

**Technical Specification for Outdoor 160 KVA Amorphous / CRGO Core
Aluminium Conductor Cable Entry Type Distribution Transformers with BEE 5
Star Losses (EE Level-5) for UG Cable Works**

1. SCOPE :

1.1 This specification covers design, engineering, manufacture, assembly stage testing, inspection and testing before supply and delivery at site of 11 KV / 433 – 250V 160 KVA Amorphous / CRGO core Aluminium conductor Distribution Transformers with upgraded BEE 5 Star Losses .

1.2 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. The material offered shall be complete with all components necessary for its 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.

1.3 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.

1.4 All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

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-1):2014	Outdoor type distribution Transformer up to and including 2500 kVA	
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.	
IS 1271	Thermal evaluation & classification of electrical insulation	
IS 3639	Fittings & accessories for Distribution 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 distribution transformers shall be installed at outdoor locations along 11 kV distribution networks, which consist of underground network. The HV side shall be connected of CB of the ring main unit through 11kV XLPE UG cable. LV side shall be connected to switch type feeder pillar through 1.1 kV single Core 630 Sq.mm (2 Runs for 500 kVA and 1 Run for 315kVA & 160KVA) Aluminium conductor XLPE cable. 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 suitable for service under fluctuations in supply voltage upto $\pm 12.5\%$ permissible under Indian Electricity Act and Rules there under.

4.0. 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.

5.0 PRINCIPAL PARAMETERS:

The Transformers shall be suitable for outdoor installation with three phase, 50 c/s, 11 KV system in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage upto $\pm 12.5\%$.

The transformer shall conform to the following specific parameters

Sl.No.	Item	Specification
1	Continuous rated capacity	160 KVA
2	System Voltage (max.)	12 KV
3	Rated Voltage HV	11 KV
4	Rated Voltage LV	433V-250V
5	Line current HV	8.398A
6	Line current LV	213.34A
7	Frequency	50 c/s +/- 5%
8	No. of phases	Three
9	Connection HV	Delta
10	Connection LV	Star (Neutral brought out)
11	Vector group	Dyn-11
12	Type of cooling	ONAN
13	Over fluxing limit	12.5%
14	Noise level (sound power level) at rated voltage and frequency	55 db
15	Permissible temperature rise over maximum ambient i) Of top oil measured by thermometer ii) Of winding measured by resistance	35 Deg. C 40 Deg. C
16	Minimum clearances in air i) HV phase to phase/phase to earth(mm) ii) LV phase to phase/phase to earth(mm)	-----As per IS-1180 latestAs per latest----- -----255/140----- -----75/40-----

6.0 TECHNICAL REQUIREMENTS:

6.1 DESIGN PARAMETERS:

I CRGO Material

a) Material: The core shall be Stack / Wound generally 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. The complete design of core must ensure permanency of the core losses 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.

b) Core clamping for CRGO:

- i. MS Channel of 100 X 50 mm min. size shall be used on top and bottom (for stacked core transformers).
 - ii. 2 x 16 mm high tensile bolts to be used in parallel at each end as clamping rods and 4 x 16 mm high tensile bolts as tie rods to be used in parallel on each side
 - iii. Channel on LV side to be reinforced at equidistance, if holes/cutting is done for LT lead in order to avoid bending of channel.
 - iv. MS channel shall be painted with varnish or oil-resistant paint.
- c) All top and bottom yoke nuts & bolts and tie rods shall be painted with oil and corrosion-resistant paint / parkarised before use.
- d) The transformer core shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 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
- e) Flux density should not more than 1.55 Tesla for CRGO Core. 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: 6% 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
- f) Clamping and Tie- rods shall be made of HT steel and shall be painted with oil and corrosion-resistant paint / parkarised.

Only prime quality CRGO sheets should be used in the transformers and no Second/Defective/Scrap CRGO finds way into transformers. Therefore regarding quality control following documents are to be furnished along with bid documents.

1. Invoices of supplier
 2. Mill's test certificate
 3. Packing list.
 4. Bill of landing
 5. Bill of entry certificate by custom
 6. Description of material, electrical analysis, Physical inspection, certificate for surface defects, thickness and width of the material.
- Subjecting to at least 10% of the transformers to routine tests and no load and load loss measurement

It is to note that, using seconds /defective CRGO sheets, the Load losses found to be more than stipulated limit. If so heavy penalty will be imposed as per clause no. 4.4 besides black listing the supplier

Transformer Sl. No. shall have to be punched on the Core-Yoke frame.

II AMORPHOUS METAL:

- i) 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.
- ii) Core clamping – Amorphous Metal Transformers and CRGO wound core
 1. Core clamping shall be with top and bottom U-shaped core clamps made of sheet steel clamped HT Steel rods for efficient clamping
 2. MS core clamps shall be painted with oil-resistant paint/ Parkarised.
 3. HT steel rods shall be used as tie rods
 4. 8 nos. 12 mm dia of high tensile steel rods shall be effectively insulated
 5. Suitable provision shall be made in the bottom core clamp/bottom plate of the transformer to arrest movement of the active part.
- iii) 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.
- iv) Flux density should not more than 1.38 Tesla for Amorphous core. No load current shall not exceed 2% of full load current and will be measured by energizing the transformer at 433 volts. 50c/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 L V phase by phase to rated phase voltage and measurement of an,bn,cn voltage will be carried out.

6.2 WINDINGS:

- a. Material: Aluminum with DPC shall be used (0.4 mm for strip & 0.25 mm for round conductor)
- b. Current density for HV and LV should not be more than 1.6 A/Sq.mm for Aluminium Conductor.
- c. L.V winding shall be in even layers so that neutral formation will be at top. Vertical ducts of 3 mm and spacers shall be provided with in each coil for H.V and L.V windings
- d. The no. of HV Coil for HV winding is 6 nos. for staked core and 1 no. for wound / amorphous Transformers
- e. Inter layer insulation shall be Epoxy dotted Kraft paper (min. 2 nos. of 2 mils)
- f. Proper bonding of inter layer insulation with the conductor shall be ensured. Test for binding strength conducted.
- g. Dimensions of winding coils are very critical .Dimensions tolerance for winding coils shall be within limits.
- h. Wedges of 3 mm shall be provided at 50% of the HV coil and LV coils in all types of transformers.
- i. Formation of Delta on HV side shall be with 13 SWG super enameled copper 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 ferrules and crimping.

- j. The star point shall be done with and aluminum ferrules for aluminum windings and crimping.
- k. The Un-balanced current i.e., current flowing in neutral during Short Circuit test at full load current shall not be more than 2% of the full load current.
- l. All the sleeves used in construction shall be fibre glass material
- m. Proper bonding of inter layer insulation with the conductor shall be ensured. Test for binding strength conducted.
- n. Dimensions of winding coils are very critical .Dimensions tolerance for winding coils shall be within limits as specified in GTP.

The winding shall be designed such that all coil assemblies of identical voltage rating shall be interchangeable.

6.2.1 OIL:

The transformer shall be supplied complete with first filling of oil and the same shall comply with ISS-335/12018. The characteristics of the oil shall be as per IS:

Sl.No	Characteristic	Specified value
1	Electric strength (breakdown voltage) Unfiltered Filtered	
2	Electric dissipation factor (tan delta) at 90 degree C	
3	Specific resistance (resistivity) at 27 degree C	
4	Specific resistance (resistivity) at 90 degree C	
5	Flash point (PM closed)	
6	Interfacial tension at 27 degree C	
7	Neutralisation value (total acidity)	
8	Water content	

Test report for each batch of oil shall be submitted.

6.3 LOSSES: The maximum losses equivalent to BEE 5 Star rating shall not exceed the values at rated voltage and rated frequency permitted at 75 Deg. C are indicated below:

KVA rating	Voltage ratio	Max. Losses @ 50% load, Watts	Max. Losses @ 100% load, Watts
160	11000/ 433 V	416 W	1281 W

The above losses are maximum allowable and there would not be any positive tolerance. Bids with higher losses than the above specified value would be treated as non-responsive.

6.3.1 Percentage Impedance: The percentage impedance at 75 Deg. C shall be 4.5% Tolerance is applicable as per IS:2026

6.3.2 Temperature Rise : Temperature rise over ambient shall not exceed the limits described below:

Top oil temp. rise measured by thermometer	:	35 Deg. C
Winding temp. rise measured by resistance	:	40 Deg. C

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

6.4 PENALTY FOR EXCESSIVE LOSSES: (During Guarantee period)

6.4.1 During testing, if it is found that the actual measured losses are more than the values as quoted by the bidder, penalty should be recovered from the bidder at double the loss capitalization formula as mentioned below:

(a) No load losses Rs.217.51 per watt or part there of excessive loss.

(b) Load loss: Rs.28.77 per watt or part there of excessive loss

For fraction of a KW, proportionate penalty will be recovered.

6.4.2 Purchaser reserves the right to reject any transformer during the test at suppliers works. If the temperature rise exceeds the guaranteed values.

6.4.3 Purchaser reserves the right to reject any transformer during the test at supplier`s works, if the impedance values differ from the guaranteed values including tolerance **as per IS 2026.**

6.4.4 Purchaser also reserves the right to retain the rejected transformer and take it into service until the Bidder replaces it with a new transformer at no extra cost. The delivery as per contract will be counted when the new transformer as per specification is provided by the manufacture.

6.5 INSULATION MATERIAL & CLEARANCES:

a) Material: Electrical grade insulation shall be Epoxy dotted Kraft paper Minimum 2 x 2 mil EDD paper shall be used as interlayer insulation.

b) 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. 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

c) Clearances:

Sl. No	Description	For CRGO wound core / CRGO Staked Core / Amorphous Core Construction (mm)
1)	Radial Clearance of LV Coil to Core (Bare Conductor) shall not be less than:	4

2)	Radial Clearance of HV & LV shall not be less than:	11
3)	Phase to Phase clearance between HV conductors shall not be less than	10
4)	Minimum electrical clearance between the winding and body of the tank shall not be less than	30
5)	Minimum End insulation to earth shall not be less than	25

6.6 TANK:

Circular cross section cooling tubes of not less than 38 mm dia and 1.25 mm thick bent & directly Welded to tank shall be provided. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise .Bidder shall submit the calculation sheet.

OR

For Corrugated tanks: Corrugations shall be built up with CRCA sheets of 1.6 mm thickness and Tanks with corrugations shall be tested for leakage test at a pressure of 0.3 kg/cm² measured at the top of the tank.

- i) Pressure Release Device: For corrugated tanks, PRD will be provided instead of Explosion vent and it operates at the pressure before 0.25 kg/cm².
- ii) Cooling tubes shall not be provided underneath the LV bushings.
- iii) Corrugated fins shall be provided underneath the LV bushings.

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 at least 50% of the bottom yoke, full core and complete top yoke. Bidder shall submit the calculation sheet.

6.6.1 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 as per IS 1852.

- i. Side walls : 4.0 mm thickness
- ii. Top and bottom plates : 6.0 mm thickness

6.6.2. 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.

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. Two sides corner shall be welded for withstanding a pressure of 1Kg/Sq.cm for 10 minutes. All the tank plates shall be of such strength that the complete transformer with oil and fittings can be lifted bodily by means of lifting lugs provided.

6.6.3 All joints of tank and fittings shall be oil tight and no bulging should occur during service. The tank design shall be such that the core and windings can be lifted freely. The tank plate shall be of such strength that the complete transformer when filled with oil may be lifted bodily by means of lifting lugs. Inside of tank shall be painted with **oil resistant paint/ Parkarised.**

6.6.4. The tank shall be reinforced by welded angle (50X50X6mm) on all the outside wall on the edge of the tank to form two equal compartments. Permanent deflection when the tank without oil is subject to a vacuum of 760 mm of mercury shall not be more than 5 mm up to 750 mm length and 6 mm up to 1250 mm length. The tank shall further be capable of withstanding a pressure of 1kg/sq.cm (g) for 10 min., and a vacuum of 0.3 kg/sq. cm (g) without any deformation.

6.6.5 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.

6.6.6. Heat dissipation by tank walls upto oil level should be limited to 500 W/sq.m (excluding top and bottom) above oil level should be limited to 250 W /sq.m cooling tube limited to 300 W/sq.m. Circular cross section cooling tubes not less than 38 mm dia and 1.25 mm thick bent and directly welded to tank shall be provided if required. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Heat dissipation calculations shall be furnished along with the bids.

6.6.7 Lifting Lugs: 2 Nos. welded heavy duty lifting lugs of MS Plate 8 mm thick (min) suitably reinforced by vertical supporting flat welded edgewise below the lug on the side wall.

6.6.8 Pulling lugs: 4 Nos. of welded heavy duty pulling lugs of MS plate 8 mm thick (min) shall be provided to pull the transformer horizontally.

6.6.9 Top cover fixing bolts of 12 mm (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) diameter spaced at 80 mm or 100 mm apart 6 mm Neoprene rubberized cork gaskets conforming to IS: 4253 Part-II will be placed between tank and cover with water tight compound between the tank flange and the gasket. The bolts outside tank shall have 2 flat washers and one spring washer.

6.6.10 ‘U’ shaped pressure relief vent of 2” diameter pipe with copper shim sheet as diaphragm shall be provided on the top of the cover of the tank such that the pressure released should be directed to the ground. The length of the vent pipe shall be such that its one end should project into tank, so that its end is 10 mm above minimum oil level. The other end of the vent pipe shall be guarded with wire mesh for preventing the entry of worms and nesting. The diaphragm shall burst at pressure between 0.76 Kg./ Sq. mm to 0.95 Kg. / Sq. mm. Conservator shall not be provided.

Transformer Sl. No. shall have to be punched on the Core-Yoke frame.

6.7 .SURFACE PREPARATION AND PAINTING

GENERAL

6.7.1.1. All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following:

- a) Proper storage to avoid exposure as well as extremes of temperature.
- b) Surface preparation prior to painting.
- c) Mixing and thinning
- d) Application of paints and the recommended limit on time intervals between coats.
- e) Shelf life for storage.

6.7.1.2 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

6.7.1.3 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 clearing. 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.

6.7.1.4 The Supplier shall, prior to protect nameplates, lettering gauges. Sight glasses, light fittings and similar such items.

6.7. 2 Cleaning and Surface preparation

6.7.2.1 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.

6.7.2.2 Steel surfaces shall be prepared by Sand / Shot blast cleaning or Chemical cleaning by Seven Tank process including Phosphating to the appropriate quality.

6.7.2.3 The pressure and volume of the compressed air supply for blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination to ensure that the cleaning process is not impaired.

6.7.2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale shall only be used where blast cleaning is impractical. Manufacturer to explain such areas in his technical offer clearly.

6.7.3. Protective Coating

As soon as all items have been cleaned and within 4 hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

6.7.4 .Paint Material

Followings are the types of paint that may be suitably used for the items to be painted at shop and supply of matching paint to site:

6.7.4.1. Oil resistant paint for inside surface.

6.7.4.2. For external surface one coat of Thermo Setting paint or 1 coat of Zinc chromate primer followed by 2 coats of Polyurethane base paint. These paints can be either air drying or stoving.

6.7.4.3. The color of the finishing coats shall be dark admiral gray conforming to No. 632 of IS – 5 of 1961.

6.7.5. Painting procedure

6.7.5.1. All painting shall be carried out in conformity with both specification and with the paint manufacturer's recommendation. All paints in any one particular system, whether shop or site applied, shall originate from one paint manufacturer.

6.7.5.2. Particular attention shall be paid to the manufacturer's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended condition. Minimum and maximum time intervals between coats shall be closely followed.

6.7.5.3. 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.

6.7.5.4. 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. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%. In all instances where two or more coats of the same paint are specified, such coatings may or may not be of contrasting colours.

6.7.5.5. Paint applied to items that are not to be painted shall be removed at supplier's expense, leaving the surface clean, unstained and undamaged.

6.7.6. Damaged paintwork

6.7.6.1. 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 originally employed.

6.7.6.2. Any damaged paint work shall be made good as follows:

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

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.

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

6.7.7 Dry Film Thickness

6.7.7.1 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 coat may or may not be of the same colour.

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

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

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

S.I.No.	Paint type	Area to be painted	No. of coats	Total Dry film thickness 9min.)
1	Thermo setting paint.	inside	01	20 microns
		outside	01	60 microns
2	Liquid paint			
	Zinc chromate (primer)	outside	01	30 microns
	Polyurethane (Finish coat)	outside	02	25 microns each
	Hot oil paint / Varnish	inside	01	35 / 10 microns

6.7.8. Tests

6.7.8.1 The painted surface shall be tested for paint thickness.

6.7.8.2 The painted surface shall pass the Cross Hatch Adhesion test, Salt spray test and hardness test as per the relevant ASTM standards.

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

6.8.3 BUSHINGS:

i) The porcelain portion of HT and LT bushings shall be of standard make and confirm to IS-2099/1973 (HV), "Specification for High voltage porcelain bushings" and IS-7421/1976 for LV IS-3347 shall be outdoor with a minimum creepage distance of 270 mm. The bushing rods and nuts shall be made of brass material 12 mm diameter for HT & 20 mm tinned copper for LT. 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.

Dry flashover voltage withstand test

Wet flashover voltage frequency voltage withstand test

Dry I min. withstand voltage

Wet half min. withstand voltage

Impulse withstand voltage (1.2/50 micro seconds positive wave)

ii) For 11 KV, 17.5 KV class bushings shall be used and for 0.433 KV, **1 KV** 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 cover.

iii) Dimensions of the bushings of the voltage class shall conform to the standards mentioned below:

Voltage class	Indian Standards or porcelain parts	For metal parts
1.1 KV	IS-3347/part-I/Sec.I/1965/1979	IS-3347/Part-I/Sec,I/1979 (As per IS-1180/1989)
17.5 KV	IS-3347/part-III/Sec.I/1972	IS-3347/Part-III/Sec.2/1982

iv) A minimum phase to phase clearance of 75 mm for LV (upto 1.1 KV bushings) and 255 mm for HV (3.3 KV 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 aluminium standard make aluminium brazing rods shall be used.

In the case of LV bushing, the internal bushing shall be made of tough insulating material like epoxy and shall have embedded stem and a strong coupling connection (screwed) properly secured with a screw type locking arrangement shall be used between stem of the internal and external bushings.

The LV bushings 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.

The design of the internal bushing for LV shall be such as to provide adequate earth clearance and creepage distance as stipulated in the standards specified. All other tests as per relevant standards shall be applicable.

The bushings shall be of reputed make supplied by those manufactures who are having manufacturing and testing facilities for manufacture of HT insulators.

The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

Cable End Boxes

The transformer shall be fitted with suitable cable end termination boxes Cable end box (to be provided for Transformer) on 11 kV side to terminate one 11 kV XLPE Cable. The HT cable box shall be prevented from ingress of moisture into the box due to rainwater directly falling on the box. The H.T cable box shall be of split type with plain faces and machined and fitted with suitable gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut bolt arrangement and M.S 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 shall be copper H.T Cable support clamp should be provided to avoid tension due to cable weight.

The transformer shall be fitted with suitable LV cable end box having non-magnetic material gland plate with appropriate size single compression brass glands on LV side to terminate 1.1kV XLPE armored cable.

Terminal Primary: 12 kV Epoxy bushings as per IS: 2099 for heavily polluted atmosphere having suitable diameter with nuts and check nuts for pad and platform mounted transformer.

Secondary Terminals shall be provided with 1.1 kV Epoxy bushings as per IS: 3347 for heavily polluted atmosphere having fixed palm type connectors with suitable locking arrangement to restrict the rotation of palm assembly. Palm shall be of copper and stud of copper duly brazed at the joint.

Suitable clamps with nuts and bolts for XLPE cables as per details given for different size of transformers. Detachable clamps with nuts and bolts for ease of removing LV cables shall be provided with Epoxy bushings Clamp arrangement with copper/brass terminal assembly.

6.9 Terminal connectors:

The LV bushing and HV bushing stems shall be provided with suitable detachable terminal connectors 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 winding for the same phase marked by corresponding small letters 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n.

6.10. Rating Plates and Star Labeling:

The rating plates on the transformer containing the information specified in clause 15.2 of IS: 2026-1977 (Part-i). 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 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 7th 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 shall be submitted along with tender.

6.11 Terminal markings

High voltage and Low voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letter IU,IV,IW 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 to be brought out and connected to local grounding terminal by an Earthing strip adequate length. The vector diagram plate shall clearly indicate the method adopted for marking the terminals both outside and interior.

6.12. LIGHTNING ARRESTORES:

9 KV, 5 KA Metal Oxide Lightning Arresters (discharge class shall be 3 as per IS-3070 part-II) as per relevant standard, one number per phase shall be fitted under the HV bushings with G.I. earth strip 25 x 3 mm connected to the body of the transformers with necessary clamping arrangements. The metal oxide lightning arresters shall be of reputed make with appropriate Indian Standards.

6.13. FITTINGS: The following standards fittings shall be provided.

- a) Rating and terminal marking plate non-detachable - 1 No
- b) Earth strip of adequate length.
- c) Earthing terminals with bolt, nuts & washers with suitable lug for connecting earth wire – 2 Nos.
- d) Lifting lugs – 4 Nos. for main tank.
- e) Bimetallic terminal connectors material made out of LM-6 aluminium alloy and high quality copper of thickness 3 mm and threading length of 25 mm which is suitable for 12 mm Brass bushing rod of HV bushing – 3 Nos. and Special type LV bimetallic bushing clamps (heavy duty) made out of LM6 aluminium alloy and high quality copper of thickness 3 mm and threading length of 25 mm which is suitable for 20 mm tinned copper bushing rod of LV bushing – 4 nos.
- f) Thermometer pocket with cap – 1 No.
- g) U shaped Pressure relief vent pipe of 2' dia with 0.025 mm diaphragm on the top of the top cover for breaking at a pressure of 0.76 to 0.95 Kg/cm² such that the pressure released should be directed to the ground and other end of the vent pipe shall be guarded with suitable mesh against entering of worm and resting.
- h) HV bushing – 3 Nos.
- i) LV bushing – 4 Nos.
- j) Pulling lugs – 4 nos.
- k) Stiffener angle 50 x 50 x 6 mm (and vertical strip of 50 x 6 mm flat).
- l) Cooling tubes – No. & length may be mentioned (as per heat dissipation calculations).
- m) Disconnector type Metal oxide lightning Arrestors (3 Nos.) with G.I. earth strip 25x3 mm of adequate length.
- n) Base channel 75x 40 mm
- o) Guarantee embossed plate welded below name plate.
- p) Oil level gauge indicating the positions of oil marked as follows
Min (-5 Deg. C)
30 deg. C

Max (90 deg. C)

- q) APEPDCL logo shall be embossed on separate plate permanently welded to the DTR.
- r) Rating plate :- Separate rating plate as indicated in IS 1180 part I of 2014 shall be permanently welded to the transformer with Sl. No. & PO No. with month & year of supply and other details duly taking approval.
- s) DTR equipment no shall be punch or engrave as per the AP_PDCL allotted equipment numbers on the transformer tank.
- t) The allotted equipment numbers also to be painted on the transformer tank for clear view from long distance
- u) Oil/Nitrogen/Air filling hole having with cover (for sealed type transformers)

6.14. FASTENERS:

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.

Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.

All nuts and pins shall be adequately locked.

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.

All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanizing, except high tensile steel bolts and spring washers which shall be electro-galvanised / plated. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

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 nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

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.

Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back or the securing screws.

6.15 MOUNTING ARRANGEMENTS:

The under base of all transformers shall be provided with two 75x 40 mm channels 460 mm long with holes to make them suitable for fixing on a platform or plinth.

The distance between the two fixing channels at the bottom shall be 415 mm

6.16 OVER LOAD CAPACITY:

The transformers shall be suitable for loading as per relevant standard as per ISS 6600/1972

7.0 TESTS:

7.1 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 be 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.

7.2 TYPE TESTS:

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/1989.)
12. Permissible flux density and over fluxing (IS-1180/Part-I/1989.)

7.3. The supplier shall furnish calculation accordance with IS:2026 to demonstrate the thermal ability of the transformers to withstand short circuit. The manufacturer will have to submit thermal calculation of short circuit withstand ability for 2 seconds and 3 seconds.

7.4 TESTS AT SITE:

The purchaser reserves the right to conduct all tests on Transformer after arrival at site and the manufacturer shall guarantee test certificate figures under actual service conditions. If the losses measured at site are found more than the guaranteed losses penalty will be levied on all the transformers of the purchase order as per clause number 4.4.1.

7.5. TOLERANCES:

Unless otherwise specified herein the test value of the transformers supplied would be within the tolerance permitted in the relevant standards. No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

7.6 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.

8.0. INSPECTION:

All tests and inspection shall be made at the place of manufacturer 10% of the quantity offered inspection and unless otherwise especially agreed upon the manufacturer and the 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 specification.

The manufacturer shall provide all services to establish and maintain quality of workman ship 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.

Along with the bid the manufacturer shall prepare Quality Assurance Plan identifying the various stages of manufacture, quality checks performed at each stage and the Customer hold points. The document shall also furnish details of method of checking, inspection and acceptance standards / values and get the approval of purchaser or his representative before proceeding with manufacturing. However, purchaser or his representative shall have the right to review the inspection reports, quality checks and results of manufacturer's in house inspection department which are not customer hold points and the manufacturer shall comply with the remarks made by purchaser or his representative on such reviews with regards to further testing, rectification or rejection etc. Manufacturer should submit the list of equipment for testing along with latest calibration certificates to the purchaser.

Purchaser shall have every right to appoint a third party inspection to carryout the inspection process. The purchaser has the right to have the test carried out at his own cost by an independent agency wherever the dispute regarding the quality of supply. Purchaser has right to test 100% of the supply selected either from the store 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 leads to blacklisting among other things.

9.0 QUALITY ASSURANCE PLAN:

9.1. 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.

i. 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.

ii. Information and copies of test certificates as in (1) above in respect of bought out accessories.

iii. List of manufacturing facilities available.

iv. Level of automation achieved and list 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 inspection.

vi. List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports shall be furnished with the bid. Manufacturer shall possess 0.1 class instruments for measurement of losses.

vii. Quality Assurance Plan (QAP) with hold points for purchaser's information to the purchaser.

i. List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.

ii. Type test certificates of the raw materials and bought out accessories.

9.2 .The successful bidder shall within 30 days of placement of order, submit following information to the purchaser.

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.

10.0 DOCUMENTATION:

The Bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.

(i) Dimensional tolerances

(ii) Weight of individual components and total weight

11.0 PACKING & FORWARDING:

11.1. The packing shall be done as per the manufacturer's standards practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea

11.2. The marking on each package shall be as per the relevant IS.

12.0 LIST OF DRAWINGS AND DOCUMENTS:

The bidder shall furnish four sets of following drawings along with his offer.

a) General outline drawing showing plan, elevation and end view dimensions, assembly and list of fittings of the equipment.

- b) Name plate details and schematic drawing. Name plate details should consist of trade mark month and year of manufacturer P.O.No. and date, guarantee period, losses, percentage impedance, Voltage ratio, vector group, full load and no load losses temperature rise, weight of core oil, total weight of transformer and other important factors etc.
- c) Core coil assembly drawing with bill of materials.

12.1 Six sets of the type test reports, duly approved by the purchaser, shall be submitted by the supplier for distribution before commencement of supply. Adequate copies of acceptance and routine test certificates, duly approved by the purchaser, shall accompany the dispatch consignment. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier's risk.

13.0 GUARANTEED TECHNICAL PARTICULARS:

The guarantee technical particulars of the transformer offered shall be given by the tenderer (as per Annexure).

13.0 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 APEPDCL 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.

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 itself shall be deemed to be the notice issued to the supplier about encashment of Bank Guarantee in case of failure to adhere to timelines & no separate notice will be served.

ANNEXURE – IA

GUARANTEED & OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMERS (To be furnished by the Manufacturer)

Sl. No.	Description	160 KVA
1	Make & Manufacturer	To be furnished by the manufacturer
2	Place of Manufacture	- do -
3	Voltage Ratio	11000V/433 – 250V
4	Voltage per turn (Volts)	
5	Rating in KVA	160KVA
6	Core Material used and Grade Flux density Over fluxing without saturation (Curve to be furnished by the Manufacturer in support of his claim)	Not more than 1.55 weber/sq.mm (for CRGO) Not more than 1.38 weber/sq.mm (for Amorphous) Not more than 12.5%
7	Thickness of core plates	Shall be furnished
8	Power factor of magnetizing current (lag. Max.)	shall be less than 1
9	Maximum temperature rise of a) Windings by resistance method b) Core by Thermometer c) Oil by Thermometer	
10	Core loss in watts a) Normal Voltage b) Maximum Voltage	
11	Magnetising (No load) current at Normal Voltage Maximum Voltage	Not to exceed 2% of F.L. current Shall be furnished
12	Resistance of windings at 20 Deg. C (with 5% tolerance) HV Winding (ohms) LV winding (ohms)	Shall be furnished
13	Reactance of winding/phase	To be furnished
14	% of end turn reinforcement	
15	Maximum losses (watts) at 50% Load Maximum losses (watts) at 100% Load	416 W 1281 W
16	Full load current HV : LV :	8.398 A 213.34 A
17	Current density used for HV winding LV winding	1.6 A/sq.mm 1.6 A/ sq.mm

Sl. No.	Description	160 KVA
18	Clearances Core & LV LV & HV HV Phase to phase (with a min. of 2 x 1 mm press board to cover tie rods) End insulation clearance to Earth Any point of winding to tank	As per clause 5.5
19	% Impedance at 75 Deg. C	4.5 (tolerance applicable as per IS 2026)
20	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 enclosed for selecting cooling and area to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise is enclosed.	Shall be furnished. 38 mm Dia 1.25 mm thickness(min) Shall be furnished
21	Inter layer insulation provided in design for 1) Top & Bottom layer 2) In between all layer 3) Details of end insulation 4) Whether 3.2 mm wedges are provided at 50% turn of the HV coil	Shall be furnished
22	Insulation materials provided For Conductors (1) HV (2) LV For Core	Shall be furnished
23	Particulars of metal oxide Lightning arrestor	Shall be furnished
24	Medium of free space above oil level.	Minimum 55% of the volume of the oil

ANNEXURE – I B

GUARANTEE & OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMER

(To be furnished by the Manufacturer)

Sl. No.	Description	160 KVA
1	Make & Manufacturer	To be furnished by the manufacturer
2	Place of Manufacture	- do -
3	Voltage Ratio	11000V/433 – 250V
4	Rating in KVA	160 KVA
5	Efficiency at 75 Deg. C a) Unity P.F. & b) 0.8 P.F. 1) 125% load 2) 100% load 3) 75% load 4) 50% load 5) 25% load	Shall be furnished
6.	Regulation at a) Unity P.F. b) 0.8 P. F. at Deg. C	Shall be furnished
7	Flash Test HV 28 kV/50Hz for 1 minute LV 3 kV/50Hz for 1 minute	Shall be confirmed
8	Over potential Test Double Voltage & Double frequency for 1 minute	Shall be confirmed
9	Impulse test	Voltage shall be 95KV peak
10	Weight content of a) Core lamination b) Windings c) Tank & Fittings d) Oil in litres e) Total Weight	Shall be furnished Shall be furnished Shall be furnished
11	Oil Data 1) Qty. for first filling (min.) 2) Grade of oil used 3) Maker's name 4) BDV at the time of filling	Shall be furnished EHV grade confirming to latest version IS 335/2018 (Grade shall be furnished) Shall be furnished Shall be furnished
12	Transformer 1) Overall length x breadth x height 2) Tank length x breadth x height 3) Thickness of plates for a) Side plate	Shall be furnished Shall be furnished 4

Sl. No.	Description	160 KVA
	b) Top & bottom plate	6
13	Size of the wire used 1) HV a) SWG/mm b) Dia c) Area (sq.mm) 2) LV a) Strip size b) No. of conductors in parallel c) Total area of cross section (sq.mm)	Shall be furnished (current density for HV & LV should not be more than 1.6 Amp/sq.mm
14	Is the name plate gives all particulars are required in tender	Shall be furnished
15	Particulars of Bushings HV/LV 1) Maker's name 2) Type IS-3347/IS-1180 3) Rating as per I.S. 4) Dry flash over voltage kV at 50 C/s 5) Wet flash over voltage kV at 50 C/s	Shall be furnished

ANNEXURE – II
ADDITIONAL DETAILS

Sl. No.	Description	160 KVA
1	Core Grade	
2	Core diameter	Mm
3	Gross Core area	
4	Net core area	Cm
5	Flux density (1.55 Tesla max. for CRGO, 1.38 Tesla max for Amorphous)	Tesla
6	Wt. Core	
7	Loss per Kg. of core at the specified Flux Density	
8	Core window height	Mm
9	Center to center distance of the core	Mm
10	No. of LV Turns	
11	No. of HV Turns	
12	Size of LV conductor bare/covered	Mm
13	Size of HV conductor bare/covered	Mm
14	No. of parallels	
15	Current density of LV winding (Max. 1.6A/sq.mm)	
16	Current density of HV winding (max 1.6 A/sq.mm)	
17	Wt. Of the LV winding for transformers	Kg.
18	Wt. Of the HV winding for transformers	Kg.
19	No. of LV coils/phase	
20	No. of HV coils/phase	
21	Height of LV Winding	Mm
22	Height of HV winding	Mm
23	ID/OD of LV winding	Mm
24	ID/OD of HV winding	Mm
25	Size of the duct in LV winding	
26	Size of the duct between HV & LV	Mm
27	HV winding to LV clearance (minimum 11 mm)	Mm
28	HV winding to tank clearance (minimum 30 mm)	Mm
29	Calculated impedance (4.5%)	%
30	HV to earth creepage distance	Mm
31	LV to earth creepage distance	Mm

ANNEXURE – III

SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl. No.	Item	Source of Material	Place of Manufacture	Place of testing and inspection
1	Laminations			
2	Aluminium			
3	Core plates			
4	Steel Castings/sections			
5	Tank			
6	Insulating Cylinders			
7	HT Fuse Links			
8	Bushing HV/LV			
9	Oil			
10	Insulated winding wire			
11	Las			

Note: one soft copy (in CD) GTP should be attached

SCHEDULE OF DEVIATION

TECHNICAL

Sl. No.	Requirements / Equipment	Specification Clause No.	Deviations	Remarks

It is hereby confirmed that except for deviations mentioned above, the offer conforms to all the other features specified in Technical Specification Section ____ of this Bid Document

DISTRIBUTION TRANSFORMER

1 Introduction

- 1.1 Requirement of conversion of 11 kV overhead systems to underground system for various areas need to procure 11000/433 voltage, oil immersed star rated Cable Entry type distribution transformers of Capacities 160 kVA.
- 1.2 It is not the intent to specify completely herein all the details of the design and construction of material. However the product for supply shall confirm in all respects high standards of Engineering, design and workmanship and shall be performing in continuous operation in manner acceptable by the APEPDCL. The offer material shall be complete with all components necessary for the intended purpose. The design and components shall be deemed to be within the scope of vendor's supply irrespective of whether those are specifically brought out in this section and or the commercial order or not.

2 Code and Standards

- 1.1 All equipments and materials shall be designed manufactured and tested in accordance with the latest applicable Indian Standard, IEC standard and CBIP manuals except where modified and or supplemented this specification.
- 1.2 Equipment and material conforming to any other standard, which ensures equal and or better quality, may be accepted. In such case copies of English version to the standards adopted shall be submitted and got approved prior to the supply. The Transformer offered for supply shall in general comply with the latest issues including amendments of the following Indian Standards but not restricted to it.

3 System Description

The distribution transformers shall be installed at outdoor locations along 11 kV distribution networks, which consist of underground network. The HV side shall be connected of CB of the ring main unit through 11kV XLPE UG cable. LV side shall be connected to switch type feeder pillar through 1.1 kV single Core 630 Sq.mm (2 Runs for 500 kVA and 1 Run for 315kVA) Aluminium conductor XLPE cable.

4 Design Criteria

Title	I.S. Code	IEC Standard
Distribution Transformer Method of Construction	IS:2026	IEC:60076 IEC:60616
Outdoor Type Oil Immersed Distribution Transformer	IS:1180(part1):2014	-
Thermal Evaluation and classification of Electrical Insulation.	IS:1271	
Fittings & Accessories for Distribution Transformers	IS:3639	-
Guide for loading of Oil Immersed Transformer	IS:6600	-
Bushings for Alternating Voltage	IS:2029	-
Dimensions of porcelain bushings for transformers	IS:2099/3347	-
Insulating oil for transformers and switchgears	IS:335	-

- The transformers shall be installed in hot, humid tropical atmosphere. All equipment accessories and wiring shall be provided to withstand the specified load and prevent fungus growth.
- The transformers shall be capable for continuous operation at rated output under the operating conditions of voltage and frequency variations as per statutory limits governed by relevant Indian Standard and Electricity Act 2003 and its amendments in force.
- The transformer shall confirm the best engineering practice.
- The designed material shall be capable to secure reliability, economy, safe and convenient operation and shall include all specified or unspecified incidental items necessary for similar equipment for convenient working in every respect.
- The transformers shall be capable of withstanding the short circuit stresses due to terminal fault between phase to phase and phase to ground on one winding with full voltage maintained on the other windings for a minimum period of three seconds.
- The transformers shall be free from annoying hum and or vibrations. The design shall be such as not to cause and undesirable interference with radio or communication circuits.

5 Specific Requirement

- 5.1 11000/433 Volt oil immersed 315 kVA & 500 kVA ONAN cooled, double wound, core type suitable for installation on plinth with LV/HV end termination boxes with appropriate air clearance for specified voltages.
- 5.2 For 315 kVA and above the winding shall be Copper.
- 5.3 Voltage Ratio: No load voltage 11000/433 volts within tolerance as stipulated in IS: 2026.
- 5.4 Rating: The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified. The rated kVA shall be the product of rated voltage in kV, and the corresponding rated current and the phase factor 1.732. When the transformer is operated with the rated primary voltage applied to the terminals of the primary winding, the apparent power (kVA) at the terminals of the secondary winding, when carrying the rated secondary current differs from rated kVA by an amount corresponding to the regulation of the transformer and is the product of the actual secondary voltage, the rated secondary current and the phase factor 1.732.
- 5.5 System: 11000 volts A.C., 50 Hz supply having solidly earthed system on HV side. The 11kV systems shall have basic insulation level of 28 kV for one minute/95 kVp impulse and maximum fault level of 26 kA. 433 volts A.C., 50 Hz supply shall be rated for 1.1 kV grade and basic insulation of 3 kV for one minute and 7.5 kVp impulse. The variations in input and output supply shall be as per statutory variation governed by relevant Indian Standard and Electricity Act 2003 with latest amendments in force. The LV neutral shall be earthed solidly at each transformer substation. The transformers will be connected in a system consisting of both overhead and underground mains.
- 5.6 Temperature Rise: The maximum temperature rise at the specified maximum continuous output shall not exceed 35 degree C by thermometer in the hottest portion of the oil or 40 degree C measured by resistance of winding above ambient temperature
- 5.7 Type of load: The transformer shall be suitable of carrying load within temperature rise indicated in the Indian Standard specifications IS: 6600 'Guide for loading of oil immersed Transformer.'
- 5.8 Overloads: The transformer shall be suitable for carrying overload within temperature rise indicated in IS: 6600 'Guide for loading of oil immersed Transformer.'

- 5.9 Connections: H.V Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth' Vector group Dyn11 of IS: 2026.
- 5.10 Guarantee: All transformers shall be supplied with guarantee period of 5 years from date of commissioning of transformer. Any deficiency during guarantee period will be made up free of cost by the supplier either by the replacement or by repairs.

6 Tank

- 6.1 The transformer tank and cover shall be fabricated from robust M.S. plate steel without pitting and shall have adequate thickness (Top cover 5 mm min., side plates 3.15 mm min. Bottom plate 5mm min.) with radiators. The tank and cover shall be of welded/Bolted construction. All seams shall be welded and where practicable they shall be double welded. All edges shall be double welded/ the tank wall shall be reinforced by stiffer to ensure rigidity, so that it can withstand without any deformation the mechanical shock during transportation.
- 6.2 All removable covers shall be provided with weather, proof, hot oil resistant, resilient gaskets. The design shall be such as to prevent any leakage of water into or oil from the tank.
- 6.3 The tank shall be subjected to a pressure test of 6.35 kg/cm² with hot oil for 12 hours when transformer is complete with all fittings. During the test average oil temperature of 45 degree C above ambient temperature shall be maintained throughout test period by circulating suitable current in H.V winding and short circulating L.V winding. There shall be no leakages during and after the test. No deflection shall be found after the removal of pressure. The type test Certificate from NABL accredited laboratory in triplicate shall be produced before dispatch of the consignment.
- 6.4 The top cover of the tank shall be suitably sloped to facilitate water drain off and shall be so designed as to facilitate lifting of the same. In case required with minimum disconnecting of pipe work and accessories. Air release plugs shall be provided on main tank top cover to cover entire area suitably.
- 6.5 The color of the finishing coats shall be dark admiral gray confirming to No:-632 of IS-5 of 1961.

7 Cleaning & Painting

- 7.1 All steel surfaces shall be thoroughly cleaned by Sand blasting or chemical agents, as required to produce a smooth surface free of scales, grease and rust.
- 7.2 The terminal surfaces in contact with insulating oil shall be painted with heat resistant and insulating –Oil resistant paint, which shall not react nor be soluble in the insulating liquid used.
- 7.3 The external surfaces , after cleaning, shall be given two coats of high quality rust resisting primer as per IS:2074 with latest amendments thereto followed by two coats of weather resisting epoxy paint specially recommended for transformer use.
- 7.4 Paints shall withstand tropical heat rain, and other environmental effects. The paint shall not scale off or crinkle or removed by abrasion due to normal handling.
- 7.5 Sufficient quantity of paint shall be furnished for touching if any on site.
- 7.6 Rusting of hardware such as nuts, bolts and fittings during operation shall be avoided by applying anti rusting solutions. All bushings and current carrying parts shall be cleaned properly after final painting.

8 Cable End Boxes

The transformer shall be fitted with suitable cable end termination boxes Cable end box (to be

provided for Transformer) on 11 kV side to terminate one 11 kV XLPE Cable. The HT cable box shall be prevented from ingress of moisture into the box due to rainwater directly falling on the box. The H.T cable box shall be of split type with plain faces and machined and fitted with suitable gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut bolt arrangement and M.S 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 shall be copper H.T Cable support clamp should be provided to avoid tension due to cable weight.

The transformer shall be fitted with suitable LV cable end box having non-magnetic material gland plate with appropriate size single compression brass glands on LV side to terminate 1.1kV XLPE armored cable.

Terminal Primary: 12 kV Epoxy bushings as per IS: 2099 for heavily polluted atmosphere having suitable diameter with nuts and check nuts for pad and platform mounted transformer.

Secondary Terminals shall be provided with 1.1 kV Epoxy bushings as per IS: 3347 for heavily polluted atmosphere having fixed palm type connectors with suitable locking arrangement to restrict the rotation of palm assembly. Palm shall be of copper and stud of copper duly brazed at the joint.

Suitable clamps with nuts and bolts for XLPE cables as per details given for different size of transformers. Detachable clamps with nuts and bolts for ease of removing LV cables shall be provided with Epoxy bushings Clamp arrangement with copper/brass terminal assembly.

9 Oil

- 9.1 Transformer oil as per IS: 335 for filling transformer tank up to height above minimum level of conservator tank. All test certificates shall be supplied by the supplier.
- 9.2 Leakage of Oil: Suitable approved material “Neoprene” of RC 70 C grade as specified in IS: 1866 shall be provided at all joints to prevent leakage of oil during continuous operation of the transformer

10 Drying Out

The transformer windings shall be thoroughly dried out and kept oil immersed to avoid further drying out and to immediately commission the transformer on receipt.

11 Clamping of leads

All leads from the coils to the terminals shall be suitably clamped to prevent snagging and fouling with other parts and the tank.

12 Phase marking

Phase marking with proper alignment as per IS: 2026 punched on small non corrosion metallic tags shall be permanently fixed for HV just below the cable box and above LV bushings.

13 Core and Coil

- Core type transformer with core built of high grade, non aging, low loss, high permeability, grain oriented and cold rolled silicon steel laminations especially suitable for core material. Premium grade M-OH of better quality with appropriate thickness core lamination shall be provided. The transformer shall be designed for minimum humming noise.
- The coils shall be manufactured from electrolytic copper fully insulated for rated voltage and purchased from original manufacturer.
- Insulating material shall be class 'A' specified as per IS: 1271 with latest amendments thereto. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum for 11 kV at primary and 433 volts at secondary connected to feeders in a lightning prevalent area.
- Suitable support between adjacent sections of coil assembly shall be provided with required bracing and other insulation so that free circulation of oil is ensured and reduce hot spot of the winding.
- All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used wherever practicable.
- No shifting or deformation to core and coil assembly during transit of transformer is allowed. The core and coil assembly shall withstand such thermal and mechanical effects of short circuit at the terminals of any winding as per IS: 2026 with latest amendments thereto.

14 Insulation level

The transformer shall be designed to withstand the following.

Voltage	Impulse Voltage (kVP)	Power Frequency Voltage (kV)
11000	95	28
415	7.5	3

15 Losses & Labeling

It is mandatory that transformers having rating 315/500 KVA shall be as per the BEE Guideline and shall be labeled accordingly.

The transformer losses at 75 degree C and at normal tap without any positive tolerance should full fill the minimum requirement as recommended by Bureau of Energy Efficiency (BEE).

Standard labeling shall be provided as per BEE guidelines.

The minimum requirements stated in the Specification for functional guarantees required in the Specification are: as per **5.3 LOSSES**

Percentage Impedance:

The % impedance shall be subject to tolerance specified in IS: 2026-1977.

Regulation: The regulation at 75°C at full load at unity and 0.8 power factor subject to the usual tolerance as per IS : 2026 and shall be specified in the bid.

Over fluxing:

The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 10 % of any tapping without injurious heating at full load conditions.

16 Fittings and Accessories

The following accessories conforming to IS: 3639 shall be provided:

- Oil conservator with drain plug, oil filling hole with blanking plate and oil level indicator with maximum level marking. Conservator tank shall be of capacity to store oil of 10% of total oil in main tank. Oil level indicator shall be so designed to indicate 10% to 90% oil quantity in the conservator tank. Normal level shall be marked at 50 % of oil level indicator/=.
- Silica gel breather shall contain minimum 0.5 kg dehydrated silica gel for 315 kVA and 500 kVA distribution transformers and shall be connected with conservator with pipe having $\frac{3}{4}$ " diameter.
- Pressure Relief vent should be provided.
- Two Numbers Earthing terminals should be provided.
- Proper Lifting lugs should be provided.
- should provide Air release plug
- should provide Oil filling hole with plug
- Oil drain outlet with full turn type valve along with valve guard at the bottom of the main tank shall be provided.
- Oil filter inlet without valve and with plug or with full turn type valve should be provided.
- should provide Jacking lugs
- Four Nos. of unidirectional flat rollers to facilitate the rolling of transformer in the direction parallel to the side where the terminals have been brought out.
- L.V. cable frames with clamps to hold one or two Nos. of XLPE cable per phase for each transformer.
- The rating plate shall be as per the sample provided by the purchased and shall indicate particulars as may be specified including No load and full load losses date of manufacture, order, guarantee period etc.

17 Tests

- 17.1 Following tests constitute the routine test. All transformers or a part of order quantity as desired by the APEPDCL shall be subjected to routine tests as per IS: 2026. All results of the tests shall be submitted in triplicate for approval/comments.
- Measurement of winding resistance.
 - Ratio, Polarity and phase relationship.
 - Impedance voltage
 - No load losses and no load current
 - Load losses
 - Insulation resistance
 - Induce over voltage withstand test
 - Separate source voltage withstand test
 - Unbalance current test (unbalance current should not be more than 2 % of full load current in neutral at full load condition)
- 17.2 Type Test (to be quoted separately)
- Impulse voltage withstand test
 - Temperature rise test
 - Short circuit test
- 17.3 Test Certificates:
- The equipment offered shall be fully type tested as per relevant standards. In case tests are

already done the bidder shall furnish the type test reports along with the offer.

18 Contract Drawing

All required drawings shall be submitted by the bidder.

19 Conditions & Requirements

Bidder must specifically confirm that the following will be complied with

- HV and LV bushings shall be on the opposite sides of the transformer main tank. HV bushing shall be mounted at an angle perpendicular to the main tank.
- Transformer shall be designed for solidly earthed system.

20 Inspection

- All raw materials used for manufacture of the transformer such as core stamping, winding conductors, insulating paper and oil shall have test certificates, excise gate pass of the manufacturer. The bidder shall furnish following documents along with their offer in respect of raw materials.
 - Invoice of supplier
 - Supplier's Certificate
 - Packing list
 - Bill of entry certificate by custom.
 - Bill of landing
- Sufficient advance intimation to organize stage inspection for inspecting core and winding shall be given.
- APEPDCL has an option to open a transformer supplied transformer in the site and if any particulars vary than the Guaranteed Technical Particulars, the whole lot of transformers will be rejected and risk purchase resorted to.
- APEPDCL shall pick any transformer and carry type tests from competent and authorized body at contractor's cost, the contractor shall have to organize packing of such transformer at site. All necessary charges for transporting and testing shall be borne by the contractor. If the transformer fails to meet the requirement of type tests, the whole lot of the transformers ordered will be forthwith rejected and risk purchase resorted to.
- Original manufacturer's test report for oil shall be submitted at the time of inspection. Arrangements for testing the oil shall be made and the same be tested in the presence of company's representative or in an independent laboratory.
- If APEPDCL intends to have inspection by competent/ authorized body at manufacturer's premises during the manufacturing and testing process, the selection of the party will be at sole discretion of the company and manufacturer will have to trust and provide all the facilities.

21.0 GUARANTEE:

The Supplier shall guarantee for the period of 60 months from the date of installation.

GUARANTEED TECHNICAL & OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMERS

(To be submitted by Bidder for each size/ rating)

Sl. No.	Description	Units
1.	Make & Manufacturer	
2.	Place of Manufacture	
3.	Voltage Ratio	
4.	Rating in KVA	
1.	<u>Core Details:</u>	
1	Core Grade	
2	Thickness of core plates	
3	Flux density (Max)	TESLA
4	Over fluxing without saturation	

5	Core Details. 1) No. of Core steps. 2) Max. width of first step lamination. 3) Stacking factor 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	
2. <u>Winding Details</u>		
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
3. Clearances		
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) a) Core & LV b) LV & HV c) HV Phase to phase d) End insulation clearance to Earth e) Any point of winding to tank	mm
4. Heat Dissipation Calculations		
1	Maximum temperature rise of Oil by Thermometer	
2	Transformer (minimum) 1) Overall length x breadth x height 2) Tank length x breath 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) Diameter & 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	
5.	<u>Efficiency, Regulation and other particulars</u>	
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	

Sd/-

**CHIEF GENERAL MANAGER / P&MM
CORPORATE OFFICE :: A.P.E.P.D.C.L.
VISAKHAPATNAM
(Ph No. 0891-2582302, 0891-2582303)**