

TECHNICAL SPECIFICATION FOR OUTDOOR TYPE DISTRIBUTION TRANSFORMERS 11 kV/433-250V 400 KVA COPPER WOUND DISTRIBUTION TRANSFORMER

1. SCOPE

This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3 phase 11 kV/433-250 V and 33 kV/433-250 V distribution transformers for outdoor use. It is not the intent to specify completely herein all the details of the design and construction of equipment. However the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance herewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

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.

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

2. STANDARD RATINGS:

The standard ratings shall be 10, 16, 25, 63, 100, 160, 200, 250, 315, 400, 500, 630, 1000, 1250, 1600, 2000 and 2500 kVA for 11 kV distribution transformers and 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600, 2000, 2500 kVA for 33 kV distribution transformers.

3. STANDARDS:

The materials shall conform in all respects to the relevant Indian/International Standards, with latest amendments thereof unless otherwise specified herein. Some of them are listed below:

Indian Title International and Standard	Recognized standards
IS -2026 Specification for Power Transformers IEC 76	
IS - 1180 Outdoor distribution Transformer up to and including 100 kVA	
IS 12444 Specification for Copper wire rod ASTM B-49	
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 better quality than the standards mentioned above, would also be acceptable. In case the bidders who wish to offer material conforming to other standards, the bidder shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

4. SERVICE CONDITIONS:

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

i)	Location	:	At various locations in the country
ii)	Maximum ambient air temperature (°C)	:	50
iii)	Minimum ambient air temperature (°C)	:	- 5
iv)	Maximum average daily ambient air temperature (°C)	:	40
v)	Maximum yearly weighted average ambient temperature (°C)	:	32
vi)	Maximum altitude above mean sea level (Metres)	:	To be specified by the user

Note:

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

5. PRINCIPAL PARAMETERS:

The transformers shall be suitable for outdoor installation with three phase, 50 Hz, 11 kV or 33 kV system in which the neutral is effectively earthed and they should be suitable for service with fluctuations in supply voltage upto plus 12.5% to minus 12.5%.

The transformers shall conform to the following specific parameters :

Sl. No.	Item	11 kV Distribution transformers	33 kV Distribution transformers
1.	System voltage (max.)	12 kV	36 kV
2.	Rated voltage HV	11 kV	33 kV
3.	Rated voltage LV	433	433-250 V
4.	Frequency 50 Hz	+/- 5%*	50 Hz +/- 5%
5.	No. of Phases	Three	Three
6.	Connection HV	Delta	Delta
7.	Connection LV	(Neutral Star brought out)	(Neutral Star brought out)
8.	Vector group	Dyn-11	Dyn-11
9.	Type of cooling	ONAN	ONAN

* The voltage level can be specified as 415-240 V/400-230 V volts as per the requirements of the purchaser.

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

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

Minimum guaranteed weight of core, conductor, Transformer oil & minimum thickness of tank sheet shall be as following:-

Sl. No.	Capacity	Minimum Weight of Material			Minimum Thickness of Tank (mm)	
	KVA	Core (Kg.)	Conductor (kg.)	Oil (kg.)	Top & Bottom	Side
1	400	620	390	387	6	4

6. TECHNICAL REQUIREMENTS:

6.1 CORE MATERIAL - CRGO

6.1.1 CRGO Material

- 6.1.1.1 The core shall be **stack type** 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 core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer. **Flux density shall not be more than 1.69 Tesla**
- 6.1.1.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage.
- 6.1.1.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall furnish necessary design data in support of this situation.
- 6.1.1.4 No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at 433 volts, 50 Hz on the secondary. Increase of voltage of 433 volts by 12.5% shall not increase the no-load current by 6% (maximum) of full load current.
- 6.1.1.5 **The name of the manufacturer and unique no allotted to him shall also be punched at a visible portion on the core assembly of each transformer.**

7. WINDINGS:

7.1 Material:

- 7.1.1 **HV and LV windings shall be wound from Double Paper covered copper winding wire.**
- 7.1.2 **HV and LV windings wound from Super Enameled copper winding wire shall not be considered.**
- 7.1.3 HV and LV windings shall be wound from Double Paper covered copper conductor/foil winding for ratings above 100 kVA.
- 7.1.4 LV winding shall be such that neutral formation will be at top.
- 7.1.5 The winding construction of single HV coil wound over LV coil is preferable.

- 7.1.6 Inter layer insulation shall be Nomex /Epoxy dotted Kraft Paper.
- 7.1.7 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted.
- 7.1.8 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars .
- 7.1.9 Current density for HV and LV winding should not be **more than 2.5 Ampere per sq mm for copper** and **1.4 Ampere per sq mm** for Aluminium Conductor.
- 7.1.10 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 7.1.11 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

8. TAPS:

No tapping shall be provided for transformers .

9. OIL:

- 9.1 The insulating oil shall comply with the requirements of IS 335 or BS 148. Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than $2.5 \times 10_{12}$ ohm-cm at 27₀C when tested as per IS 6103.
- 9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.
- 9.3 The oil shall be filled under vacuum.
- 9.4 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

10 INSULATION LEVELS:

Sl.No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency (Voltage kV)
1.	0.433	–	3
2.	11	95	28
3.	33	170	70

11 LOSSES:

- 11.1 The bidder shall guarantee individually the no-load loss and load loss without any positive tolerance. The bidder shall also guarantee the total losses at 50% and 100% load condition (at rated voltage and frequency and at 75₀C).
- 11.2 The maximum allowable losses at rated voltage and rated frequency permitted 75₀C for 11/0.433 kV transformers can be chosen by the utility from the values of 3 star, 4 star or 5 star rating for transformers up to rating of 200 kVA as indicated below:

Voltage Ratio 11000/433-250 V	Rating (kVA)	3 Star		4 Star		5 Star	
		Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)
11000/433-250 V	16	150	480	135	440	120	400
11000/433-250 V	25	210	695	190	635	175	595
11000/433-250 V	63	380	1250	340	1140	300	1050
11000/433-250 V	100	520	1800	475	1650	435	1500
11000/433-250 V	160	770	2200	670	1950	570	1700
11000/433-250 V	200	890	2700	780	2300	670	2100

- 11.2.1 For transformers of other ratings the following maximum allowable losses at rated voltage and frequency and at 75₀C shall be taken:

Voltage Ratio	Rating (kVA)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)
11000/433-250 V	10	98	300
11000/433-250 V	250	1050	3320
11000/433-250 V	315	1100	3630
11000/433-250 V	400	1450	4630

11000/433-250 V	500	1600	5500
11000/433-250 V	630	2000	6640
11000/433-250 V	1000	3000	9800
11000/433-250 V	1250	3600	12000
11000/433-250 V	1600	4500	15000
11000/433-250 V	2000	5400	18400
11000/433-250 V	2500	6500	22500
33000/433-250 V	100	560	1820
33000/433-250 V	160	780	2580
33000/433-250 V	200	900	3000
33000/433-250 V	315	1300	4300
33000/433-250 V	400	1520	5100
33000/433-250 V	500	1950	6450
33000/433-250 V	630	2300	7600
33000/433-250 V	1000	3450	11350
33000/433-250 V	1250	4000	13250
33000/433-250 V	1600	4850	16000
33000/433-250 V	2000	5700	18500
33000/433-250 V	2500	7050	23000

11.3 Whenever the star ratings for the above transformers become available the values of 3 star, 4 star or 5 star could be taken by the utility. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above.

12 TOLERANCES:

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

13 PERCENTAGE IMPEDANCE:

The value of impedance of transformers at 75°C shall be 4.5% for transformers up to and 200 kVA and for ratings above 200 kVA shall be in accordance with IS 2026.

14 TEMPERATURE RISE: The temperature rise over ambient shall not exceed the limits given below:

14.1.1 Top oil temperature rise measured by thermometer : 35°C

14.2 Winding temperature rise measured by resistance method : 40°C

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

14.3 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.

15 PENALTY FOR NON PERFORMANCE:

15.1 During testing at supplier's works if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.

15.2 Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.

15.3 Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance.

16. INSULATION MATERIAL:

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

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

17 TANK:

The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

All joints of tank and fittings shall be oil tight and no bulging should occur during service.

Inside of tank shall be painted with varnish/hot oil resistant paint.

The top cover of the tank shall be slightly sloping to drain rain water.

The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

18 PLAIN TANK:

18.1 The transformer tank shall be of robust construction rectangular/octagonal /round/ elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 3.15 mm for the bottom and top and not less than 2.5 mm for the sides for distribution transformers upto and including 25 kVA, 5.0 mm and 3.15 mm respectively for transformers of more than 25 kVA and up to and including 100 kVA and 6 mm and 4 mm respectively above 100 kVA.

18.2 In case of rectangular tanks above 100 kVA the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm² for 30 minutes. In case of transformers of 100 kVA and below, there shall be no joints at corners and there shall not be more than 2 joints in total.

18.3 Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/ sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747.

18.4 The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.

18.5 Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below:

(All figures in mm)

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

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

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

18.8 **Unique number, provided by the purchaser, has to be punched on the top cover and sidewall of transformer in visible condition. 'PVVNL PROPERTY' also to be punched below unique number on sidewall of the transformer tank.**

19. CONSERVATOR:

19.1 The conservator shall be provided on transformers of rating 63 kVA and above for plain tank and 200 kVA and above for corrugated tank. For other ratings transformers manufacturer may adopt their standard practice or follow utility's requirement. For sealed type transformers conservator is not required.

19.2 When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover. In addition, the cover of the

- main tank shall be provided with an air release plug.
- 19.3 The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 500g of silicagel conforming to IS 3401 for transformers upto 200 kVA and 1 kg for transformers above 200 kVA.
- 19.4 The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- 19.5 The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- 19.6 The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to -5₀C) should be above the sump level.

20 SURFACE PREPARATION AND PAINTING:

20.1 GENERAL: The transformer tank body shall be painted with **dark green** colour and the conservator shall be painted with **white colour**.

- 20.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 20.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used with prior approval of purchaser.

20.2 CLEANING AND SURFACE PREPARATION:

- 20.2.1 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.
- 20.2.2 Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).
- 20.2.3 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer to clearly explain such areas in his technical offer.

20.3 PROTECTIVE COATING:

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

20.4 PAINT MATERIAL:

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

20.5. PAINTING PROCEDURE:

- 20.5.1 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.
- 20.5.2 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%.

20.6. DAMAGED PAINTWORK:

- 20.6.1 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 was originally applied.
- 20.6.2 Any damaged paint work shall be made good as follows:
- 20.6.3 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- 20.6.4 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.
- 20.6.5 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

20.7 DRY FILM THICKNESS:

- 20.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour.
- 20.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer’s recommendation.
- 20.7.3 Particular attention must be paid to full film thickness at the edges.
- 20.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl. No.	Paint type Area to be painted		No. of coats	Total dry film thickness (min.) (microns)
1.	Thermo setting powder paint	Inside	01	30
2.	Liquid paint:			
	a) Epoxy (primer)	Outside	01	60
	b) P.U. Paint (Finish coat)	Outside	02	25 each
	c) Hot oil paint. Varnish	Inside	01	35/10

20.8 TESTS FOR PAINTED SURFACE:

- 20.8.1 The painted surface shall be tested for paint thickness.
- 20.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and Salt spray test and Hardness test as type test as per the relevant ASTM standards.

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

21. BUSHINGS:

- 21.1. The bushings shall conform to the relevant standards specified and shall be of outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for HT and 30 mm for LT bushings. The bushings shall be fixed to the transformers on side with straight pockets and in the same plane or the top cover for transformers above 100 kVA. For transformers of 100 kVA and below the bushing can be mounted on pipes. The tests as per latest IS 2099 and IS 7421 shall be conducted on the transformer bushings.

- 21.2 For 33 kV, 52 kV class bushings shall be used for transformers of ratings 500 kVA and above. And for transformers below 500 KVA, 33 kV class bushings, for 11 kV, 17.5 kV class bushings and for 0.433 kV, 1.1 kV class bushings shall be used.
- 21.3 Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.
- 21.4 Bushings of plain shades as per IS 3347 shall be mounted on the side of the Tank and not on top cover.
- 21.5 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.
- 21.6 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Voltage Clearance	Phase to Phase	Phase to earth
33 kV	350 mm	320 mm
11 kV	255 mm	140 mm
LV	75 mm	40 mm

The clearances in case of cable box shall be as below:

Voltage Clearance	Phase to Phase	Phase to earth
33 kV	351 mm	222 mm
11 kV	127 mm	76 mm
LV	45 mm	20 mm

The aforesaid clearances are minimum clearances and no negative tolerance on these clearances shall be allowed.

- 21.7 Lightning arrestors shall be provided on HV bushings.
- 21.8 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section – IX.
- 21.9 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.
- 21.10 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

22. TERMINAL CONNECTORS:

The LV and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561.

22.1 TERMINAL MARKINGS:

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

23 FITTINGS:

The following standard fittings shall be provided :

- i. Rating and terminal marking plates, non-detachable.
- ii. Earthing terminals with lugs - 2 Nos.
- iii. Lifting lugs for main tank and top cover
- iv. Terminal connectors on the HV/LV bushings (For bare terminations only).
- v. HV bushings - 3 Nos.
- vi. LV bushings - 4 Nos.
- vii. Pulling lugs
- viii. Stiffener
- ix. Radiators - No. and length may be mentioned (as per heat dissipation calculations)/ corrugations.
- x. Lightning Arresstor, 9 kV, 5 kA

- xi Prismatic oil level gauge.
- xii. Oil filling hole having p. 1- ¼ “ thread with plug and drain plug on the conservator.
- xiii Silicagel breather
- xiv. Base channel 75x40 mm for up to 100 kVA and 100 mmx50 mm above 100 kVA, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- xv. 4 No. rollers for transformers of 200 kVA and above.
- xvi. Pressure relief device or explosion vent.

NOTE : OIL DRAIN VALVE IS NOT TO BE PROVIDED

24 FASTENERS:

- 24.1 All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.
- 24.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.
- 24.3 All nuts and pins shall be adequately locked.
- 24.4 Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.
- 24.5 All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanising, 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.
- 24.6 Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.
- 24.7 The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- 24.8 Taper washers shall be provided where necessary.
- 24.9 Protective washers of suitable material shall be provided front and back of the securing screws.

25. OVERLOAD CAPACITY:

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

26. PROTECTION FEATURES:

Reputed make (L&T, Siemens, Havells, ABB etc.) externally mounted LT MCCB on the LV Side of the Transformer:

- 26.1 Externally Mounted LT Breaker on the LV Side of the Transformer:
- 26.2 **3 Pole 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 bidder shall furnish the time / current characteristics of LT circuit breaker and 11 kV fuses for various current multiples.
- 26.3 The two characteristics shall be drawn on the same sheet to indicate coordination between the circuit breaker and fuse. The bidder shall carry out coordination test as indicated above and this forms one of the tests for acceptance test.
- 26.4 The breaker shall be coordinated thermally with the transformer design to follow closely the variations of oil temperature due to fluctuating loads and ambient temperatures.
- 26.5 The breaker shall be mounted under the LT cable box in a separate closed chamber. The incomer to the MCCB shall be connected with the LT bushings through single core copper leads of adequate size, the wiring shall be dressed properly and shall not be visible from outside. The MCCB chamber shall be so designed that only ON/Off switch shall be exposed from the front.

The outgoing cable lead shall be exposed outside the MCCB box and shall terminate on separate terminals placed at least 50 mm apart so that Aluminum cable/leads can be connected easily without opening MCCB box. The MCCB shall be mechanically fixed on the transformer body in such a way that theft of MCCB is prevented at the installation site. The rate for LT cable box, MCCB and connecting arrangement shall be quoted separately.

- 26.6 Arrangements shall be provided to enable the circuit breaker to be closed and opened manually standing on ground.
- 26.7 The cross section of the current carrying parts of the breaker shall withstand the full load current density not more than 2.5 A/sq. mm (for additional mechanical strength the area should be more.)
- 26.8 Rated short circuit breaking capacity of the breaker shall not be less than 10 kA. The circuit breaker shall conform to IS 13947.
- 26.9 The detailed technical specification of MCCB are enclosed separately with the tender documents.

27. LIGHTNING ARRESTORS:

9 kV, 5 kA metal oxide lightning arrestors Distribution class type of reputed make as per relevant standard, one number per phase shall be provided to be fitted under the HV bushing with GI earth strip 25×4 mm connected to the body of the transformer with necessary clamping arrangement. The lightning arrestor with polymer insulator, in confirmation to the relevant IS, can also be used. The rates for lightning arrestors with connecting/fixing arrangement shall be quoted separately.

28. TESTS:

All the equipment offered shall be fully type tested by the bidder or his collaborator as per the relevant standards including the additional type tests. The type test must have been conducted on a transformer of same design **during the last five years** at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. Offers without type test reports will be treated as non-responsive.

- a. Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards.
- b. The requirements of site tests are also given in this clause.
- c. The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted with the bid.
- d. The procedure for testing shall be in accordance with IS1180/2026 as the case may be except for temperature rise test.
- e. Before despatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

29. ROUTINE TESTS:

- a. Ratio, polarity, phase sequence and vector group.
- b. No Load current and losses at service voltage and normal frequency.
- c. Load losses at rated current and normal frequency.
- d. Impedance voltage test.
- e. Resistance of windings at each tap, cold (at or near the test bed temperature).
- f. Insulation resistance.
- g. Induced over voltage withstand test.
- h. Separate source voltage withstand test.
- i. 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.
- j. Oil samples (one sample per lot) to comply with IS 1866.
- k. Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
- l. Pressure and vacuum test for checking the deflection.

30. TYPE TESTS TO BE CONDUCTED ON ONE UNIT

In addition to the tests mentioned in clause 28 and 29 following tests shall be conducted:

- m. Temperature rise test for determining the maximum temperature rise after continuous full

- n. load run. The ambient temperature and time of test should be stated in the test certificate. Impulse voltage test: with chopped wave of IS 2026 part-III. BIL for 11 kV shall be 95 kV peak instead of 75 kV.
- o. Short circuit withstand test: Thermal and dynamic ability.
- p. Air Pressure Test: As per IS – 1180.
- q. Magnetic Balance Test.
- r. Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.
- s. Noise-level measurement.
- t. Measurement of zero-phase sequence impedance.
- u. Measurement of Harmonics of no-load current.
- v. Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq cm absolute (250 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

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

31. ACCEPTANCE TESTS:

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

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.

32. INSPECTION:

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

33. INSPECTION AND TESTING OF TRANSFORMER OIL

- a. To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative.
- b. To ensure about the quality of transformers, the inspection shall be carried out by the purchaser's representative at following two stages:-
 - 33.b.1 Online anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.
 - 33.b.2 At finished stage i.e. transformers are fully assembled and are ready for despatch.
- c. The stage inspection shall be carried out in accordance with **Annexure-II**.
- d. After the main raw-material i.e. core and coil material and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, as far as possible within seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled (only in case of CRGO material) to ensure that the CRGO laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating about the readiness of transformers, for final inspection for carrying out tests as per relevant IS shall be sent by the firm along with Routine Test Certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection. The proforma for pre delivery inspection of Distribution transformers is placed at **Annex- III**.
- e. In case of any defect/defective workmanship observed at any stage by the purchaser's Inspecting Officer, the same shall be pointed out to the firm in writing for taking remedial measures. Further processing should only be done after clearance from the Inspecting Officer/ purchaser.

- f. All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the Inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as Active Part Inspection during Acceptance Tests.
- g. The manufacturer shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical /electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.
- h. Purchaser shall have every right to appoint a third party inspection to carry out the inspection process.
- i. The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser has every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.

34. QUALITY ASSURANCE PLAN:

- a. 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.
- b. 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.
- c. Information and copies of test certificates as above in respect of bought out accessories.
- d. List of manufacturing facilities available.
- e. Level of automation achieved and list of areas where manual processing exists.
- f. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.
- g. List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports. These shall be furnished with the bid. Manufacturer shall possess 0.1 accuracy class instruments for measurement of losses.
- h. Quality Assurance Plan (QAP) with hold points for purchaser's inspection.
- i. The successful bidder shall within 30 days of placement of order, submit following information to the purchaser :
- j. List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- k. Type test certificates of the raw materials and bought out accessories.
- l. 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.

35. DOCUMENTATION:

- a. The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.
- b. Dimensional tolerances.
- c. Weight of individual components and total weight.
- d. An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.
- e. Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.
- f. Typical general arrangement drawing showing both primary and secondary sides and end-elevation and plan of the transformer.

36. PACKING AND FORWARDING:

- a. The packing shall be done as per the manufacturer's standard practice. However, it should

be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.

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

37. MANADATORY SPARES:

Mandatory spares shall be supplied as per the purchaser’s requirement.

38. GUARANTEE:

- a. The manufacturers of the transformer shall provide a guarantee of **66 months** from the date of receipt at the stores of the Utility or **60 months** from the date of commissioning, whichever is earlier. In case the distribution transformer fails within the guarantee period the purchaser will immediately inform the supplier who shall take back the failed DT within 15 days from the date of the intimation at his own cost and replace/repair the transformer within forty five days of date of intimation with a roll over guarantee.
- b. The outage period i.e. period from the date of failure till unit is repaired/replaced shall not be counted for arriving at the guarantee period.
- c. In the event of the supplier ’s inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

39. SCHEDULES:

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

Schedule-A : Guaranteed Technical Particulars

Schedule-B : Schedule of Deviations

40. DEVIATIONS:

- a. The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit with his bid in the relevant schedule a detailed list of all deviations without any ambiguity. In the absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specifications and no post-bid negotiations shall take place in this regard.
- b. The discrepancies, if any, between the specification and the catalogues and / or literatures submitted as part of the offer by the bidders, shall not be considered and representations in this regard shall not be entertained.
- c. If it is observed that there are deviations in the offer in guaranteed technical particulars other than those specified in the deviation schedules then such deviations shall be treated as deviations.
- d. All the schedules shall be prepared by vendor and are to be enclosed with the bid.

41. GUARANTTED PARAMETERS

Capacity	Minimum Weight of Material			Max. Losses (Watts)		Minimum Thickness of Tank (mm)		
	KVA	Core (kg)	Conductor (kg)	Oil (kg)	50% Loading	100% Loading	Top & Bottom	Side
400	620	390	387		1225	3450	6	4

***Flux density shall not be more than 1.69 tesla**

No negative tolerances shall be allowed on above parameters. The offer of the firms whose GTP does not meet the above requirements shall be summarily rejected.