

ANNEXURE -I
TECHNICAL SPECIFICATION

**160 kVA, 250 kVA, 315 kVA & 500 kVA , 1 star 3-Phase Distribution
Transformers 11 kV/433-250V**

**(Out
door
Type)**

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 distribution transformers for outdoor use.
- The equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.
- 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 STANDARDS:

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

2.2

Indian Standards	Title	International Standards
IS -2026	Specification for Power Transformers	IEC 76
IS 1180 (Part-I): 2014	Outdoor Type Oil Immersed Distribution Transformers upto and including 2500kVA, 33kV-Specification	
IS 12444	Specification for Copper wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	IEC Pub296

IS-5	Specification for colors for ready mixed paints	
IS -104	Ready mixed paint, brushing zinc chromate, priming	

IS-2099	Specification for high voltage porcelain bushing	
IS-649	Testing for steel sheets and strips and magnetic circuits	
IS-3024	Cold rolled grain oriented electrical sheets and strips	
IS -4257	Dimensions for clamping arrangements for bushings	
IS -7421	Specification for Low Voltage bushings	
IS -3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS -5484	Specification for Al Wire rods	ASTM B - 233
IS -9335	Specification for Insulating Kraft Paper	IEC 554
IS -1576	Specification for Insulating Press Board	IEC 641
IS -6600	Guide for loading of oil Immersed Transformers	IEC 76
IS -2362	Determination of water content in oil for porcelain bushing of transformer	
IS -6162	Paper covered Aluminium conductor	
IS -6160	Rectangular Electrical conductor for electrical machines	
IS -5561	Electrical power connector	
IS -6103	Testing of specific resistance of electrical insulating	
IS -6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS -6792	Determination of electrical strength of insulating oil	
IS -10028	Installation and maintenance of transformers.	

3. SERVICE CONDITIONS:

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

i)	Location	:	At various locations in the country
ii)	Maximum ambient air temperature (OC)	:	50

iii)	Minimum ambient air temperature(OC)	:	-5
iv)	Maximum average daily ambient air temperature (OC)	:	40
v)	Maximum yearly weighted average ambient temperature(OC)	:	32

Maximum altitude of 1000 meters above mean sea level .

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

4. PRINCIPAL PARAMETERS:

4.1 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 with fluctuations in supply voltage upto plus 12.5% to minus 12.5%.

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

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

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

kVA rating	Audible sound levels(decibels)
101-300	55
301-500	56

TECHNICAL REQUIREMENTS:

5. CORE MATERIAL

5.1 The core shall be stack / wound type of high grade Cold Rolled Grain Oriented 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.

- 5.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at [http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto %20420%20kV-CM%20List.pdf](http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf)
- 5.3 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.
- 5.4 No-load current above 200 kVA up to 500kVA shall not exceed 2% of full load current and for 160 kVA shall not exceed 3% of full load current, and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no- load current by 5% of full load current.
- 5.5 Please refer to "**Check-list for Inspection of Prime quality CRGO for Transformers**" attached at Annexure-A. It is mandatory to follow the procedure given in this Annexure.
- 6.0) **WINDINGS:**
- Material:**
- 6.1 HV and LV windings shall be wound from Double Paper covered Aluminum conductor.
- 6.2 LV winding shall be such that neutral formation will be at top.
- 6.3 The winding construction of single HV coil wound over LV coil is preferable.
- 6.4 Inter layer insulation shall be Nomex /Epoxy dotted Kraft Paper.
- 6.5 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted.
- 6.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars (GTP Schedule I).
- 6.7 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 6.8 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.
- 7.0) **TAPPING RANGES AND METHODS:**
- 7.1 The tapping shall be as per provisions of IS: 1180 Part-I (2014).
- 7.2 Tap changing shall be carried out by means of an externally operated self-position switch and when the transformer is in de-energised condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Arrangement for pad

8.0) OIL:

- 8.1 The insulating oil shall comply with the requirements of IS 335. Use of recycled oil is not acceptable. The specific resistance of the oil shall be as per IS 335.
- 8.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.
- 8.3 The oil shall be filled under vacuum.
- 8.4 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.

9.0) INSULATION LEVELS:-

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

10.0) LOSSES:

- 10.1 The transformer of HV voltage up to 11kV, the losses shall be as below.

Rating of the Transformer	Total losses (no-load + load losses at 75°C) at 50% of rated load (watts)	Total losses at 100% of rated load (watts)
160kVA Distribution Transformer	670	1950
250kVA Distribution Transformer	980	2930
315kVA Distribution Transformer	1025	3100
500kVA Distribution Transformer	1510	4300

- 10.2. The above losses are maximum allowable and there would not be any positive tolerance. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. Offers with losses lower than the maximum allowable losses will be evaluated on total owning cost basis in accordance with methodology given in Annex-I (A).

11.0) TOLERANCES:

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

- 12.0) PERCENTAGE IMPEDANCE:-** The percentage impedance of transformers at 75°C for different ratings beyond 200kVA shall be as per Table 6 of IS 1180(Part-1):2014 and for 160 kVA Transformer shall be as per table 3 of IS 1180 part 2014.

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

- 13.1)** The permissible temperature rise shall be as per IS: 1180 (Part-I):2014.

- 13.2) The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

14.0) PENALTY FOR NON PERFORMANCE:

- 14.1 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.
- 14.2 Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.
- 14.3 Purchaser shall reject any transformer during the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance.

15.0) INSULATION MATERIAL:

- 15.1 Electrical grade insulation epoxy dotted Kraft Paper/Nomex and pressboard of standard make or any other superior material subject to approval of the purchaser shall be used.
- 15.2 All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations.

16.0) TANK:

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

i) **PLAIN TANK:**

- 16.2.1 The transformer tank shall be of robust construction, elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness not less than 6 mm for the bottom and top and 4mm for the sides for distribution transformers. Tolerances as per IS1852 shall be applicable. 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.
- (i) The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.

- (ii) Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below: (All figures are in mm)

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

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

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

17. CONSERVATOR:

- (i). Transformers with plain tank construction, the provision of conservator is mandatory.
- (ii). When a conservator is provided, oil guage 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 [32mm (1 1/4")] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug
- (iii). The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 500g of silica gel conforming to IS 3401 for transformers upto 200 kVA.
- (iv). The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total voloumn of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- (v). The cover or main tank shall be provided with an air release plug to enable air tapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- (vi). The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so

For Cable entry Type Transformers

The specification is same except. Instead of Bushings, Cable Chambers for LT and HT 11KV with suitable size shall be provided on both LT & HT sides, maintaining sufficient clearance as per CEA regulations.