

# TECHNICAL SPECIFICATION FOR OUTDOOR 3 PHASE 315 KVA AMORPHOUS / CRGO CORE CSP TYPE COPPER CONDUCTOR DISTRIBUTION TRANSFORMERS

**1. SCOPE :** This specification covers oil immersed naturally cooled, three phase, 50Hz, CSP TYPE Copper conductor outdoor type Distribution Transformers of capacity 315KVA on systems with nominal voltages of 11KV.

The transformers shall be guaranteed for 5 years from the date of supply.

## **2. 2.0 STANDARDS:**

**2.1** The materials shall conform in all respects to the relevant Indian/International Standards specifications, which shall mean latest revisions, amendments/changes adopted and published, unless otherwise specified herein before. International and Internationally recognized standards to which these standards generally correspond are also listed below:

Indian Standard	Title	International and Internationally recognised standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers upto and including 2500kVA,	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS -3347	Specification for porcelain Transformer bushing	DIN 42531,23,3
IS-335	Specification for Transformer Oil	BS 148, D-1473, D-1533- 1934, 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 - 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.	

Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above would also be acceptable. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English Translations shall be furnished along with the offer. In case of conflict the order of precedence shall be (i) IS (ii) IEC (iii) Other standards. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail. Anything not covered by this specification, will be as per relevant CEA, REC, IS and CBIP manual in order.

**3. SYSTEM DETAILS :** The transformers shall be suitable for outdoor installation with three phase 50Hz, 11KV system in which the neutral is effectively earthed and they should be designed suitable for service under fluctuations in supply voltage upto  $\pm 12.5\%$  under Indian Electricity Act and Rules there under.

**4. SERVICE CONDITIONS:**

The Distribution Transformers to be supplied against this specification shall be suitable for satisfactory continuous operation under the following climatic conditions.

i)	Location	:	At various locations in the State of A.P.
ii)	Max. ambient air temp. (Deg.C)	:	50
iii)	Min. ambient air temp. (Deg.C)	:	7.5
iv)	Average daily ambient air temperature (Deg.C)	:	35
v)	Max. relative humidity (%)	:	100
vi)	Max. altitude above mean sea level (meters)	:	1000
vii)	Average annual rainfall (mm)	:	9100
viii)	Max. wind pressure (Kg./Sq.mm)	:	200
ix)	Isoceraunic level (days per year)	:	50
x)	Siesmic level (Horizontal accn. )	:	0.10 g.

The equipment shall be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth.

**5. RATING**

- a) Primary voltage : 11KV
- b) Secondary voltage
  - i) Between phases : 433 V
  - ii) Between phases to neutral : 250 V

The windings of the transformers shall be connected Delta on the primary side and Y (Star) on the secondary side. The neutral of the LT winding shall be brought out to a separate terminal. The vector group shall be Dyn. II.

**6. TEMPERATURE RISE:** The temperature rise over ambient shall not exceed the limits given below:

- 6.1 Top oil temperature rise measured by thermometer : 40 deg.cen
- 6.2 Winding temperature rise measured by resistance method : 45 deg.cen

**Bids not meeting the above limits of temperature rise will be treated as non-responsive.**

6.3 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.

**7. NO LOAD VOLTAGE RATING:** The no-load voltage ratios shall be as follows 11000/433-250 Volts.

**8. TAPS:** Tapping shall be provided on the higher voltage winding for variation of HV voltage within range of (+) 5.0 % to (-) 10.0 % in steps of 2.5% as per IS 1180 Part I of 2014.

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. Provision shall be made for locking the tapping switch handle in position. Suitable aluminium anodised plate shall be fixed for tap changing switch to know the position number of tap

## **9.0 DESIGN & CONSTRUCTION CORE:**

### **9.1 MATERIAL – CRGO / AMORPHOUS METAL**

1) **CRGO Material :** The core shall be Stack / Wound. Material shall be CRGO sheet (M4 or Better grade) only prime quality material should be used. Prime excesses, Used material, Scrap, seconds, material or core removed from the second hand transformers shall not be used.

The core shall be of high grade cold rolled grain oriented 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. All core clamping bolts shall be effectively insulated by Zinc Chromate and paper. The complete design of core must ensure permanency of the core losses with continuous working of the transformers.

- (a) The transformer core shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 12.5% without injurious heating to full load conditions and shall not get saturated. The bidder shall furnish necessary design data in support of this situation.
- (b) Flux density should not be more than 1.55 webers m<sup>2</sup> (Tesla) No load current shall not 1.25% for 315KVA and will be measured by energizing the transformer at 433Volts 50Hz on the secondary. Increase of voltage of 433Volts by 10% shall not increase the no load current disproportionately high. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of an bu and cu voltage will be carried out.
- (c) Number of steps of core shall be minimum 7 Nos. for 315 KVA. Wound core design is also accepted and the no. of coils for wound core is 1.

- (d) Diameter of Core should not be less than for 315KVA – 170 mm
- (e) Effective area of core should not be less than for 315KVA – 200 Sq.mm
- (f) Core clamping: (i) MS channel to be used 100x50mm size for 315KVA on top and bottom.
  - (ii) 2x16mm high tensile bolts to be used for 315 KVA in parallel at each end.
  - (iii) Channel on LV side to be reinforced at equidistance if holes/cuttings is done on LT side to avoid bending of channel.
  - (iv) MS channel shall be painted with varnish or oil resistant paint.
- (g) Tie rods : 8Nos. of **M16 high tensile steel rods** shall be effectively insulated.
- (h) (i) All top and bottom yoke nuts and bolts and tie rods shall be painted with oil and corrosion resistant paint **and phosphate coated paint for tie rods** before use.
  - (ii) Core base and bottom yoke shall be supported with 75x40mm MS channel with proper bolting. Flat or cut channels will not be accepted.

## 2) AMORPHOUS METAL:

- (a) The core shall be high quality amorphous ribbons having very low loss formed into wound cores of rectangular shape, bolted together to the frames firmly to prevent vibration or noise. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the flux density allowed in the design shall be clearly stated in the offer. Curve showing the properties of the metal shall be attached with the offer.
- (b) Core Clamping – Amorphous Metal Transformers
  - 1. Core clamping shall be with top and bottom U-shaped core clamps made of sheet steel clamped with MS tie rods for efficient clamping.
  - 2. MS core clamps shall be painted with varnish or hot oil resistant paint.
  - 3. Suitable provision shall be made in the bottom core clamp / bottom plate of the transformer to Arrest movement of the active part.
- (c) The transformer 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.
- (d) No load current shall not exceed 2% of full load current and will be measured by energizing the transformer at 433 volts, 50 c/s on the secondary. Increase of voltage of 433 volts by 12.5 % shall not increase the no load current by Max. 5% of full load current. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of an, bn, cn voltage will be carried out.

Note : 1) The tenderer shall furnish the design details of the core construction along with their offer with reference to the losses quoted.

*2) Equal weightage shall be given to the transformers with Amorphous metal core and CRGO.*

## **9.2. WINDING :**

- (a) Material : Double paper covered insulated electrolytic grade conductor DPC insulated copper shall be used.
- (b) **Current density for HV & LV winding should not be more than 2.5 A/sq.mm for copper.**
- (c) HV cross section shall not be less than 3.40 Sq.mm for 315 KVA.
- (d) LV cross section shall not be less than 150 Sq.mm for 315 KVA
- (e) LV winding shall be in even layers so that neutral formation will be at top
  - (i) Formation of Delta on HV side shall be with 13SWG super enameled in wire with multi layered (not less than 13 layers) paper insulation. Necessary resin bonded paper insulation tubes or bakelite bits may be used through. This shall be done with ferrols and crimping.
  - (ii) All the sleeves used in construction shall be fibre glass material.
  - (iii) The star point shall be done with copper ferrules and crimping.
  - (iv) The HT jumpers from winding to the HT bushing (fuse link) inside the transformer should be provided with lugs to bolts and nuts. The jumper wires should pass through resin bonded paper cylinders and fiberglass sleeves.

Vertical ducts and spacers shall be provided within each coil for HV and LV windings. Dovetail spacers shall be used in between HV coils and they shall be fixed to the vertical ducts which are provided between HV & LV.

Wedges of 3mm shall be provided at 50% turns of the HV Coils.

**9.3. LOSSES AND IMPEDANCE:** The maximum losses and impedance for various ratings of transformers of 11KV class should be as shown below.

**TABLE –1**

<b>KVA rating</b>	<b>Voltage ratio</b>	<b>Max. Losses @ 50% load, Watts</b>	<b>Max. Losses @ 100% load, Watts</b>	<b>% impedance (subject to tolerance to as per IS-1180 Part I of 2014)</b>
315	11000/ 433 V	772 W	1920 W	4.5%

## **9.4. INSULATION MATERIAL AND CLEARANCES :**

a) Materials : Electrical grade insulation Kraft paper of Triveni / Ballapur make subject to approval of the purchase and press board of Senapaty Whitelay or Raman make

subject to approval of the purchaser shall be used. Inter layer insulation shall be covered with Epoxy dotted paper.

- (b) Radial clearance of LV coil to core (bare conductor) shall not be less than 4.5 mm for 315 KVA.
- (c) Radial clearance of HV & LV shall not be less than 11.0 mm for 315 KVA.
- (d) Phase to phase clearance between HV Conductors shall not be less than 10mm for 11KV with a minimum of 2x1 mm press board to cover the tie rods.
- (e) The minimum electrical clearance between the winding and body of the tank (between inside surface of the tank and outside edge of the winding) should be 30mm.
- (f) Minimum end insulation to earth shall be 25 mm.
- (g) No. of coils HV/Phase 6(min) for 315KVA Transformers.
- (h) Thickness of locking spacers between HV coils - 10mm Min.
- (i) No. of axial wedges between LV & HV winding equispaced around 12 Nos.
- (j) Tap lead shall be insulated 1.5mm thick with paper insulation.
- (k) Manufacturing drawing showing various clearances shall be got approved by the AP\_PDCL.

#### **9.5. TANK :**

a) The transformer tank shall be of robust construction rectangular in shape and shall be built up of tested MS sheets of the following thickness **with tolerance applicable as per IS 1852.**

i) Side walls (Min): 4.00 mm thickness

ii) Top & bottom plates (Min): 6.00 mm thickness

The four walls of the tank shall be made of TWO “L” shaped sheets (without joints) fully welded at the corners from inside and outside of the tank for withstanding a pressure of 1Kg/Sq.cm for 10 minutes. All the tank plates shall be of such a strength that the complete transformer with oil and fittings can be lifted bodily by means of lifting lugs provided. The top cover of the tank shall be bent “L” shape 4 sides to avoid entry of water through cracks of gasket.

Reinforced of welding stiffener angle (50x50x6 mm) on all the outside walls of the tank shall be provided to form three equal compartments. The tank through longer sidewalls shall be reinforced additionally by welding suitable size flat/angle vertically to provide sturdy and robust construction to withstand extreme pressure conditions. All joints of tank and fittings shall be oil tight and no bulging should occur during the service. The tank design shall be such that the core coil assembly can be lifted freely. The hooks that will be used for anchoring the core shall be so located as not to foul with the core coil assembly. “U” shaped pressure relief vent of 2” dia pipe with 0.025mm copper shim sheet/ **0.4 mm Backelite thick sheet** as diaphragm shall be provided on the top cover of the tank such that the pressure released should be directed to the ground. The vent shall be provided on opposite side of the CB operating rod. The diaphragm shall be provided near to the top cover and other end of the vent pipe shall be guarded with suitable mesh against entering of worms and resting. The diaphragm should burst at a pressure between 0.76Kg./Sq.cm to 0.95Kg./Sq.cm Permanent deflection when the tank without oil is subjected to vacuum of 760mm Mercury shall not be more than 5mm upto 750mm length 6mm upto 1250mm length. The tank shall be capable of withstanding a

pressure upto 0.7Kg./Sq.cm without any deformation. Inside of the tank shall be painted with hot oil proof paint.

b) Pressure test will be conducted by the inspecting officer on a transformer vent pipe against each lot offered for inspection. The diaphragm should burst at a pressure between 0.76Kg./Sq.mm to 0.95Kg./Sq.mm. For any operational failure of vent pipe and consequent damaged to the tank an addition to insisting for free replacement of the tank, the AP\_PDCL may at its option, recover an estimated loss sustained by it from the manufacturer.

c) The transformer tank top cover shall be fixed with bolts and four corner bolts shall be provided with "Four M12 anti theft SS bolts (fasteners) with provision to put seals (2 mm hole on tail side), to prevent opening of the cover at site by miscreants and suitable continuous neoprene gasket (Rectangular Ring) to avoid leakage of Nitrogen and all the fittings including bushings in position shall be tested for leakage at a pressure of 0.7Kg./Sq.cm inside the tank for 10 minutes. The above test shall be carried out before final sealing of the transformers.

d) The tank shall be fitted with round cooling tubes of minimum of 38mm outer dia and 1.25mm thick bent and directly welded on both sides i.e., inside and outside of the tank. The cooling tubes shall not be provided underneath the LV bushing to avoid puncturing of the tubes due to falling down of LV lead on them. (or)

The radiators can be press fin type of 1.2 mm thickness to achieve the desired cooling to limit the specified temperature rise. They should be fixed at right angles to the sides and not diagonally. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. The size of the radiator shall be such that it covers atleast 50% of the bottom yoke, full core and complete top yoke. Bidder shall submit the calculation sheet.

e) Heat dissipation by tank walls excluding top and bottom should be limited to 500W/Sq.mt upto the oil level, 250 Watts/sq.mt above oil level and 300Watts/Sq.mt for cooling tubes. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Tenderer shall submit the calculation sheets.

f) Total minimum oil volume for CSP Transformers

Sl.No.	Rating KVA	Oil in Ltrs. (Including of oil Observed in core coil assembly)	Permissible oil absorption in Litres.
1.	315	500	15

g) Total minimum weights

Sl.No.	Rating KVA	Core Lamination min. in Kgs.	Winding with Insulation Min. in Kgs.
1.	315	470	220

h) Lifting lugs: 4Nos. welded heavy duty lifting lugs of MS plate 8mm thick suitably reinforced vertical supporting flat welded edgewise below the lug on the side wall.

- i) Pulling lugs: 4Nos. welded heavy duty pulling lugs of MS plate 8mm thick shall be provided to pull the transformer horizontally.
- j) Top cover fixing bolts : GI 12mm dia (as per **IS 1180 part-I of 2014** Clause no. 15.3.of (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**) spaced at 100mm apart, 6mm continuous neoprene gasket(Rectangular Ring) conforming to IS-4253 Part II will be placed between tank and cover. The bolts outside tank shall have 2 flat washers and one spring washer. The four corner bolt shall be welded to prevent opening of the tank cover.
- k) The top cover shall be provided with four sealing bolts of GI 12 mm diameter at all corners with 2 mm hole on tail side
- l) All transformers shall be capable of giving their continuous rated output without exceeding the specified temperature rise.
- m) The size of the tank shall be such that sufficient space is available for the oil to expand at extreme conditions. The volume of the free space above oil level shall not be less than 55% of the volume of the oil.
- n) The top cover of the tank shall be slightly sloping to drain rain water.

**THE SEALING:** - The space on the top of the oil shall be filled with nitrogen. The nitrogen plus oil volume inside the tank shall be such that even under extreme operating conditions, the pressure generated inside the tank does not exceed 0.406 Kg/Cm<sup>2</sup> positive or negative. The volume of space above oil level shall be normally be not less than volume than 55% of the volume of oil. The nitrogen shall confirm to commercial grade of IS.1747/1973. The company must arrange facilities for testing of presence of Nitrogen in the random picked up transformer from each lot.

Manufacturer has to punch his company monogram and The word “APEPDCL.,” shall be punched on the side sheet of the Tank above rating & diagram plate **The size of the embossing of the word “APEDCL” is of 2 Inches. The following information shall also be embossed on a separate MS sheet of thickness 2mm and firmly welded (No Tack welding) on both sides of the transformer. The size of the word is of 1” inch.**

- a) P.O. No. & Date,
- b) Year of manufacture
- c) Make and Serial No.
- d) 5 years Guarantee period.

**9.5.1.** Conservator shall not be provided for these transformers.

**9.6. BUSHINGS :** i) The porcelain portion of HT and LT bushings shall be of standard make and conform to IS-2099/1973 (HV), “Specification for High voltage porcelain bushings” and IS-7421/1974 for LV IS-3347 shall be outdoor. The bushing rods and nuts shall be as per clause 18 of specification. The bushings shall be fixed to the transformers on sides with straight pockets and in the same plane.



The tests as per IS-2099/1962 shall be conducted on the transformer bushings as detailed below:

- a) Dry flash over voltage.
  - b) Wet flash over voltage.
  - c) Dry 1 Minute withstand voltage.
  - d) Impulse withstand voltage (1.2/50 Micro Seconds –Ve wave)
  - e) Manufacturer's test certification may be furnished for every lot of offer.
- ii) For 11KV, 17.5KV Class bushings shall be used and for 0.433KV, 1.1KV class bushings shall be used. Bushings of plain sheds as per IS-3347 shall be mounted on the side of the tank and not on top level.
- iii) Dimensions of the bushings of the following voltage class shall conform to Indian Standards mentioned below. The bushings shall be provided from the registered vendors of the APTRANSCO/APEPDCL.
- | Voltage class | Indian Standards or porcelain parts | For metal parts                                    |
|---------------|-------------------------------------|--|
| 1.1KV         | IS-3347/part-I/Sec.I/1965/1979      | IS-3347/Part-I/Sec,I/1979<br>(As per IS-1180/1989) |
| 17.5KV        | IS-3347/part-III/Sec.I/1972         | IS-3347/Part-III/Sec.2/1982                        |
- iv) A minimum phase to phase clearance of 75mm for LV (upto 1.1KV bushing) and 255mm for HV (3.3KV and above) bushings shall be obtained with the bushing mounted on the transformer.
- v) The bushings shall be fixed on sides with pockets in the same plane. Arcing horns shall not be provided and instead brass caps shall be provided.
- vi) Brazing of all inter connections; jumpers from winding to bushing shall have cross section larger than the winding conductor. For copper, silver brazing alloy to be used for Aluminium L&T Aluminium brazing rods shall be used.
- vii) In the case of LV bushings, the internal bushings shall be made of tough insulating material like epoxy and shall have embedded stem and a strong coupling connection (screwed), properly secured with a split pin shall be used between stem of the internal and external bushings.
- viii) The LV bushing shall be so located that even under the hottest conditions the level of the transformer oil shall be below the opening meant for fixing the LV bushings. The LV jumpers and bushing material shall be selected and designed for this condition
- ix) The design of the internal bushing for LV shall be such as to provide adequate earth clearance as stipulated in the clause 10, 2.1 of IS1180 Part.I and creepage distance as per Clause 7.1 of IS 2099. All other tests as per relevant standards shall be applicable.
- x) The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

xi) The LV bushing 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. High voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letters 1U, 1V, 1W and low voltage windings for the same phase marked by corresponding small letters 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Terminal connectors shall be type tested as per IS 5561.

The vector diagram plate shall clearly indicate the method adopted for marking the terminals both outside and interior.

**10. LIGHTNING ARRESTERS :** 9KV, 5KA metal oxide lightning arrestors of reputed make conforming to IS-3070 Part-III under the HV bushings with GI earth strip 25X4mm connected to the body of the transformer with necessary clamping arrangements, shall be provided. The Metal Oxide Lightning Arrestors shall be of reputed make and of Disconnector type.

**11. TERMINALS:** Brass rods of 12 mm dia for HV and Tinned copper rods of 20mm dia for LV.

**12. TERMINAL MARKING PLATES AND RATING PLATES:** The transformers shall be provided with a plate showing the relative physical position of the terminal and their markings engraved on it. The transformers shall be provided with non-detachable rating plate of Aluminium anodized material fitted in a visible position, furnishing the information as specified in IS: 2026. The rating plate shall be embossed/engraved type. The relative position of tapping switch and corresponding voltages may also be shown on the rating plate. Further M.S. plate of size 125 mm X 125mm be got welded on width side of transformer on stiffener angle. On this plate, name of firm, orders No. and date, rating, serial No. and date of dispatch should be engraved.

#### **12.1. Rating Plates and Star Labeling:**

The rating plates on the transformer containing the information specified in IS : 1180 (Part-1) of 2014. 50% & 100% load losses of the transformer should also be mentioned on the rating plate.

**Star Labeling:** 5-Star rating label in accordance with colour, code, dimensions & design, logo etc., shall be provided on each transformer as per the design/recommendations of Bureau of Efficiency (BEE). Expenses incurred to get star rating labeling is in the account of suppliers only. The certificate of registration issued by BEE shall be submitted along with tender.

**Standard mark:** As per the Gazette of India published on 7<sup>th</sup> May of 2015 sample of any electrical transformer should bear the standard mark obtained from Bureau of Indian Standards. Expenses incurred towards Standard Mark are solely on the account of suppliers only. The certificate issued by BIS or Proof of having applied to BIS for Standard Mark shall be submitted along with tender.

**13. FITTINGS:** The following standard fittings shall be provided.

- a) Rating and terminal marking plates non detachable -2Nos.
- b) Earthing terminals with lugs -2Nos.
- c) Lifting lugs -4Nos.for main tank and 2Nos. for top cover.
- d) H.V Bushings 3 Nos. with bimetallic terminal connectors.
- e) L.V Bushings 4 Nos. with bimetallic terminal connectors.
- f) Thermometer pocket with cap- 1No.
- g) Metal Oxide Lightning Arrestors (Disconnecter Type) with G.I earth strip of 25x4 mm.
- h) Pulling lugs – 4 Nos.
- i) Stiffner angle (50 x 50 x 6 mm) & vertical strip of 50 x 5 mm flat.
- j) LT circuit breaker make, type and technical details and its position along with operating rod.
- k) U shaped pressure relief vent with 0.025 mm Cu / **0.4 mm Bakelite thick sheet** diaphragm on the top of the top cover for breaking at a pressure of 0.76 to 0.95 Kg/Cm<sup>2</sup>.
- l) Cooling tubes – number and lengths may be mentioned.
- m) Indicating lamp.
- n) Circuit breaker operating mechanism.
- o) Nitrogen filling pipe with welded cap capable of re-use.
- p) LV epoxy Bushings - 4 Nos.
- q) Base channels 100x50 mm
- r) Tank and over all dimensions.
- s) Weight content of a) core b) Windings c) Tank & fittings d) Weight/Qty of oil, e) over all weight.
- t) 5 year guarantee embossed plate welded below name plate.
- u) Die cast oil level gauge indicating three positions of oil marked as minimum 5 degrees, 30degrees and maximum as 98 degrees
- v) 4 No. rollers for transformers of 200 kVA and above

**14. MOUNTING ARRANGEMENT :** The under base of all transformers shall be provided with two 100x50mm channels 460mm long as shown in REC specification 2/73 with holes to make them suitable for fixing on a platform or plinth.

**15. OVER LOAD CAPACITY:** The tenderer should state clearly the percentage overload the transformers can take for a continuous period of 1 hour. The transformers shall suitable for loading as per IS-6600/1972. The transformer shall be designed to obtain maximum efficiency at 75% load.

**16. The transformers shall have the following CSP features.**

**INTERNAL HV FUSES ON THE HT SIDE OF TRANSFORMER:** Specification for the H.T FUSES: Expulsion/any other suitable fuse placed in series with the primary windings. This fuse is mounted normally inside of the primary winding. This fuse is mounted normally inside of the primary winding. This fuse is mounted normally inside of the primary bushing and is connected to the high voltage winding through a terminal block. This has to protect that part of the electrical distribution system which is ahead of the distribution transformers from faults which occur inside the distribution transformer i.e, either to the winding or to the other part of the transformer. It shall be ensured that this fuse does not blow for faulting on the secondary side (LT side) of the transformer i.e., the blowing characteristics of the fuse and LT breakers shall be so coordinated that

the fuse shall not blow for any faults on the secondary side of the transformer beyond LT breaker and these faults shall be cleared by the LT breaker only.

**ii) INTERNALLY MOUNTED OIL IMMERSSED LT BREAKER ON THE LV SIDE OF THE TRANSFORMER:** LT Circuit Breaker: All LT faults after the breaker shall be cleared by this breaker. As such it shall be designed for perfect coordination with the HT Fuse link. The supplier shall furnish the time-current characteristic of LT Circuit breaker and 11 KV fuses for various current multiples. The two characteristics shall be drawn on the same sheet to indicate coordination between the carried out on one of the transformers. In addition the supplier shall carry out coordination test as indicated above, and this forms one of the tests for acceptance test.

The breaker is to be mounted on the secondary side of the transformer under oil to minimize premature operations from primary surges as would be with undersized line fuses. Three single pole elements are preferred. The breaker shall be coordinated thermally with the transformer rating to follow closely the variations of coil temperature due to fluctuations and ambient temperatures.

This is to be accomplished by connecting the breaker in series between the secondary winding and the load current. The breaker shall be located in the same oil as the core and coil assembly so that the bimetal and sensitive to be temperature of oil as well as the load current (offers with LV breakers of MCCB type are not acceptable for Board.)

The circuit breaker may be an electro-mechanical device with three main elements viz., (a) temperature sensing, (b) latching and tripping and (c) current interruption.

The temperature sensing function might be accomplished through the use of bimetallic string which would be built into the breaker such that load current of the transformer flows through them. In addition to this a magnetic tripping device is to be provided for 100 KVA and above rating transformers. The circuit breaker shall be mounted inside of the transformer so that these bimetallic string are within the top oil layer of the transformer. The latching and tripping functions of the circuit breaker may be carried out within an assembly parts similar to those used in industrial type air circuit breaker. The circuit breaker shall also be closed and opened manually standing on ground. The current carrying parts of the breakers shall be cover plus a set of copper tungsten current interrupting contacts. The cross section of the current carrying parts of the breaker shall withstand the full load current at a current density not more than 2.5 A/Sq.mm (for additional mechanical strength the area should be more).

The magnetic element shall increase the opening speed of the circuit breaker under high fault current conditions for 315 KVA and above ratings. The response of circuit breaker to the thermal activity shall remain unchanged by the addition of the magnetic trip element. The specification to which the breaker conforms shall be indicted.

Beside, a signal light, controlled by a bimetal in the breaker shall switch on when the transformer load reaches a pre-determined level indicating that the transformer has been over-loaded and change out shall have to be scheduled without causing an unplanned service interruptions.

iii) **LOAD MANAGEMENT SIGNAL LIGHT:** The load management signal light shall perform two functions. It shall show visually when the particular transformer has been operating in an overload condition and shall provide knowledge that for good system management, the economical change out point for the transformer is fast approaching. The signal light need not indicate temporary over loads and shall turn on only when the over load condition has existed at a given level for a certain length of time. The LT CSP circuit breaker shall have a set of auxiliary contact built in for signal light operation. These normally open contacts shall form part of the signal light circuit. The signal light circuit shall consist of an auxiliary transformer winding (one or two turns) which generate about 4 volts, for the signal light contacts set within the circuit breakers and the signal light is to be mounted on the transformer tank. The signal light contact set is mechanically connected to the main circuit breaker latching and bimetal system. The signal light mechanism is adjusted so that the signal light contacts will close at a present thermal condition, which occurs before the main latching system opens the main contacts. The net results are a visual, external indication that a present load condition has been reached by the transformer. The signal light mechanism does not reset itself when the load drops off; the signal light remains lighted once the signal light contacts close and can only be turned off by manually operating the external circuit breaker handle.

**17. TRANSFORMER OIL:** The transformer shall be supplied complete with first filling of oil and the same shall comply with IS-335/1983 with latest version thereof. The ageing characteristics after accelerated ageing shall be as given in Appendix-C of S-335/1983 (or) latest version. The characteristics of the oil shall be as follows.

Sl.No.	Characteristic	Specified value
1.	Electric strength (breakdown voltage)	
	Unfiltered	30 KV (rms) (min)
	Filtered	50 KV (rms) (min)
2.	Electric dissipation factor (tan delta) at 90Deg.C	0.01 (max)
3.	Specific resistance (resistivity) at 27Deg.C (ohm-cm)	$12^{10} \times 10$
4.	Flash point (PM closed)	140Deg.C (min)
5.	Inter facial tension at 27Deg.C.	0.03 N/M (min)
6.	Neutralization value (total acidity)	0.05mg/KOH/g (max)
7.	Water content PPM	35 (max)

## **18. TESTS:**

### **18.1 TYPE TESTS:**

The transformers offered should have been got type tested.

The bidder will furnish Type Test Results. The following type tests must have been conducted on the material offered as per the relevant IS in NABL accredited laboratory as per the latest revision of the Technical Specification and the date of type test will not be later than 5 years.

1. Measurement of winding resistance (IS 2026 (part-I) :1977)
2. Measurement of voltage ratio and check of voltage vector relation ship (IS 2026 (part-I) :1977)

3. Measurement of Impedance voltage/short circuit impedance and load loss (IS 2026 (part-I) :1977)
4. Measurement of No Load loss and current (IS 2026 (part-I) :1977)
5. Measurement of Insulation resistance (IS 2026 (part-I) :1977)
6. Induced of over voltage with stand test (IS 2026 (part-3) :1981)
7. Separate source voltage withstand test (IS 2026 (part-3) :1981)
8. Impulse voltage test: (IS-2026 (Part-III)/1981- Voltage shall be 95KV peak  
Insulation levels:

Sl. No	Volatage(KV)	Impulse voltage (KV peak)	Power frequency voltage (KV)
1	0.433	-	3
2	11	95	28

9. Temperature rise tests (IS 2026 (part-II) :1977)
10. Short Circuit test (IS 2026 (part-I) :1977) (Dynamic & Thermal ability)
11. Air pressure test (IS-1180/Part-I.)
12. Permissible flux density and over fluxing (IS-1180/Part-I/1989.)

### 18.3. **ROUTINE TESTS/ ACCEPTANCE TESTS :**

All transformers shall be subjected to routine tests at the manufacturer's works. The following routine tests shall be carried out in accordance with the details specified in IS:1180 (Part-I) and IS:2026 or as agreed upon between the AP\_PDCL and the manufacturer.

1. Measurement of winding resistance (IS 2026 (part-I) :1977)
2. Measurement of voltage ratio and check of voltage vector relation ship (IS 2026 (part-I) :1977)
3. Measurement of Impedance voltage/short circuit impedance and load loss (IS 2026 (part-I) :1977)
4. Measurement of No Load loss and current (IS 2026 (part-I) :1977)
5. Measurement of Insulation resistance (IS 2026 (part-I) :1977)
6. Measurement of Induced over voltage with stand test (IS 2026 (part-3) :1981)
7. Separate source voltage withstand test (IS 2026 (part-3) :1981)
8. *Checking of weights, dimensions fitting and accessories, tank thickness, oil qty., material, finish and workmanship as per purchaser order and contract drawings.*
9. *Checking of di-electric strength of transformer oil*
10. *Load losses as specified in the specification.*
11. *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.*

All above acceptance and routine tests shall be carried out by the supplier in presence of purchaser's representative on atleast 10% of quantity offered every time.

**In addition to the above measurement of losses at 50% load and 100% load losses calculations at 75 Degrees for 100% transformers is to conducted and report submitted.**

Following tests shall be carried out at manufacturer's works on one unit of each rating by the supplier in presence of purchase representative.

- I. Heat run test- One unit of the ordered quantity of each rating.
- II. Heat run test shall have to be conducted at suppliers cost on one transformer of each rating, generally from first offered lot, during the course of supplies.

To facilitate conduction of heat run test on any unit in any lot at any point of time during the supply, the manufacturer will provide a thermometer pocket which gets immersed in oil on the side of the transformer in all the transformers. The depth of the projecting stem of this pocket inside the transformer will be below oil level. It shall not fringe with electrical clearance nor obstruct the untanking of the active part.

- III. 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 tender.

**18.4 AIR PRESSURE TEST: (Routine Test) :** The transformer tank with all the fittings including bushing in position shall be tested for leakage at a pressure of 0.8 Kg./cm<sup>2</sup> above atmosphere pressure maintained inside the tank for 10 minutes. There should be no leakage at any joint. (This may be carried out periodically, say after every 50 transformers.

**19. BUSHINGS HT & LT:** Tests as per ISS 2099/1962 shall be conducted on the transformer bushings as detailed below:

- a) Dry flash over voltage
- b) Wet flash over voltage
- c) Dry 1Minute withstand voltage
- d) Wet 1Minute withstand voltage
- e) Impulse withstand voltage (1.2/50Micro seconds +ve wave)
- f) Minimum oil immersed flashover voltage.

Manufacturer's test certificates may be furnished. Manufacturer shall be the approved registered vendor of the AP\_PDCL.

**20. TEST CERTIFICATES:** The test certificates for all routine and latest (within 5 years) type tests for the transformers and also the bushing and transformer oil shall be submitted with tender.

**21. DRAWINGS:** 2 copies of the dimensional drawings and internal assembly drawings of each transformer shall be submitted with the tender.

**22. TOLERANCES:** Unless otherwise specified herein the test value of the transformers supplied should be within the tolerance permitted in the IS 2026 on the guaranteed values. No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

#### **CHALLENGE TESTING:**

The other manufacture can also request challenge testing for any test based on specification and losses. The challenger would request for testing with testing fee. The challenge test fees are proposed at least three times the cost of testing. This is likely to deter unnecessary challenges. The challenger would have the opportunity

to select the sample from the store and any such challenge should be made within the guarantee period. The party challenged, and the utility could witness the challenged testing.

The challenged testing would cover the

1. Measurement of magnetizing current
2. No Load losses test.
3. Load Losses test (At 50% loading or as per acceptance test)
4. Temperature rise test.

The challenge test could be conducted at NABL accredited laboratory, like ERDA and CPRI. If the values are within limit the product gets confirmed or else not confirmed. No positive tolerance in losses is permitted. If the product is not confirmed the manufacturer would pay the challenge fee and challenger would get the fee refunded. However as redressal system the challenger would allowed to ask for fresh testing of two more samples from the store and the same be tested in NABL laboratory in presence of party challenged, challenger and the utility. If any one or both sample does not confirm the test then the product said to have failed the test. In such cases the manufacturer will be declared as unsuccessful manufacturer for the said product with wide publicity and would not be allowed to compete in tenders of the Boards for the period of three years and heavy penalty would be imposed.

**23. FINISHING:** The exterior of the transformer and other ferrous fittings shall be thoroughly cleaned, scraped and given a primary coat and the two finishing coats of durable oil and weather resisting paint of enamel. **The colour of the finishing coats shall be dark admiral gray conforming to No.632 of IS 5 of 1961 colour for ready mixed paints.**

**24. GUARANTEED AND OTHER PARTICULARS FOR TRANSFORMERS:**  
To be filled in and submitted by the tenderer.

**25.** Tender will have to produce documentary evidence for the purchase of CRGO sheet, Winding Copper Wire and Oil.

**26. A). STAGE INSPECTION:** The stage inspection of the transformers during the manufacturing/assembling stage shall be carried out by the purchaser's representative. The purchaser have absolute right to reject the raw material/component/sub assemblies or complete equipment not conforming to the requirements of the specifications or of poor quality/workmanship. The purchaser at his option may collect the samples of the following raw material/components for his independent testing.

- |    |                   |   |
|----|-------------------|---|
| a) | CRGO Lamination : | One specimen sheet of 300-500 mm length and 500 mm width (for each lot of raw material used by the supplier). |
| b) | HV Winding Wire : | 1250mm length specimen for each type.   |
| c) | LV Winding Wire : | 1250mm length specimen for each type.   |
| d) | Transformer oil : | 5 lit, in bottle of 1 lt. Each.   |



**B) INSPECTION :** I) In respect of raw materials such as core stampings, winding conductor, insulating paper and oil, you shall use materials manufactured/supplied by standard and reputed manufacturers approved by the APEPDCL/APTRANSCO and furnished the manufacturers test certificate as well as proof of purchase. 10% of the offered quantity for inspection will be inspected at the premises of the Company by Quality Control wing of APEPDCL.

ii. The APEPDCL may, at its option open a transformer supplied to stores in your presence at APEPDCL's laboratory. If any of the guaranteed technical particulars are found to be at variance during this test the APEPDCL reserves the right to reject the whole lot supplied.

iii. In addition to the above, the APEPDCL may pick up any transformer and decide to get it type-tested at CPRI at APEPDCL cost. The tenderer will have to organize packing etc. at APEPDCL stores for which charges will be paid by APEPDCL. If the transformer fails to meet the requirements of type tests, the quantity of transformer ordered on them will be rejected and APEPDCL may go in for risk purchase.

**C) SEALING OF TRANSFORMERS AFTER TESTING AND INDIVIDUAL TEST REPORTS:**

After witnessing testing on sample quantity and physical inspection of all offered Transformers, the purchaser's representative will provide numbered lead/ plastic seal bits to two opposite corners of tank and inspection cover of all offered Transformers, for delivery of correct inspected materials only. The seal bit numbers shall also be mentioned in the test reports signed by purchaser's representative submitted for delivery instructions.

Manufacturer should submit the list of equipment for testing along with latest calibration certificates to the purchaser.

**D). TESTING FACILITIES:** The tenderer should have adequate testing facility and also arrange for measurement of losses, resistance etc.

**E). INSPECTION AND TESTING OF TRANSFORMER OIL:** To ascertain the quality of transformer oil the manufacturer's test report should be submitted at the time of inspection. Arrangements should also be made for testing the transformer oil, after taking out the samples from the manufactured transformer and tested in the presence of AP\_PDCL's representative (or) if desired, in an independent laboratory.

**27. WARRANTY:**

- i The period of warranty will be 5 years (five years) the date of acceptance of the material in stores i.e. Form-13 date of last consignment, last piece transformers received against this specification.
- ii If the failure after erection and commissioning at site is more than 5% the AP\_PDCL reserves the right to cancel the balance quantity of the order or take such suitable action deemed fit. The same will be treated as failure of basic contractual conditions and same to the organization if any can be claimed.

- iii 50% of the performance guarantee (Security) amount will be deducted in case the failure rate of Distribution Transformers is more than 5% and below 10% during warranty period.
- iv 100% performance guarantee (Security) amount will be deducted in case the failure rate of Distribution Transformers is more than 10% during the warranty period.
- v The recovered performance guarantee (Security) amount will be replenished from the immediately pending bill if any or direct by supplier
- vi **The supplier shall rectify and return the material failed within guarantee period duly repaired and tested as per approved Guaranteed Technical Particulars and tender specification within 30 days from the date of receipt of intimation without any cost, failing which performance bank guarantee shall be encashed without any notice**
- vii **The above clause it self shall be deemed to be the notice issued to the supplier about encashment of Bank Guarantee incase of failure to adhere to timelines & no separate notice will be served.**

## ANNEXURE – I

### GUARANTEED TECHNICAL & OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMERS

Sl. No.	Description	315KVA
1	Make & Manufacturer	
2	Place of Manufacture	
3	Voltage Ratio	
4	Rating in KVA	
<b><u>5. Core Details:</u></b>		
1	Core Grade	
2	Thickness of core plates	
3	Flux density (Max)	TESLA
4	Over fluxing without saturation	
5	Core 1) No. of Core steps. 2) Max. width of first lamination. 3) Stacking 4) Core building factor.	
6	Core diameter	Cm
7	Gross Core area	Cm
8	Net Core area	Cm

9	Wt. Core	Kg.
10	Loss per Kg. of core at the specified Flux Density	Watts/kg
11	Core loss in watts a) Normal Voltage b) Maximum Voltage	
12	Power factor magnetizing current (lag max)	
13	Magnetizing (No load) current at a) Normal Voltage b) Maximum Voltage	
14	Core window height	Mm
15	Center to center distance of the core	Mm
16	Maximum temperature rise of Core by Thermometer	
<b>6.Winding Details</b>		
1	Maximum temperature rise of Windings by resistance method	
2	Winding material : LV : HV	
3	Resistance of windings at 20 Deg. C (with 5% tolerance for LV) a) HV Winding (ohms) b) LV winding (ohms)	
4	No. of LV Turns	
5	No. of HV Turns	
6	Size of LV conductor bare/covered	Mm
7	Rounding Factor for LV	
8	No. of parallels	
9	Area of LV cross section (sq.mm)	sq.mm
10	Size of HV conductor bare/covered	Mm
11	Area of HV cross section (sq.mm)	sq.mm

12	Current density of LV winding	Amp/sq.mm
13	Current density of HV winding	Amp/sq.mm
14	Wt. Of the HV winding for transformers	Kg.
15	Wt. Of the LV winding for transformers	Kg.
16	No. of LV Coils/Phase	
17	No. of HV Coils/Phase	
18	ID/OD of LV winding	mm
19	ID/OD of HV winding	mm
20	Height of LV winding	mm
21	Height of HV winding	mm
22	Axial height of HV coil	mm
23	Axial height of LV coil	mm
24	Radial depth of LV coil	mm
25	Radial depth of HV coil	mm
26	Full load current HV	Amps

27	Full load current LV	Amps
28	Full load losses (watts) at 75 Deg. C	Amps
29	Estimated stray losses	Watts
30	Estimated Breaker Losses	Watts
31	Total Losses(Full load losses+ stray losses+ Breaker Losses)	Watts
32	Calculated Impedance	%
33	Edge strip size on LV coil (top & Bottom)	mm
<b><u>7.Clearances</u></b>		
1	Size of the duct in HV winding	mm
2	Size of the duct in LV winding	mm
3	Size of the duct between HV & LV	mm
4	HV winding to LV clearance	mm
5	HV winding to tank clearance	mm
6	HV to earth creepage distance	mm
7	LV to earth creepage distance	mm
8	Clearances (minimum)	mm
	a) Core & LV	
	b) LV & HV	
	c) HV Phase to phase	
	d) End insulation clearance to Earth	
	e)Any point of winding to tank	
<b><u>8.Heat Disspation Calculations</u></b>		
1	Maximum temperature rise of Oil by Thermometer	

2	Transformer (minimum) 1) Overall length x breadth x height 2) Tank length x breadth x height 3) Height of Oil level in tank 4) Thickness of plates a) Side walls (min.) b) Top & bottom plate (min.)	
3	Radiation: 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 to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise & also transformer tank size is sufficient is enclosed. 5) Minimum free space available above oil level.	
4	Weight content of a) Core lamination (min.) b) Windings (min.) c) Tank & Fittings d) Oil e) Oil Qty in liters(min.) f) Core channels, rods, bolts, etc g) Insulation material inside tank. h) Total Weight	
5	Oil Data 1) Qty. for first filling (min.) 2) Grade of oil used 3) Maker's name 4) BDV at the time of filling	
<b>9.Efficiency,Regulation, and other particulars</b>		
1	Efficiency at 75 Deg. C a) Unity P.F. & b) 0.8 P.F. 125% load 100% load 75% load 50% load 25% load	
2	Regulation at a) Unity P.F. b) 0.8 P.F at 75 Deg. C	
3	Percentage Impedance at 75 Deg. C	
4	Flash Test HV 28 KV/50Hz for I minute LV 3 KV/50 Hz for 1 minute	
5	Over potential Test Double Voltage & Double frequency for 1 minute	
6	Impulse test	

7	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% turn of the HV coil.	
8	Insulation materials provided a) For Conductors (1) HV (2) LV b) For Core	
9	Is the name plate gives all particulars are required in tender	
10	Particulars of Bushing HV/LV 1) Maker's name 2) Type IS-3347/IS-1180 3) Rating as per I.S. 4) Dry power frequency voltage withstand test 5) Wet power frequency voltage withstand test	
11	Particulars of metal oxide Lightning arrestor	
12	Medium of free space above oil level Transformer	
13	Details of type tests conducted (indicating rating, year of testing, details of tests)	

**NOTE :** The following shall be specifically confirmed.

- Whether the offer conforms to the limits of impedance mentioned in the specification
- Whether the offer conforms to the limits of temperature rise mentioned in the specification
- Whether the losses of the transformers offered are within the limits specified
- Whether the transformer offered is already type tested for the design and test reports enclosed.
- The tenderer shall furnish the design details of the core construction such as number of steps, thickness of core sheet, stacking factor, core building factor, core length, width, stack height per step, core diameter, gross and net areas of core, etc., along with their offer with references to the full load and no load losses quoted and calculation sheets for heat dissipation calculation, minimum available free space, oil quantity calculation, & cost analysis of the Transformer (Annexure-II)*

**ANNEXURE – II**

**SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION**

<b>Sl. No.</b>	<b>Item</b>	<b>Source of Material</b>	<b>Place of Manufacture</b>	<b>Place of testing and inspection</b>
1	Core Laminations			
2	Copper winding wire			
3	Steel Castings/sections			
4	Tank			
5	Insulating Cylinders			
6	Bushing HV/LV			
7	Oil			
8	Las			
9	Radiators			
10	Insulators			
11	Insulation Paper			

Note: The bidder has to invariable furnish the above information.

## **LIST OF FITTINGS AND PARTICULARS TO BE FURNISHED IN THE DRAWING**

1. Rating and terminal marking plate (non detachable)
2. Earthing terminal with lugs 2 Nos.
3. Lifting lugs 4 Nos. for main tank and 2Nos. for top cover
4. pulling lugs 4Nos
5. HV bushings 3Nos. with bimetallic terminal connector
6. LV Bushings 4Nos. with bimetallic terminal connector
7. Thermometer pocket with cap
8. Metal oxide lightning Arrestors (Disconnecter type)
9. Stiffner angle (40x40x5mm)
10. LT circuit breaker make, type and technical details and its position along which operating rod.
11. U shaped pressure relief vent with 0.025mm copper diaphragm pressure relief vent on the top cover of the tank.
12. Cooling tubes if required (length of the cooling tubes is to be furnished along with heat dissipation calculation)
13. LV Epoxy bushings 4 Nos.
14. Base channels 100x50
15. Tank and over all dimensions
17. 5 year guarantee embossed plate welded below name plate.
18. Weights of (a) Core (b) windings (c) Tank and fittings  
(d) Weight Qty. of oil (e) over all weight
19. Die cast oil level gauge indicating three positions of oil marked as minimum 5 degrees, 30degrees and maximum as 98 degrees

NOTE: 1) The top cover shall be fitted with nut and bolt and continuous neoprene gasket (Rectangular Ring)arrangement.

2) Corner bolts are to be welded to prevent the top cover being removed in the field

3) All bolts shall have spring washers



## SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl.No. testing	Item	Source of material	Place of manufacture	Place of
1.	Lamination			
2.	Copper aluminium			
3.	Core plate			
4.	Steel castings			
5.	Tank			
6.	Radiators			
7.	Insulators			
8.	Cylinders			
9.	Insulation paper			
10.	Bushing HV/LV			
11.	Oil			
12.	Insulated winding wire			
13.	a) Tap changer			
	b) Pressure relief vent			