as per IEC/IS standards to hold SF6 gas without leakage.	
15.	Whether the RMU enclosure made provision for sensors for temperature compensated pressure measurement in the relevant gas compartment to monitor the pressure of SF6 gas.	
16.	Whether the RMU enclosure is sealed pressure system.	

17.	Weight of RMU complete with operating mechanism.	
18.	RMUs are provided with necessary take off terminals	
19.	Whether the gas chamber is made of stainless steel/cast resin tank	

### **SCHEDULE OF GUARANTEED PARTICULARS FOR DT BREAKER**

01.	Manufacturer's Name and Country of origin	
02.	Manufacturer's Design / Type ref/Model.	
03.	Material used for making the body of the breaker	
04.	Standards of manufacturing	
05.	Whether the breakers are manufactured as per IEC/IS standards	
06.	Maximum temperature with stand of the breakers	
07.	1)Spacing between live part to Earth inside the breaker 2)Spacing between poles	
08.	Period of guarantee of the breaker	
09.	Rated frequency	
10.	Rated voltage	
11.	Highest system voltage	
12.	Rated current	
13.	Short time current rating with duration	
14.	Certificate or report of short circuit type test	
15.	Rated operating duty cycle	
16.	Short circuit breaking current (a)Symmetrical (b)Symmetrical at rated voltage (c)Asymmetrical at rated voltage (i)Per Phase (ii)Average (d)DC Component	
17.	Arcing time (At rated breaking current) in ms.	
18.	Opening time	
19.	Total break time in milli sec. (a)At 10% rated interrupting capacity (b)At rated interrupting capacity	
20.	Breaking Current (a)Rated out of phase current (b)Rated cable charging current	



	(c )Rated kilometric fault level (d)Rated capacitor breaking current	
21.	Make time in ms.	
22.	Maximum temperature rise over ambient (a)Main contacts Terminals	
23.	Rated restriking voltage at 100% and 50% rated capacity. (a)Amplitude factor (b)Phase factor ©Natural frequency (d)R.R.R.V.(Volts/micro sec.)	
24.	Dry 1 minute power frequency withstand test voltage (a)Between line terminal and earth KV RMS (b)Between terminals with breaker contacts open KV RMS.	
25.	1.2/50 full wave impulse withstand test voltage (a)Between line terminal and earth KVp. (b)Between terminals with breaker contacts open KVp.	
26.	VCB interrupter make	
27.	Contact separation distance	
28.	Type of main contacts	
29.	Contact pressure	
30.	Contact resistance	
31.	Life of the interrupter (in number of operations)	
32.	(i)Tripping at rated current (ii)Tripping at maximum fault current. (iii)Mechanical operations.	
33.	Details of main contacts making contact with the breaker truck with the panel	
34.	Control circuit voltage AC/DC.	
35.	Whether trip free or not	
36.	Whether all the interlocks provided	

**SCHEDULE OF GUARANTEED PARTICULARS FOR LOAD BREAK  
ISOLATORS & EARTHING ARRANGEMENTS**

SL.NO.	DESCRIPTION	ISOLATORS	EARTHING SWITCH FOR DT & ISOLATOR
01.	Manufacturer's Name and Country of origin		
02.	Manufacturer's Design / Type ref/Model.		
03.	Material used for making the body of the isolators .		
04.	Standards of manufacturing		
05.	Whether the isolators & earth positions are manufactured as per IEC/IS standards		
06.	Maximum temperature with stand of the isolators & earth switches		
07.	1)Spacing between live part to Earth 2)Spacing between fixed and moving contacts in the open position.		
08.	Period of guarantee of the isolators		
09.	Rated frequency		
10.	Rated voltage		
11.	Highest system voltage		
12.	Rated current		
13.	Short time current rating with duration		
14.	Certificate or report of short circuit type test		
15.	Rated operating duty cycle		
16.	Short circuit breaking current		
17.	Arcing time (At rated breaking current) in ms.		
18.	Opening time		
19	Whether all the interlocks provided		
20	Whether Sufficient arrangements are made to operate the isolators through SCADA in future, also to be ensured for provision of space for accommodation of motor in future		
21	Fault passage indicator 1)Type/Model 2)Self powered Yes/No 3)Current readings 4)Fault currents 5)Phase currents		

**SCHEDULE OF GUARANTEED PARTICULARS FOR CURRENT TRANSFORMERS**

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design ref / model	
03.	Applicable Standards	
04.	1)Type of CT 2)Ratio	
05.	Rated Primary current	
06.	Rated secondary current	
07.	Rated frequency	
08.	Transformation ratio	
09.	Number of cores	
10.	Rated output (a) For Core-I	
11.	Class of insulation	
12.	Class of accuracy For Protection	
13.	Short time current rating and its duration	
14.	Secondary resistance at 70 Deg °C	
15.	Continuous over load (percentage)	
16.	One minute power frequency dry withstand voltage	
17.	1.2/50 micro sec. impulse withstand test voltage	
18.	One minute power frequency withstand test voltage on secondary	
19.	Instrument safety factor	
20.	Type of primary winding	
21.	Literature/leaflets pamphlets about the current transformer offered	
22.	Period of guarantee	

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR SELF  
POWERED MICRO PROCESSOR BASED NUMERICAL RELAYS**

01.	Manufacturer's Name and Country of origin		
02.	Manufacturer's design / Ref. Type		
03.	Applicable Standards		
04.	CurrentSetting range for (a)Overcurrent relay	IDMT	
	(b)Earthfault Element	Definite Time	
05.	Whether the relay has the in-built facilities of IDMT, OL, EL		
06.	Details of IDMT Characteristics		
07.	Accuracy for different settings and limits of errors		
08.	Whether Alpha numeric / LED display		
09.	Whether compatible for 1 A CT Secondary		
10.	Whether draw out type		
11.	Types of case		
12.	Reset time		
13.	Burden of relay		
14.	Maximum and Minimum, operating ambient air temp.		
15.	Whether technical literature pamphlets about the relay offered.		
16.	Period of guarantee.		
17.	Certificate of Proof for Electro Magnetic Interference.		

### 53.0 Minimum Guarantee/Warranty Required for supplied Materials

Notwithstanding any of the specifications above, the minimum Guarantee/Warranty requirement for major materials shall be as per below table:

Sr. No.	Material	Gurantee / Warranty
1	3-Phase Distribution Transformers 11 or 33 kV/433-250V (Outdoor Type)	60 months from Commissioning
2	RMU(Ring Main Unit)	60 months from Commissioning
3	ACSR Conductors	36 months from Commissioning
4	LT upto (1100 V) XLPE Insulated	36 months from Commissioning
5	LT Aerial Bunched Cables	36 months from Commissioning
6	XLPE Power Cables (11kV & 33 kV)	36 months from Commissioning
7	33 KV & 11 KV Insulators	36 months from Commissioning
8	Tubular Steel Poles	36 months from Commissioning
9	Feeder Pillar Box	36 months from Commissioning

### 54.0 11 KV SWITCHGEAR

#### 1. General

This section of specification covers the design, manufacture, assembly, shop testing/inspection before dispatch, packing, forwarding, transportation to site, insurance (during transit, storage and erection), storage, erection, supervision, site testing and commissioning of 11 kV, 3 phase 50 Hz air insulated metal clad indoor switchgear unit with horizontal draw out circuit breaker at 66/11 kV Substation.

The scope of supply shall also include necessary special tools and plants required for erection, maintenance.

The switchgear panel should be complete in all respects with insulators, bimetallic connectors, interrupting chamber (vacuum circuit breaker), operating

mechanisms control cabinet, interlocks, auxiliary switches indicating devices, supporting structures, accessories, etc., described herein and briefly listed in the schedule of requirements. The spares/attachments which are necessary for the smooth functioning of the equipment and specifically are not mentioned here shall be assumed to be included the scope of supply.

## 2. Standards

2.1 The circuit Breaker shall confirm to the latest revision with amendment available of relevant standards, rules, and code. Some of which are listed herein for ready reference.

Sl. No.	IS	IEC	Item
1	IS-13118 (1991)	IEC-56	Specification of High Voltage AC Circuit Breaker
	IS-12729	IEC-694	Common clauses for high voltages switchgear and control gear standards
2	IS-2705 (1992)		Current Transformer
3	IS-3156 (1992)		Voltage Transformer
4	IS-3231 (1987)		Relays
5	IS-1248		Ammeter & Voltmeter
6	IS-375		Arrangement of Breaker Busbars main connection and auxiliary wiring
7	CBIP REPORT NO.-88 (JULY) 1996	IEC-687	Static Energy Meter
8	IS-3072		Installation and maintenance of switchgear
9	IS : 9135		Guide for testing of circuit breakers with respect to out of phase switching
10		IEC : 60060	High voltage testing technique
11	IEC-17A Group 1981	Study Dec.	Sealing of interrupters/breakers

12	IS-3427		Metal enclosed Switchgear and Control gear
13	IS-1554	IEC-227	PVC insulated cables upto and including 1000 volts
14	IS : 5		Colors for ready mixed paints and enamels
15		IEC : 529	Degree of protection
16	IS : 996	IEC-34	Single phase Small AC and universal electrical motors
17	IS : 2629, 2633	Iso : 1460	Hot dip galvanising

2.2 Equipment confirming to other international standards will also be considered if they are ensure performance and constructional feature equivalent or superior to the standard listed above. Bidder shall clearly indicate the standard as adopted.

### 3. Service Conditions

#### 3.1 Climatic Conditions

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions.

#### 4. Configurations of different type of panels (to be customized by utility as per capacity and requirement)

TYPE	RATING	NO.
Incomer	800A	3
Bus Coupler	800A	1
Bus PT	11000/ $\sqrt{3}$ /110/ $\sqrt{3}$	3
OUTGOING FEEDER	800A	9

<b>J6</b>	<b>11 kV Indoor Switchgear Panel Complete in all respects as per specification and direction of Employer/PMC.</b>			
	Simplex Cubicle Switchgear Panel for Transformer Incomer complete in all respects as per specification and direction of Employer/PMC.		Nos	<b>3</b>
	Simplex Cubicle Switchgear Panel for outgoing line complete in all respects as per specification and direction of Employer/PMC.		Nos	<b>9</b>
	Simplex Cubicle Switchgear Panel for Bus coupler complete in all respects as per specification and direction of Employer/PMC.		Nos	<b>1</b>
	Bus VT PT1 and PT2 for measuring panels Complete in all respects		Nos	<b>3</b>
<b>J7</b>	Simplex Control and Relay Panel for HV Side of 33/11 kV Transformer at Taxistand Substation complete in all respects as per specification and direction of Employer/PMC.		Nos	<b>1</b>

## 5. Construction

5.1 The 11 kV HT Switch board shall be totally enclosed dust and vermin proof, sheet metal clad, floor mounted, free standing, indoor type and shall house circuit breakers, busbars, control equipments, cable termination, current transformers, potential transformers, instruments, relays and other accessories. All HT panels shall be with fully draw out type breaker carriages, compartmentalized design with cold rolled sheet steel (thickness 2.0 mm for non load bearing and 3.0mm for load bearing parts) and with IP-4X class of enclosure. The Circuit Breaker compartment, Busbar compartment, Cable compartment and LT compartment shall have its own pressure relief flaps/vents with a view to release pressure which would develop in the unlikely event of fault. The vents shall not allow entry of vermin in any case. Bus bar, metering, circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non-draw out type and safe guard in every respect from damages and provided with mechanical indicator of connection and disconnection position. The switchgear shall be completed with all necessary wiring fuses, auxiliary contacts terminal boards etc.

5.2 For each of the incoming and outgoing cubicles, the cable connection, HT bus bars and all low voltage control devices shall be housed in separate enclosures. These enclosures shall be necessarily isolated from that for main circuit breaker chamber to offer better safety and protection of working personnel. All doors other than cable chamber shall be of hinged and lockable type with Neoprene gaskets at all joints and the cable chamber shall be fixed with nuts and bolts. Additional wire mesh guards and gaskets shall be provided for cable chamber.



5.3 The arcing contacts and bus bar should be rated for 25ka for 1s Bus bars shall be capable of connecting one switchgear panel to other through proper insulated arrangement, which does not decrease the insulation strength of the bus bar at the point of connection between two panels. The panels shall be modular in design.

5.4 The breakers should be able to be drawn out in horizontal position at ground level [with vertical/horizontal isolation] when breaker is drawn out in horizontal position none of the live components inside the 11 KV switchgear panel should be accessible. The safety shutters shall be robust and shall automatically cover the live components when the breaker is drawn out. The switchgear shall have complete interlocking arrangements at the fully inserted and fully drawn out and test positions. Withdrawal of the breaker should not be possible in ON position, it should not be possible to close the circuit breaker in service unless the entire auxiliary and control circuit are connected.

5.5 Breaker should have three distinct positions inside the cubical; i.e. service, test and isolated.

5.6 The switchboard shall be suitable to handle full rated capacity in the naturally ventilated atmosphere and it shall be able to control and contain the high short circuit energy under internal arc conditions and ensure safety of the operating personnel in case of faults.

5.7 The cubicle door can be fully shut with breaker in 'ISOLATED' position to stop ingress of dust and vermin. All switching operations shall be performed with the door closed.

5.8 The VT/Relay compartments shall have degree of protective not less than IP52 in accordance with IS:13947. However remaining compartments can have IP 4X type sealing. All louvers if provided shall have very fine Brass or GI mesh screen.

5.9 Safety shutters complying with IEC-60298 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. It shall also be possible to padlock shutters individually. In case, insulating shutters are provided, these shall meet the requirements of

Clause 3.102.1 Note –2 of IEC-60298 and necessary tests are per IEC –60298 Clause 5.103.1 shall be carried out. A clearly visible warning label “Isolate elsewhere before earthing” shall be provided on the shutters of incoming and tie connections which could be energized from other end.

5.10 The switchboard shall have the facility of extension on both sides. Adopter panels and dummy panels required to meet the various busbar arrangement, cable / busduct termination and layouts shall be included in Bidder's scope of work.

5.11 Bus duct inter connection is also includes in the Bidder Scope of Work. The interconnection shall be top entry type with required enclosure and bus duct site. Adequate support shall be provided for this inter-connection by higher from roof.

## **6. Bus bars and connectors and insulators**

6.1 Bus bars and all other electrical connection between various components shall be made of high conductive aluminum alloy of rectangular cross sections. The bus bars shall be able to carry the rated current of 1600 Amp continuously without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system up to full SC rating specified.

6.2 All bus bars connections shall be firmly and rigidly mounted on suitable insulators to withstand short circuit stresses and vibrations.

6.3 Adequate clearance between 11 KV point and earth and between phases shall be provided to ensure safety as per provision in the relevant Indian standard specification/CEA regulations and the same shall be capable of withstanding the specified high voltage tests as per IS-13118/IEC-56 and amendment thereof.

6.4 Sharp edges and bends either in the bus bars or bus bar connections shall be avoided as far as possible. Wherever such bends or edges are un-avoidable, suitable compound or any other insulation shall be supplied to prevent local ionization and consequent flashover.

6.5 Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

Busbar insulators shall be of arc and track resistant high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100 pico coulomb at rated capacity.

## **7. Circuit breaker**

7.1 HT circuit breakers envisaged in the specification shall be designed to control and protect the power system. The circuit breaker shall conform to IS 13118: 1991, IS 3427: 1969, IEC 298, IEC : 694 and IEC publication 56.

7.2 All circuit breakers shall be of horizontal isolation & horizontal draw out type construction having easy manufacturing facility with separate lockable doors over their compartment. The circuit breakers shall be fitted with necessary safety mechanical interlocks.

7.3 The moving carriage of circuit breaker shall be provided with earthing contacts continuously so that the breaker remains positively earthed in “service” position and during withdrawal operation up to “test” position. The breaker shall have anti pumping features.

7.4 All circuit breakers shall have three operational positions such as “Service”, “Test” and “Isolated” position with positive indication for each position. All circuit breakers of identical rating shall be physically & electrically interchangeable.

7.5 The HT breaker shall be provided with motor operated, spring charged independent closing mechanism. The mechanism shall have one geared motor which will automatically recharge the mechanism as soon as breaker is closed. These breakers shall have electrical and mechanical trip free features and an emergency mechanical push to trip the same. All the features of the equipment shall ensure complete safety of the operation and shall be complete with approved safety devices to protect against potential hazards to operating personnel or to the equipment around. The breakers shall also have facilities for manual operation during emergency and servicing. Mechanism shall be simple, rugged and reliable with minimum number of linkages. No damage to parts shall take place in case of any inadvertent attempt for wrong operation.

7.6 All HT breakers shall be provided with at least 8 potential free Aux. contacts to be used for interlocking / signaling purposes. Contact arrangement may be 4 NO + 4 NC and these shall be rated for 220 VDC, 6 Amp.

7.7 The circuit breakers shall be capable of rapid & smooth interruption of current under all conditions completely suppressing all undesirable phenomenon even under most severe & persistent short circuit condition or when interrupting small leading or lagging reactive current.

7.8 The circuit breaker and panel should be completely type tested for 25 KA for 1 sec. and Test Certificate from independent authority should be submitted along with the Tender.

7.9 Facilities to check contact erosion shall be provided particularly.

7.10 Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Isolation of circuit breaker from bus bar or insertion into bus bar shall only be possible when the breaker is in the open position.

7.11 Vacuum interrupter should have an expected life of 30000 operations at rated current and should be capable for operating more than 100 times at rated short circuit current.

7.12 The switchgear should be designed for 2500 KVAR charging duty.

7.13 Mechanical indicators shall be provided on the breaker trucks to indicate OPEN / CLOSED conditions of the circuit breaker, and CHARGED/DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These may be visible without opening the breaker compartment door.

## **8. Control and Interlocks**

The circuit breaker will normally be controlled from local panels through closing and trip coils.

Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

Each panel shall have two separate limit switches, one for the Service position and the other for Isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions.

Auxiliary Contacts of breaker / contactor may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker / contactor operating mechanism.

Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.

## **9. Protection relays**

9.1 All the switchgears shall be provided with protective relays designed to disconnect faulty circuit with speed and discrimination and shall confirm to IS-3231 (1987) or latest revision thereof regarding accuracy and other feature. Composite relay unit having S/C, O/C, E/F etc. shall be preferred.

9.2 All protective & auxiliary relays shall be in dust & vermin proof enclosure, flush mounted on front side of metering compartment and shall be draw out type.

9.3 Insulation of relays should withstand 2.5 KV AC (rms) at 50 Hz for one second between all circuits and the case and between all circuits not intended to be connected together as per IS – 3231 : 1965.

9.4 Relays should be able to withstand Impulse and High Frequency Disturbance as per IS 8686: 1977.

9.5 All relays and timers shall be rated for control supply voltage as mentioned elsewhere and shall be capable of satisfactory continuous operation between 75-110% of the rated voltage.

9.6 Bidder shall furnish in their offers the details of Relays (make, type, range etc.) considered by them for each feeder in a tabular form together with descriptive literature of the Relays offered.

a) All relays shall be draw out type confirming to all requirements as per IS:3231 and shall be suitable for operation from CT secondaries as required. All static relays shall confirm to IS :8686 .

b) The protective relays, except for lock-out relays shall have self - reset contacts, and shall be suitable for efficient and reliable operation of the protective schemes

c) All timers shall be either electromagnetic or static type.

d) All relays & timers shall be designed for satisfactory performance under specified tropical and humid conditions.

e) The bidder shall include in his bid a list of installations where the relays offered are in trouble free operation.

f) The relays and timer shall operate under extreme conditions of control voltage variation.

g) They shall not have any inbuilt batteries, and shall operate on available DC supply. They shall be provided with hand-reset operation indicators (flags) or LEDs with pushbuttons for resetting and for analysing the cause of breaker operation.

h) Shall have built-in test facilities, or can be provided with necessary test blocks and test switches. One testing plug shall be provided for each switchboard.

i) The auto reclose logic shall be generated from local panel. The logic shall be, with the tripping of the feeder breaker under faults after a time delay of 1000 ms. closing command shall be given to particular breaker. If the breaker close/trips then no further closing command shall be issued. However this shall not be used for, I/C, B/C and capacitor feeder.

j) Over voltage relay provided on bus PT shall be used as a backup.

- k) The over voltage trip logic shall be extended only to capacitor feeder.
- l) The protection relay should have potential free contacts as per the protection logic requirement.
- m) Reverse blocking principle for the feeders with incomer shall be provided.
- n) Intertripping of incomer with upstream breaker shall be provided.
- o) Automatic power factor control relay shall be provided one in each section for switching on the capacitor
- p) All equipment shall have necessary protections. However, following minimum protections shall be provided.

FEEDER TYPE	Differential (87T)	REF (64R)	Over Current -50	Over Current DMT(51)	Earth Fault (51N)	Under Voltage -27	Over Voltage -59	Fuse Failure
Incomer	Yes	Yes	Yes	Yes	Yes	-	-	-
Bus Coupler	-	-	-	Yes	Yes	-	-	-
Capacitor feeder	-	-	Yes	Yes	Yes	-	-	-
Normal feeder	-	-	Yes	Yes	Yes	-	-	-
Bus PT	-	-	-	-	-	Yes	Yes	Yes

- q) The capacitor protection scheme shall be designed for the capacitor configuration given elsewhere.

## 10. Current transformers

10.1 Two core CTs shall be employed for measuring instruments and automatic tripping of circuit breakers on overload, Earth Fault and short circuit

protection. CT can be mounted on cable side of breakers with easy accessibility. Class of accuracy and burden for protection CT shall be 5P10 and for metering CT the same shall be class 0.5. The VA burden of the CTs shall be min. 25% more than the calculated value. However, the min. VA burden of CTs shall be 20 VA. CT shall conform to IS : 2705 (Parts 1-4) 1992 with its latest amendments.

However bidder shall furnish the actual VA ratings calculation required for the CT considering the relays and meters provide, for employer approval.

10.2 All the CT's shall be cast resin insulated, Bar primary/Wound secondary type. All secondary connections shall be brought out through conduits to terminal blocks having provision of shorting links.

10.3 Ratio of the CT's shall be as indicated in the protection SLD.

10.4 Short time rating of CTs shall be 25 KA for 1 second. CTs shall be double core and dual ratio. Saturation factor for metering core shall not exceed 2.5.

10.5 The designed accuracy should be available even at the lowest ratios and all CTs shall withstand fault current corresponding to 25KA for 1 sec.

10.6 The secondary terminal of the current transformers shall be such that effective and firm wire terminations are possible. Shorting links of adequate capacity shall be provided at the terminal blocks for sorting of the leads from secondary terminals of current transformers. The secondary terminal of the CTs shall be earthed at one point.

10.7 The secondary winding resistance of CTs shall be as low as possible but not greater than 0.2 Ohms per 100 turns.

## **11. Potential transformers (PT)**

TWO (2) Nos. single phase units of  $((11/\sqrt{3}) \text{ kV}/(110/\sqrt{3})\text{V})$  PTs shall be mounted on incoming panels. HRC fuse protection of adequate rating shall be provided on HT and LT side of PT. Accuracy class of PT shall be 0.5. The primary and secondary of these PTs shall be "Star" connected and used for, all



protection and measuring purposes onboard viz. line volt meters, energy meters etc. PTs shall conform to IS:3156 (Parts 1-4):1992 with its latest amendments.

Potential transformers shall be cast resin, draw out type. PT changeover scheme shall be provided in the switchboard.

All PT should have suitable current limited fuse both at primary and secondary.

## **12. Cable glands and clamping arrangement for holding suitable cable boxes**

12.1 Two nos, brass-wiping glands for each incomer and one no. Brass wiping gland for each outgoing panel of adequate dimension for XLPE cable up to 400 sq. mm size shall be supplied along with panels. For bus coupler no cable glands should be provided.

12.2 Suitable cable boxes as per requirement of cable shall be arranged by the bidder. The panel shall however provide a flat of size 50x6 mm<sup>2</sup> with suitable clamp made of 50x6 mm<sup>2</sup> flat along with Nuts Bolts and Washers for holding the cable boxes. The flat should be fitted at a suitable height with allotted arrangement for adjustment of height from 300mm to 500mm at site. The clamp and flat shall have suitable stud type arrangement for earthing cable and cable box.

12.3 All control cable/wire entries shall be by means of suitable cable glands, such glands shall be of brass and tinned.

## **13. Auxiliary/control wiring**

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 2.5 mm<sup>2</sup> of copper. Colors of the secondary/auxiliary wiring should confirm to IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly run and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel shall be run in flexible tubes and the same shall be so mounted to

avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

#### **14. Static energy meters - Deleted**

#### **15. Painting**

All metallic surface [except enameled and bright parts] exposed to weather shall be given suitable primer coat and two coats of first quality paint of approved color. The supplier shall also supply adequate quantities of paints, Varnish etc. for use of finished cost and for use of patching up any scratches received during transport, handling erection testing and commissioning.

Instead of above proper powder coating after proper pre-treatment is acceptable and in that case earlier condition will not applicable.

#### **16. Tests**

The design of circuit breaker shall be proven through all the routine and type tests in accordance with IS 13118: 1991/IEC 56 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 5 year from the date of tender opening shall not be acceptable.

#### **17. Technical Parameters (to be customized by utility as per capacity and requirement)**

##### **17.1 11 kV Circuit Breakers**

Sl.No.	DESCRIPTION	VALUES
i)	Rate Voltage (kV rms)	11 kV
ii)	Rated frequency (Hz)	50
iii)	System neutral earthing	Solidly grounded system
iv)	Type of arc quenching medium	Vacuum

v)	Rated normal current at site conditions (Amps)	800 Amp for I/C breaker and Bus Coupler and 400 Amp for Outgoing feeders
vi)	Number of poles	3
vii)	Installation	Indoor type
viii)	Temperature rise	As per IEC 56 (Table-4) Page-19
ix)	Rated short circuit	
	a) Interrupting capacity at 11 kV	25 kA
	b) The percentage DC components	As per IEC 56 & (Ref. Page 51, 21 of IEC)
	c) Minimum number of Short Circuit operation the Circuit Breaker can withstand	100
x)	Rated short circuit making capacity	62.5 KA
xi)	First pole to clear factor	1.5
xii)	Rated short time current carrying capacity	25 kA
xiii)	Rated duration of short circuit	1 Seconds
xiv)	Total break time for any current upto the rated breaking current with limiting condition of operating and quenching media pressure (ms)	As per IS/IEC
xv)	Closing time (rms)	As per IS/IEC
xvi)	Standard value of rated transient recovery voltage for terminal fault	As per IEC-56
xvii)	Standard value of rated line	
	Characteristics for short line faults	

	RRRV	KV/ms=0.214
	Surge Peak Factor	Factor K=1.6 A
	Impedance	Z (ohms) = 450
xviii)	Rated operating	
	a) Duty cycle	O-0.3 Second-CO-3 Minutes-CO
	b) Auto reclosing	Suitable for three phase Auto reclosing
xix)	Rated insulation level under heavy pollution condition 1.2/50 micro second lightening Impulse withstand voltage (kV peak) to earth	75 kV
xx)	Power frequency withstand voltage kV (rms) to earth (kV rms)	28 kV
xxi)	Rated characteristic for out of Phase breaking	
	a) Out of phase breaking capacity	25% of rated breaking capacity
	b) Standard values of transient recovery	As per IEC-56
	c) Operating mechanism	Spring operated, Anti pumping and Trip free mechanism
	d) Power available for operating mechanism	Three phase 415 Volts 50 C/S or single phase 50 C/S 240 Volts
xxii)	a) Rated supply voltage of closing and operating devices and auxiliary circuits	1) 220 VDC 2) 240 Volts AC 50 C/S single phase 3) 415 Volts 50 Hz three phase
	b) Permissible voltage variation	1) In case of DC Power supply voltage variation shall be between 85% to 110% of normal voltage. 2) In case of AC power supply voltage variation shall be of the normal voltage as per IS-15% to +10%

	c) Permissible frequency	$\pm 3\%$ from normal 50 Hz as per IS : 2026 Part-I 1977 para 4.4
	d) Combined variation of frequency and voltage	$\pm 15\%$
xxiii)	Number of auxiliary contacts	10 NO and 10 NC on each pole Continuous current rating 10 Amps, DC breaking rating capacity shall be 2 Amps with circuit time constant less than 20 ms at 220/30 volts DC
xxiv)	Number of coils	1 (One) trip coils and 1 close coil with anti-pumping arrangement
xxv)	Rated terminal load	100 kg. Static. The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces.

#### **18. Completeness Of Equipment:**

Any fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary for the satisfactory operation of the equipment, shall be deemed to have been included in this specification.

#### **19. Packings:**

All material shall be suitably packed for transport, direct to site and Manufacturer shall be responsible for all damages/losses due to improper packing. All boxes shall be marked with signs indicating the up and down sides of the boxes along with the unpacking instructions, if considered necessary by the Manufacturers.

**55.0 Letters for Amendment in Technical Specification**

The bidder shall ensure that due attention has been given in supply of materials and erection works as per latest amendments issued by REC from time to time. Some amendment letters are attached herewith for reference of the bidder.



रुरल इलेक्ट्रिफिकेशन कारपोरेशन लिमिटेड  
Rural Electrification Corporation Limited

(भारत सरकार का उद्यम)/ A Government of India Enterprise)

Regd. Office: Core-4 SCOPE Complex, 7, Lodhi Road, New Delhi 110 003  
Tel: 011-24369851 FAX: 011-24369850 , Email:- [ddugjyquality@gmail.com](mailto:ddugjyquality@gmail.com)  
CIN: L40101DL1969GO1005095 Website: [www.recindia.nic.in](http://www.recindia.nic.in)

Ref. No. REC/DDUGJY/SBD/ 749.

Dated: 27-07-2016

To  
All Project Implementing Agencies  
(DISCOMs/SEBs/CPSUs/Power Departments)  
RE-DDUGJY Projects

**Sub: Amendment in Technical Specification of 11 kV Composite Insulators -reg**

Sir/Madam,

This has reference to the Standard Bidding Document Vol -III Section-I Technical Specification of 11 kV Composite Insulators to be used under DDUGJY scheme. The clause no. 5 of technical specification has been amended which is as here under:

Existing Provision in the Clause	Amended Clause
The minimum shed diameter for long rod insulator should be 100 mm	The minimum shed diameter for long rod insulator should be between 75-100 mm

This is for kind information please.

Yours sincerely,

(G S Bhati)

General Manager (DDUGJY)

Copy to:  
ZM/CPM- Please circulate to PIAs in the states of your purview.

**Zonal Offices** : Hyderabad, Kolkata, Mumbai , Panchkula & Lucknow  
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**Sub Offices** : Dehradun, Raipur  
**Training Centre** : Central Institute for Rural Electrification (CIRE), Hyderabad



एक कदम स्वच्छता की ओर



## रूरल इलेक्ट्रीफिकेशन कारपोरेशन लिमिटेड Rural Electrification Corporation Limited

(भारत सरकार का उद्यम) / (A Government of India Enterprise)

Regd. Office: Core-4, SCOPE Complex, 7 Lodhi Road, New Delhi 110 003

Tel: +91-11-4102 0101 Fax: +91.11.2436 0644 E-mail: reccorp@recl.nic.in

CIN : L40101DL1969GOI005095 Website: www.recindia.nic.in

Ref. No. REC/DDUGJY/SBD/770

Dated: 05-08-2016

To

All Project Implementing Agencies  
(DISCOMs/SEBs/CPSUs/Power Departments)  
RE-DDUGJY Projects

### Sub: Amendment in Technical Specification of Piercing Connector -reg

Sir/Madam,

This has reference to the technical Specification of Piercing Connector to be used under RE-DDUGJY (erstwhile RGGVY) XII Plan & DDUGJY schemes. The clause no. 5.4.1 of technical specification which shall constitute Acceptance Tests for Insulation Piercing Connectors (IPC) has been amended which is as here under:

Existing Provision in the Clause	Amended Clause
<ul style="list-style-type: none"> <li>Visual</li> <li>Dimensional (as per SCD and overall dimensions submitted with Tender Offer)</li> <li><b>Electrical Ageing Test</b></li> <li>Dielectric and Water Tightness Test.</li> <li>Mechanical Tightening Test</li> <li>Effect of Tightening on Main Core</li> <li>Effect of Tightening on Branch Core</li> </ul>	<ul style="list-style-type: none"> <li>Visual</li> <li>Dimensional (as per SCD and overall dimensions submitted with Tender Offer)</li> <li>Dielectric and Water Tightness Test.</li> <li>Mechanical Tightening Test</li> <li>Effect of Tightening on Main Core</li> <li>Effect of Tightening on Branch Core</li> </ul>

This is for kind information please.

Yours sincerely,

(G S Bhati)

Executive Director (DDUGJY)

Copy to:

1. ZM/CPM- Please circulate to PIAs in the states of your purview.

**Zonal Offices** : Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow  
**Project Offices** : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu Patna, Ranchi, Shillong, Shimla, Thiruvananthapuram & Vadodara  
**Sub Offices** : Dehradun, Raipur  
**Training Centre** : Central Institute for Rural Electrification (CIRE), Hyderabad





No. REC/DDUGJY/SBD/DTR-TS/ 969

Dated: 29.09.2016

To,

All PIAs /DISCOMs/Power Deptt.

**Subject: Methodology of Loss Capitalisation in Technical Specification of Distribution Transformer under DDUGJY -reg.**

Dear Ma'M / Sir,

Ministry of Power vide OM No 44/15/2015 dated 14.08.2015 had formed two committees viz. Committee 'A' & 'B' to facilitate and handhold states in mobilizing major materials with Standard Technical Specifications at competitive prices through a transparent bidding process under DDUGJY / IPDS Schemes. Committee A had identified the major high value items viz., Power Transformers, Distribution Transformers, Conductor, AB Cables & Energy Meter, finalized their Technical Specification and aggregated the quantity.

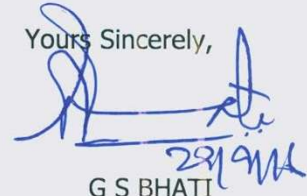
During the meeting held on June 29, 2016 under the Chairmanship of Hon'ble MoS (IC) for Power, Coal and New & Renewable Energy, it was decided that states are free to procure the materials on their own, if it is felt that their rates are lower than CPP rates. Accordingly, REC vide letter no. REC/DDUGJY/NIMM/745 dated 26.07.2016 (copy enclosed) allowed full turnkey mode of execution under DDUGJY and revised Standard Bidding Documents for full turnkey execution were circulated to all States vide REC letter No. REC/DDUGJY/SBD/239 on 22.08.2016.

The Technical Specification of Distribution Transformer, finalized by Committee 'A', mentioned the methodology for computing total owning cost based on loss capitalization. Since it would be practically not feasible to implement the Loss Capitalisation methodology for tender evaluation in full turnkey projects, the methodology of Total Owning Cost based on Loss Capitalisation may not be insisted upon for full turnkey tenders. However, States opting to go for direct procurement of Distribution Transformers may take care of this methodology based on their State practice.

This is for kind information and further needful action please.

Thanking You.

Yours Sincerely,



G S BHATI

Executive Director (DDUGJY-III)

Copy for kind information to:

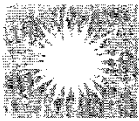
1. The ZMs/CPMs, REC ZOs/POs – to circulate to all PIAs in the states of their jurisdiction

**Zonal Offices** : Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow

**Project Offices** : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi, Shillong, Shimla, Thiruvananthapuram & Vadodara

**Sub Offices** : Dehradun, Raipur

**Training Centre** : Central Institute for Rural Electrification (CIRE), Hyderabad



**आर ई सी**  
**REC**

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**रुल इलेक्ट्रिफिकेशन कारपोरेशन लिमिटेड**

**Rural Electrification Corporation Limited**

(भारत सरकार का उद्यम) / **A Government of India Enterprise**

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Tel: 011-24369851 FAX: 011-24369850 , Email:- [ddugjyquality@gmail.com](mailto:ddugjyquality@gmail.com)  
CIN: L40101DL1969GO1005095 Website: [www.recindia.nic.in](http://www.recindia.nic.in)

No. REC/DDUGJY/SBD/2017-18 / 1129

Dated: 15.05.2017

To,

All Project Implementing Agencies  
DISCOMs /Power Deptt./ SEBs/CPSUs

**Subject:** Regarding Technical Specifications of LTDB in Standard Bidding Documents for DDUGJY

Ma'M / Sir,

This has reference to revised Standard Bidding Documents for full turnkey contracts under DDUGJY & IPDS circulated vide letter No. REC/DDUGJY/SBD/239 dated 22.08.2016. The Technical Specification of LTDB (Low Tension Distribution Boxes) specifies metallic boxes using deep drawn methodology. In addition to this, "Low Tension Distribution Box (LTDB) can also be manufactured by sheet bending process for developing three side walls (from a single sheet) with top & bottom walls welded to the same and front door fabricated separately and hinged."

This is for kind information and further needful action please.

Thanking You,

Yours Sincerely,

G S BHATI

Executive Director (DDUGJY)

Copy for kind information to:

1. All ZM/CPM - Please circulate to PIAs in the states of your purview.

**Zonal Offices** : Hyderabad, Kolkata, Mumbai , Panchkula & Lucknow  
**Project Offices** : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi , Shillong, Shimla, Thiruvananthapuram & Vadodara  
**Sub Offices** : Dehradun, Raipur  
**Training Centre** : Central Institute for Rural Electrification (CIRES), Hyderabad



एक कदम स्वच्छता की ओर

REC/DDUGJY/SBD/2017/2148

Date: 21.07.2017

To,  
All PIAs  
(States Discoms/Power Departments)

Sub: Modification in technical specification for CTs, PTs under DDUGJY Scheme.

Sir / Madam,

A representation was received from MPPKVCL seeking clarification in technical specification for CTs & PTs under DDUGJY scheme. In this connection, following modification has been made in the technical specification for CTs & PTs :

SI No	TS Clause No	Existing Technical Specification	REC Comments / Clarification
1	TS for current Transformers Clause No. 4.7. (1)	The primary terminal shall be of standard size of 30mm dia X 80 mm length of heavily tinned(min. thickness 15 micron) electrolytic copper of 99.9% conductivity.	Clause may be modified to : The primary terminal shall be of <b>maximum</b> size of 30mm dia X 80 mm length of heavily tinned(min. thickness 15 micron) electrolytic copper of 99.9% conductivity. Manufacturer shall design the diameter of primary terminal keeping current density 1.6 A per sq. mm for the given capacity of CT.
2	TS for potential Transformers Clause No. 7	The secondary terminals studs shall be provided with at least 3 nuts and two plain washers. These shall be made of brass duly nickel plated. The min. stud outer dia shall be 10 mm & length 15 mm.	Clause may be modified to : The secondary terminals studs shall be provided with at least 3 nuts and two plain washers. These shall be made of brass duly nickel plated. The min. stud outer dia shall be <b>6 mm</b> & length 15 mm.
3	TS for metering units, Clause No.9	Brass rods 12mm dia for Primary and 6mm dia for secondary.	Keeping current density of 1.6 A per sq. mm size of rod may be designed by manufacturer for given CT / PT.

**Regional and State Offices** : Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow  
: Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi, Shillong, Shimla, Thiruvananthapuram & Vadodara  
: Dehradun, Raipur  
**Training Centre** : Central Institute for Rural Electrification (CIRE), Hyderabad



SI No	TS Clause No	Existing Technical Specification	REC Comments / Clarification
4	TS for Metering Units, Clause No 10.b	Tank including top cover shall be Hot Dip Galvanized.	Existing clause of TS will prevail. However state may decide to use Hot dip galvanized / Epoxy paint tank for CT/PT unit as per their prevailing state practices.

This is for your kind information and necessary action please.

Thanking You,

Yours faithfully,



(A Veluchamy)  
Addl. General Manager  
DDUGJY-Q&FM

Copy for kind information to:

1. The Sr. CPM / CPM, REC Regional office, for kind information please.

REC/DDUGJY/SBD/TS/2017-18/D.No.3091

Dated: 25.08.2017

The Chairman / Managing Director/ Chief Engineer  
All Project Implementing Agencies (PIA)/DISCOM/  
State Power Utilities/ Power Department

**Sub: Clarification in Technical Specifications of various equipment included in the Standard Bidding Document (SBD) of DDUGJY/IPDS**

Dear Sir/Madam,

Following clarification pertains to technical specification of DDUGJY scheme are hereby conveyed:

Sl. No.	Name of materials	Particulars	Provision in SBD	Amended Provision
1	Distribution Transformers	Vacuum type test on transformer tank	Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq. cm absolute (250 mm of Hg) for one hour. (clause no.- 31.10- pgno-80)	"Vacuum Type Test on Transformer Tank" shall be carried out as per IS-1180 (Part-1): 2014 i.e. The transformer tank shall be subjected to air pressure 80 kPa for 30 minutes and vacuum of 250 mm of mercury for 30 minutes.
2	Power Transformers	Maximum temperature rise over ambient temperature for oil/winding above ambient temperature	Permissible Temperature rise over ambient temperature shall be as per IS-2026 (point no.-25 page no.-6)	The maximum temperature rise over ambient temperature for oil/winding above ambient temperature shall be as per IS-2026(Part-2):2010. i.e. Maximum temperature rise over ambient temperature for top oil measured by thermometer should be 50 degree C. and for winding measured by resistance should be 55 degree C
3	XLPE Power Cables	Bleeding blooming type test	Bleeding and blooming tests (for outer sheath) (clause no-6.0, pgno-367)	"Bleeding Blooming Test" is deleted for XLPE cables.




Sl. No.	Name of materials	Particulars	Provision in SBD	Amended Provision
4	Isolators & AB switches	Maximum temperature rise over ambient temperature.	The maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed to the direct rays of Sun shall not exceed 45 degree above ambient (clause no.-4- pgno-488)	Maximum permitted temperature rise over ambient temperature will be as per Table-4 of IS-9921 (Part-2 ).
5	Power Transformers	Noise level measurement type test	Noise Level Measurement IEC 551 Table : 6 Transformer Type Tests ambient (clause no.-8.2.1 pgno-31)	No change
6	XLPE Power Cable	Drum length	All Power Cables shall be supplied in drum length of 1000 m. Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. (clause no.-5.0 pgno-366)	Drum length for power cable shall be 200/300/500m as per requirement of utility/Discom.
7	11 kV AB Switch	Number of Post Insulator per stack	The complete set of three phase AB Switches shall have stacks of post insulators. 11KV AB Switches : 3 No. 11KV Post Insulator per stack (clause no.- 3 pgno-487)	For 11kV AB switch, one (1) no. 11 kV post insulator per stack shall be permitted.
8	33 kV AB Switch	Number of Post Insulator per stack	The complete set of three phase AB Switches shall have stacks of post insulators. 33KV AB Switches : 3	For 33kV AB Switch, two (2) no. 22 kV post insulator or 3 No 11 KV post Insulators shall be permitted in each stack

Sl. No.	Name of materials	Particulars	Provision in SBD	Amended Provision
			No. 33KV Post Insulator per stack (clause no.- 3 pgno-487)	
9	11 kV Isolator	Number of Post Insulator per stack	11 KV isolators shall comprise of three numbers 11 KV insulators per stack and 9 such stack shall be supplied with each isolator. (clause no.- 9 pgno-484)	Post insulators for the 11kV isolators shall comprise of one (01) no. 11kV insulator per stack and nine (9) such stack shall be supplied with each isolator.
10	33 kV Isolator	Number of Post Insulator per stack	33 KV isolators, two numbers 33 KV insulators per stack and 9 stacks shall be supplied with each isolator (clause no.- 9 pgno-484)	Post insulators for 33kV isolators shall comprise two (02) nos. of 22kV insulators or 3 No of 11 KV post insulators or One no 33kV post insulator per stack and nine (9) such stack shall be supplied with each isolator

This is issued with the approval of the competent authority

Thank you

Yours faithfully,

  
 (A. Veluchamy)  
 Addl. General Manager  
 (DDUGJY-QA&FM)

Copy for uploading in DDUGJY web portal

REC/DDUGJY/SBD/2017-18/609

Date: 05.10.2018

To  
All Project Implementing Agencies,  
DDUGJY-RE Projects XII Plan & DDUGJY/IPDS Scheme

Sub: Amendments in technical specification of AB Cable Accessories and Insulation Piercing Connectors (IPC) provided in Standard Bidding Document for DDUGJY-RE 12 Plan and DDUGJY/IPDS scheme.

Sir,  
This has reference to the technical specifications of AB Cable accessories and Insulation Piercing Connectors (IPC) to be used DDUGJY-RE Projects XII Plan & DDUGJY/IPDS Schemes. In this connection, please find enclosed the amendments/corrections in clause 5.1.10.4, 5.2 & 5.3 of technical specification of AB Cable Accessories and Insulation Piercing Connectors (IPC) provided in Standard Bidding Document.

This is for information and further needful action please.

Yours sincerely,



G S BHATI  
Executive Director (PMD-II/QA)

Copy to:  
Sr. CPM/CPM, REC RO/SO- with a request to please circulate to PIAs in the states of your purview.

**Regional** : Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow  
**and** : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi, Shillong, Shimla,  
**State** : Thiruvananthapuram & Vadodara  
**Offices** : Dehradun, Raipur  
**Training Centre** : Central Institute for Rural Electrification (CIRE), Hyderabad



**AMENDMENT PROPOSED IN TECHNICAL SPECIFICATIONS OF CABLE ACCESSORIES OF SBD (DDUGJY)**

SI No	Clause No. of SBD	Heading in clause	Provision as per Technical Specification of SBD	Amendments/ Recommendation
1	5.1.10.4	Insulation Piercing Connector (IPC)	<p>The following shall constitute Type Tests for IPC :</p> <ul style="list-style-type: none"> <li>• Electrical Ageing Test</li> <li>• Dielectric and Water Tightness Test.</li> <li>• Mechanical Tightening Test</li> <li>• Effect of Tightening on main Core</li> <li>• Effect of Tightening on Branch core</li> <li>• Over-current Test (if applicable) \</li> </ul>	<p>The following shall constitute Type Tests for IPC :</p> <ul style="list-style-type: none"> <li>• Electrical Ageing Test</li> <li>• Dielectric and Water Tightness Test.</li> <li>• Mechanical Tightening Test</li> <li>• Effect of Tightening on main Core</li> <li>• Effect of Tightening on Branch core</li> <li>• Over-current Test (Applicable as per relevant clause of latest version of NFC 33020)</li> </ul>
2	5.1.10.4	Suspension Assembly (SA)	<p>The following shall be Type Test for Suspension Assembly (SA)</p> <ul style="list-style-type: none"> <li>• Mechanical Test</li> <li>• Voltage Test</li> <li>• Climatic Aging Test</li> <li>• Corrosion Test</li> <li>• <b>Endurance Test under Thermal &amp; Mechanical Stresses.</b></li> </ul>	<p>The following shall be Type Test for Suspension Assembly (SA)</p> <ul style="list-style-type: none"> <li>• Mechanical Test</li> <li>• Voltage Test</li> <li>• Climatic Aging Test</li> <li>• Corrosion Test</li> <li>• <b>Endurance Test under Thermal &amp; Mechanical Stresses (optional till testing facilities are available in India)</b></li> </ul>
3	5.1.10.4	Anchoring Assemblies (AA)	<p>The following shall be Type Tests for Anchoring Assemblies (AA)</p> <ul style="list-style-type: none"> <li>• Mechanical Test</li> <li>• Voltage Test</li> <li>• <b>Dynamic Test</b></li> <li>• Climatic Aging Test</li> <li>• Corrosion Test</li> <li>• Endurance Test under Thermal &amp; Mechanical Stresses</li> </ul>	<p>The following shall be Type Tests for Anchoring Assemblies (AA)</p> <ul style="list-style-type: none"> <li>• Mechanical Test</li> <li>• Voltage Test</li> <li>• <b>Dynamic Test (Applicable for areas having sub zero minimum temperature)</b></li> <li>• Climatic Aging Test</li> <li>• Corrosion Test</li> <li>• Endurance Test under Thermal &amp; Mechanical Stresses</li> </ul>

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4	5.2	Anchoring Clamp for Insulated Messenger	<p>The clamps should be designed to Anchor LT-AB cable with insulated messenger. The clamp should consist of an Aluminium alloy corrosion resistant <b>castled</b> body, bail of stainless steel and self adjusting plastic wedges which shall anchor/hold the neutral messenger without damaging the insulation.</p> <ul style="list-style-type: none"> <li>• No losable part in the process of clamping arrangement</li> <li>• The clamp should conform to the standard NFC 33041 and 33042 or equivalent I.S. if any.</li> <li>• The clamp body should be made of corrosion resistant Aluminum alloy, bail should be of stainless steel and wedges should be weather and UV resistant polymer.</li> <li>• <b>Ultimate tensile strength of the clamp should not be less than 15 km for 50/70sq.mm insulated messenger wire / 10 KN for 25/35 sq.mm insulated messenger wire.</b></li> <li>• <b>Slip load of the clamp should not be less than 3 KN for 50/70 sq.mm. messenger wire / 2 KN for 25/35 sq.mm. messenger wire.</b></li> </ul>	<p>The clamps should be designed to Anchor LT-AB cable with insulated messenger. The clamp should consist of an Aluminum alloy corrosion resistant body, bail of stainless steel and self adjusting plastic wedges which shall anchor/hold the neutral messenger without damaging the insulation.</p> <ul style="list-style-type: none"> <li>• No losable part in the process of clamping arrangement</li> <li>• The clamp should conform to the standard NFC 33041 and 33042 or equivalent I.S. if any.</li> <li>• The clamp body should be made of corrosion resistant Aluminum alloy, bail should be of stainless steel and wedges should be weather and UV resistant polymer.</li> <li>• <b>Ultimate tensile strength of the clamp should be as per Table-6 of Technical Specification.</b></li> </ul>
5	5.3	Suspension Clamp for insulated neutral messenger	<p>The clamp should be designed to hang L.T – AB cable with insulated neutral messengers. The neutral messengers should be fixed by an adjustable grip device. A movable link should allow longitudinal and transversal movement of the clamp body.</p>	<p>The clamp should be designed to hang L.T – AB cable with insulated neutral messengers. The neutral messengers should be fixed by an adjustable grip device. A movable link should allow longitudinal and transversal movement of the clamp body.</p>

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			<ul style="list-style-type: none"> <li>• No losable part in the process of clamping arrangement.</li> <li>• The clamp should conform to the standard NFC 33040 or equivalent I.S, if any.</li> <li>• The clamp and the link made of Polymer should provide an additional insulation between the cable and the pole.</li> <li>• The clamps and movable links should be made of weather and UV resistant glass fibre reinforced polymer.</li> <li>• Clamps should be fixed with pole by eye hook / bracket. Bracket should be made of corrosion resistant aluminum alloy.</li> <li>• <b>Ultimate tensile strength of the clamp should not be less than 15 KN for 50/70 sq.mm. Insulated messenger wire 4.3 KN for 25/35 sq.mm. Insulated messenger wire.</b></li> <li>• <b>Maximum allowable load of the clamp should not be less than 20 KN for 50/70 sq.mm. insulated messenger wire/15 KN for 25/30 sq.mm insulated messenger wire.</b></li> </ul>	<ul style="list-style-type: none"> <li>• No losable part in the process of clamping arrangement.</li> <li>• The clamp should conform to the <b>latest version of</b> standard NFC 33040 or equivalent I.S, if any.</li> <li>• The clamp and the link made of Polymer should provide an additional insulation between the cable and the pole.</li> <li>• The clamps and movable links should be made of weather and UV resistant glass fibre reinforced polymer.</li> <li>• Clamps should be fixed with pole by eye hook / bracket. Bracket should be made of corrosion resistant aluminum alloy.</li> <li>• Ultimate tensile strength of the clamp should be as per Table-10 of Technical Specification.</li> </ul> <p style="text-align: right;">pg. 3</p>