

Technical Specification of 16 KVA Single Phase Oil Immersed Distribution Transformers (Outdoor Type)

1. SCOPE:

- 1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed naturally cooled 11 kV/240 V, 11/.../3 kV/240 V single phase distribution transformers for outdoor use.
- 1.2 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.
- 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 the 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.

1.5 STANDARD RATINGS

- 1.5.1 Standard ratings of single phase transformers shall be 5, 10, 16 and 25 kVA.

2. STANDARDS:

- 2.1 The materials shall conform in all respects to the relevant Indian Standard, with latest amendments thereof unless otherwise specified herein; some of them are listed below.
- 2.2 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 bidder who wishes 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.

3. **SERVICE CONDMONS:**

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,	
IS 12444	Specification for Conner wire rod	ASTM B-49
IS-335	Specification for Transformer/Mineral Oil	IEC Pub 296
IS-5	Specification for colors for ready mixed paints	
IS -104	Ready mixed paint, brushing zinc chromate,	
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	
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 8- 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	
IS - 6162	Pa=r covered Aluminum conductor	
IS - 6160	Rectangular Electrical conductor for electrical	
IS - 5561	Electrical power connector	
IS - 6103	Testing of specific resistance of electrical	
IS - 6262	Method of test for power factor and dielectric	
IS - 6792	Determination of electrical strength of insulating	
IS - 10028	Installation and maintenance of transformers.	

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) | Max ambient air temperature (OC) | 50 |
| iii) | Minimum ambient air temperature (QC) | -5 |

iv)	Maximum Average daily ambient	
	air temperature ($^{\circ}\text{C}$)	40
	Maximum Yearly weighted average	
v)	ambient temperature ($^{\circ}\text{C}$)	32
	Maximum altitude above 5000 meters	
	mean sea level (metres)	
vi)		

For HP, J&K, Uttarakhand, Sikkim,
Assam, Meghalaya,
Manipur, Nagaland, Tripura, Arunachal

The climatic conditions specified above are indicative and can be changed by the user as per requirements.

- 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:

- The Transformer shall be suitable for outdoor installation with single phase, 50 Hz, 11 kV systems in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 12.5% to minus 12.5%.
- The transformer shall conform to the following specific parameters. Rated HV side value (11 kV or 11/-./3 kV) shall be specified in the detailed bill of quantity by purchaser.

Sl.No.	Particulars	Parameters
1.	Continuous rated capacity	16 KVA
2.	System voltage (max.)	12KV
3.	Rated voltage HV	11 KV
4.	Rated voltage LV	240 V
5.	Frequency	50 c/s \pm 5%
6.	No. of phases	Single
7.	Vector Group	
8.	Type of transformer	Outdoor
9.	Type of cooling	ONAN
10.	Class of insulation	Class A
11.	Winding Material	Aluminium
12.	Material of core	CRGO/AMORPHOUS
13.	Type of core construction	Wound/Stack/Rectangular
14.	Over fluxing limit (due to combined effect of voltage and frequency)	12.5 %
15.	Permissible temperature over ambient under full load condition: i) Of top oil measured by thermometer ii) Of winding measured by resistance	35 Deg.C 40 Deg.C
16.	Minimum clearances in air a) Phase to earth (mm) H.T b) Phase to earth (mm) LT	140 40
17.	Total losses (watts) at 75 Deg. C. (Max.) (As per Energy Efficient level-2) i) At 50% loading ii) At 100% loading	82 Watts 224 Watts
18.	% age Impedance (with a tolerance of $\pm 10\%$)	4.0%
19.	Max. Flux Density at Normal voltage and frequency	1.47 Tesla
20.	Max. Current density	1.6 A/mm Sq
21.	ICB	Internally mounted
22.	Radiator required	Not required
23.	Magnetizing Current (max.) a) At 100% rated voltage b) At 112.5% rated voltage	1.5%+ 30% tolerance on 1.5% as per IS:2026 of rated full load current 3% + 30% tolerance on 3% as per IS:2026 of rated full load current

4.3 INSULATION LEVELS

Voltage (Volts)	Impulse Voltage (kV Peak)	Power Frequency (kV)
433	—	3
11000	75	28
11000/ $\sqrt{3}$	60	20

5. TECHNICAL REQUIREMENTS:**5.1 CORE MATERIAL:**

- 5.1.1 (A) CRGO MATERIAL:** Transformer core shall be wound core type/stack/rectangular type construction using prime grade imported M-4 or better high quality cold rolled grain oriented (CRGO) steel with heat resistant insulating coating/Amorphous Metal Core.

The core shall be properly stress relieved by annealing in inert atmosphere. The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 12.5% without injurious heating. The operating flux density shall be such that there is a clear safe margin over the fluxing limit of 12.5%.

CRGO Laminations used shall be of prime grade and not second grade steel laminations. Only those bidders who directly imported CRGO either from the manufacturer or through their accredited marketing organization of repute (and not through any agent) shall be considered.

ALTERNATIVE

B) AMORPHOUS METAL CORE: The core shall be made of high quality Amorphous ribbons having very low loss formed into wound or rectangular shape, bolted together 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 shall be clearly stated in the offer. Curve showing the properties of the metal shall be attached with the offer. 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 data in support of this situation.

Core clamping for Amorphous metal transformers.

- Core clamping shall be with top and bottom U-shaped core clamps made of sheet steel clamped with HT steel strap for efficient clamping.
- MS core clamps shall be painted with varnish or oil-resistant paint.
- Suitable provision shall be made in the bottom core clamp/bottom plate of the transformer to arrest movement of the active part.

NOTE: Equal weightage shall be given to the transformer with amorphous metal core and CRGO core.

- 5.1.2** 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>.

- 5.1.3** The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 12.5% without injurious heating. The operating flux density shall be such that there is a clear safe margin over the over fluxing limit of 12.5%.

- 5.1.4** No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.

- 5.1.5** 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.

5.2 WINDINGS MATERIALS:

- 5.2.1** HV and LV windings shall be wound from Aluminum/Copper conductors covered with double paper/enamel. The inter layer insulation shall be of nomex/epoxy resin dotted kraft paper.

- 5.2.2** Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength to be conducted.

- 5.2.3 The core coil assembly shall be dried in an oven. The type of winding shall be indicated in the tender. Whether LV windings are of conventional type or foil wound shall be indicated.
- 5.2.4 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in guaranteed technical particulars (GTP).
- 5.2.5 The core coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 5.2.6 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.

5.3 WINDING CONNECTION AND TERMINAL ARRANGEMENTS:

- 5.3.1 For 11 kV transformers both ends of primary winding shall be brought out through HV bushings. For 11/>3 kV transformers, neutral end of the primary HV winding shall be brought out for connecting to 'Neutral' supply wire through 1 kV bushings. There shall be provision for connecting 'Neutral' terminal, to local 'Earth' by way of a tinned Copper strip of adequate size and dimension. The secondary winding shall be connected to two LV bushings.

5.4 OIL:

- 5.4.1 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 not be less than 2×10^{12} ohm-cm at 27 °C when tested as per IS 6103.
- 5.4.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling
- 5.4.3 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.

6. LOSSES:

- 6.1 The bidder shall guarantee Individually the no-load loss and load loss without any positive tolerance. The bidder shall also guarantee the total losses (no load + load losses at 75 °C) at the 50% of rated load and total losses at 100% of rated shall not exceed the maximum total loss values given in Table-9 of IS 1180(Part-1):2014.

6.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75 °C for 11/0.433 kV transformers can be chosen by the utility as per **Table-9 for ratings 5,10, 16, 25kVA** as per **Energy Efficiency Level-2 specified in IS 1180 (Part-1): 2014** for single phase distribution transformers.

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

7. PERCENTAGE IMPEDANCE:

7.1 The percentage impedance of single-phase transformers at 75 °C for different ratings upto 25 kVA shall be as per Table 9 of IS 1180(Part-1):2014.

8. TEMPERATURE RISE:

8.1 The permissible temperature rise shall be as per IS: 1180

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

9. PENALTY FOR NON PERFORMANCE

9.1 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.

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

9.3 Purchaser shall reject any transformer during _the test at supplier's works, if the impedance values differ from the guaranteed values including tolerance and if they do not meet the requirements of clause 7.1

10. BUSHINGS:

10.1 The bushings shall be either porcelain or epoxy type and shall conform to the relevant standards specified. Polymer insulator bushings conforming with relevant IEC can also be used.

10.2 For HV, 12 kV class bushings shall be used and for LV, 1 kV class bushings shall be used.

- 10.3 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.
- 10.4 The HV bushings shall be fixed to the top cover of the transformer and the LV bushings shall be fixed to transformer on sides and in the same plane.
- 10.5 The bushing rods and nuts shall be of brass/stainless steel.
- 10.6 Arcing horns will be provided on HV bushings shall not have arcing horns and 1 clamp for LA shall also be provided for each HT bushing. Supply of LA is not included in DT supplier's scope.
- 10.7 Bushings shall be marked with manufacture(s name, month and year of manufacture.

11. BUSHING TERMINALS:

- 11.1 HV terminal shall be designed to directly receive ACSR conductor upto 7/2.59 mm (without requiring the use of lug) and the LV terminals shall be suitable for directly receiving LT cables (aluminum) ranging from 10 Sq mm to 25 Sq mm both in vertical and horizontal position and the arrangements should be such as to avoid bimetallic corrosion. Terminal connectors must be type tested as per IS 5561.

12. TANK:

- 12.1 The oil volume inside the tank shall be such that even under the extreme operating conditions, the pressure generated inside the tank does 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.
- 12.2 The tank cover shall have plasticized surface at the top to guard against bird faults. Alternately, suitable insulating shrouds shall be provided on the bushing terminals.
- 12.3 The Transformer tank shall be of robust construction round/rectangular in shape and shall be built up of tested CRCNMild Steel Sheet.
- 12.4 The tank shall be capable of withstanding a pressure of 1 kg/cm² (g) and a vacuum of 760 mm of Hg for 30 minutes without any permanent deflection (Air pressure test shall be conducted as per IS - IIS0(Part-I):2014.
- 12.5 The L - seam joint, C - seam joint and all fittings and accessories shall be oil tight and no deflection / bulging should occur during service.

- 12.6 Manufacturer should carry out the all the welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the Purchaser.
- 12.7 The circular bottom plate edges of the tank should be folded upward, for at least 25 mm, to have sufficient overlap with vertical sidewall of the transformer.
- 12.8 The Transformer tank and the top cover shall be designed in such a manner as to leave no external pockets in which water can lodge.
- 12.9 Tank shall have permanent lugs for lifting the transformer bodily and there shall be facilities for lifting the core coil assembly separately.
- 12.10 The transformer shall be provided with two mounting lugs suitable for fixing the transformer to a single pole by means of 2 bolts of 20 mm diameter as per ANSI C 57.12.20-1988.
- 12.11 Both mounting lugs are made with steel of minimum 5 mm thickness.
- 12.12 Jump proof lips shall be provided for upper mounting lug.
- 12.13 Mounting lug faces shall be in one plane.
- 12.14 Minimum Oil level mark shall be embossed inside the tank (at 250 C).
- 12.15 The top cover shall be fixed to the tank through clamping only.
- 12.16 HV bushing pocket shall be embossed to top side of the top cover so as to eliminate ingress of moisture and water.
- 12.17 The edges of the top cover shall be formed, so as to cover the top end of the tank and gasket.
- 12.18 Nitrite/ polyurethane /neoprene rubber gaskets' conforming to latest IS 4253 part-II shall be provided between tank and top cover.
- 12.19 The gaskets shall be continuous i.e. without any joint.

13. TANK SEALING:

- 13.1 The space on the top of the oil shall be filled with dry air or nitrogen. The nitrogen plus oil

volume inside the tank shall be such that even under extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative. The nitrogen shall conform to commercial grade of the relevant standards.

14. SURFACE PREPARATION AND PAINTING:

14.1 GENERAL

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

14.1.2 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.

14.2 CLEANING AND SURFACE PREPARATION:

14.2.1 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. Steel surfaces shall be prepared by Shot blast cleaning (IS 9954) to grade Sa. 2.5 of ISO 8501-1 or chemical cleaning including phosphating (IS 3618).

14.2.2 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.

14.2.3 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where shot blast cleaning is impractical. Manufacturer shall indicate such location, for purchaser's information, in his *offer*.

14.3 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.

14.4 PAINT MATERIAL:

Following 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:

- 14.4.1 The painting shall be as per Annexure-Paint which is attached herewith.
- 14.4.2 For external surfaces one coat of Thermo Setting paint or 1 coat of epoxy primer followed by 2 coats of polyurethane base paint. These paints can be either air-drying or stoving.
- 14.4.3 In case of highly polluted area, chemical atmosphere or at a place very near the sea coast, paint as above with one intermediate coat of high build MIO (Micaceous iron oxide) as an intermediate coat may be used to give a total dry film thickness of 150 to 180 microns.
- 14.5 **PAINTING PROCEDURE:**
- 14.5.1 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.
- 14.5.2 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. In all instances where two or more coats of the same paint are specified, such coatings may or may not be of contrasting colours.
- 14.5.3 **DAMAGED PAINTWORK:**
- 14.5.4 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 employed.
- 14.5.5 Any damaged paint work shall be made good as follows:
- 14.5.6 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- 14.5.7 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.
- 14.5.8 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

14.6 DRY FILM THICKNESS:

- 14.6.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Over spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour.
- 14.6.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.
- 14.6.3 Particular attention must be paid to full film thickness at edges.

14.7 TESTS:

- The painted surface shall be tested for paint thickness.
 - The painted surface shall pass the cross hatch adhesion test and impact test as routine test, Salt spray and Hardness test as type test as per the relevant ASTM standards.
- 14.8 The paint shade shall be as per Annexure-Paint which is attached herewith.

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

15. RATING AND TERMINAL PLATES:

- 15.1 Each transformer shall be provided with rating plate made of anodized aluminum/stainless steel material securely fixed on the outer body, easily accessible, showing the information given in Fig.2 of IS IIS0(Part-1):2014 for single phase transformers. The entries on the rating plates shall be indelibly marked by engraving.
- 15.2 Each transformer shall be provided with a terminal marking plate in accordance with Fig.5 of IS IIS0(Part-1):2014. The rating and terminal marking plates may be combined into one plate at the option of manufacturer.
- 15.3 The distribution transformer be marked with the Standard Mark and the use of Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and regulations made there under. As per Quality Control Order for Electrical Transformers- 2015, issued by Dept. of Heavy Industries, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).

16. PRESSURE AND VACCUM REQUIREMENTS:

- 16.1 Single phase transformers up to 25kVA, the transformer tank shall be of robust construction, round in shape shall be capable of withstanding a pressure of 100kPa and a vacuum of 760 mm of mercury.

17. FITTINGS:

- 17.1 The following standard fittings shall be provided :
- 17.1.1 Two earthing terminals with earthing symbol.
 - 17.1.2 Lifting lugs for the complete transformer as well as for core and winding assembly.
 - 17.1.3 HV side neutral grounding strip(where one of the bushing terminal is connected to earth).
 - 17.1.4 Rating and terminal marking plates.(Non detachable type)
 - 17.1.5 Pressure relief device or self-ventilating cover
 - 17.1.6 HV bushings.
 - 17.1.7 LV bushings.
 - 17.1.8 HV and LV terminal connectors.
 - 17.1.9 Top cover fixing clamps.
 - 17.1.10 Mounting lugs - 2 Nos.
 - 17.1.11 Bird guard.
 - 17.1.12 LV earthing arrangement.
 - 17.1.13 Any other fitting required as per IS: 1180 (Part 1)

18. FASTENERS:

- 18.1 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.

- 18.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.
- 18.3 All nuts and pins shall be adequately locked.
- 18.4 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.
- 18.5 All bolts/nuts/washers exposed to atmosphere should be as follows.
- a) Size 12 mm or below - Stainless steel
 - b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.
- 18.6 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.
- 18.7 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.
- 18.8 Taper washers shall be provided where necessary. Protective washers of suitable material shall be provided front and back of the securing screws.

19. OVER LOAD CAPACITY:

- 19.1 The transformer shall be suitable for loading as per latest IS 6600.

20. TESTS:

All the equipment offered shall be fully type tested by the bidder as per the relevant standards including the additional type tests mentioned at clause 23. The type test must have been conducted on a transformer of same design during the last five years at the time of bidding. The bidder shall furnish four sets of type test reports along with the offer. **In case, the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/ERDA/NTH**

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accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.

- 20.1 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards
- 20.2 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. However, if the same are not available at the time of bidding, the same may be submitted after order but before commencement of supply.
- 20.3 The procedure for testing shall be in accordance with IS 1180(Part-1): 2014/2026 as the case may be except for temperature rise.
- 20.4 Before dispatch each of the completely assembled transformer shall be subjected to the routine tests at the manufacturers works.

21. ROUTINE TESTS:

- 21.1 Ratio, polarity tests.
- 21.2 No load current and losses at service voltage and normal frequency.
- 21.3 Load losses at rated current and normal frequency.
- 21.4 Impedance Voltage test.
- 21.5 Resistance of windings cold(at or near the test bed temperature).
- 21.6 Insulation resistance.
- 21.7 Induced over voltage withstand test.
- 21.8 Separate source voltage withstand test. This test will not be applicable for single phase DTs with $11/\sqrt{3}$ kV as primary voltage.
- 21.9 Oil sample test (one sample per lot) to comply with IS 1866.
- 21.10 Air pressure test on empty tank as per IS 1180

22. TYPE TESTS TO BE CONDUCTED ON ONE UNIT:

In addition to the tests mentioned above following tests shall be conducted:

- 22.1 Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.
- 22.2 Impulse voltage withstand test: As per IS 2026 part-III. Basic insulation level (BIL) for 11 kV shall be 75 kV peak while for $11/\sqrt{3}$ kV, it will be 60KVp
- 22.3 Air pressure test: As per IS 1180 (Part-I):2014.
- 22.4 Short circuit withstand test: Thermal and dynamic ability.
- 22.5 Oil samples (Post short circuit and temperature rise test) - Only DGA & BDV test shall be conducted.
- 22.6 Noise level measurement.
- 22.7 Permissible flux density and over fluxing withstand test.
- 22.8 Type test certificates for the tests carried out on prototype of same specifications shall be Submitted along with the bid.
- 22.9 The purchaser may select the transformer for type tests randomly.

23. Short Circuit Test and Impulse Voltage Withstand Test: 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.

- 23.1 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un- tanking after a short circuit test.
- 23.2 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.
- 23.3 It may also be noted that the purchaser reserved the right to conduct short circuit test and impulse voltage test in accordance with the IS, afresh on each ordered rating at purchaser's 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 their 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.

24. TESTS AT SITE:

- 24.1 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.

25. ACCEPTANCE TESTS:

- 25.1 The transformers shall be subjected to the following routine/ acceptance test in the presence of purchaser's representative at the place of manufacture before despatch without any extra charges. The testing shall be carried out in accordance with IS 1180, Part-1 (2014) and IS 2026. Checking of mass, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP/QA plan and contract drawings.
- 25.2 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.
- 25.3 All tests as specified in clause 22.

26. INSPECTION:

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

26.1.5 Bill of entry certificate by custom.

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

26.2 To ensure about the quality of transformers, the inspection shall be carried out by the purchaser's representative at following stages:

26.2.1 Online anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.

26.2.2 When the raw material is received, and the assembly is in process in the shop floor.

26.2.3 At finished stage i.e. transformers are fully assembled and are ready for despatch.

26.3 After the main raw-materials i.e. core and coil materials 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 and as in clauses above, 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.

26.4 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.

26.5 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.

- 26.6 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.
- 26.7 Along with the bid the manufacturer shall prepare Quality Assurance Plan (QAP) 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.
- 26.8 Purchaser shall have every right to appoint a third party inspection to carry out the inspection process. 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 of supply. 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 penalise the manufacturer, which may lead to blacklisting among other things.

27. QUALITY ASSURANCE PLAN:

- 27.1 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 material offered.
- 27.2 Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of bidder's representative and copies of test certificates.
- 27.3 Information and copies of test certificates as above in respect of bought out accessories.
- 27.4 List of manufacturing facilities available.
- 27.5 Level of automation achieved and list of areas where manual processing exists.

- 27.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- 27.7 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 accuracy class instruments for measurement of losses.
- 27.8 Quality assurance plan with hold points for purchaser's inspection.
- 27.9 The successful bidder shall within 30 days of placement of order, submit following information to the purchaser.
- 27.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- 27.9.2 Type test certificates of the raw materials and bought out accessories.
- 27.10 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.
- 27.11 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Dept. of Heavy Industries, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1:(2014).

28. DOCUMENTATION:

- 28.1 Completely dimensioned drawings indicating general arrangement and details of fittings, clearances and winding details shall accompany the tender.
- 28.2 Drawings of internal constructional details and fixing details of coils should also be indicated. Tank dimensions, position of fittings, clearances between leads within the transformer, core grade of laminations, distance of core centers, area of conductor bare and with insulation. No. of coils, No. of turns per coil material of bushing metal parts etc., shall also be furnished with tender.

29. PACKING and FORWARDING:

- 29.1 The packing shall be done as per the manufacturer's standard practice.
However, he should ensure the packing is such that, the material should not get damaged during transit by rail/road.
- 29.2 The marking on each package shall be as per the relevant IS.

30. GUARANTEE:

The material will be guaranteed for a period of at least 60 calendar months from the date of installation at the site or 66 months from the date of receipt of material by the purchaser at the site/store, whichever is earlier, called the "maintenance period." If the material is damaged within the guaranteed period, it shall be replaced/repared by the supplier free of cost within one month of receipt of intimation.

If a transformer is damaged within above guarantee period, then the guarantee period of the repaired transformer will be extended by 24 months. The total guarantee period will now be 84/90 months as applicable."

Both stage and final inspection of at least 10-20 percent of the quantity of repaired transformer will be carried out at the manufacturer's works/local repairing center. The manufacturer has to inform the address of the local repairer in advance.

In case, the repair work/replacement of transformer is not effected within three months of the above notice/intimation the consignees will ensure deduction of the amount equal to the price of new transformer from pending bills of the contractor. Such defaults shall be taken into consideration by the consignees while evaluating and reporting the performance of the contractor.

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.

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.

Further, installation of 10 percent Distribution Transformers (both new and repaired) shall be carried out in the supervision of manufacturer's representative.

- 30.1 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.

Methodology for computing total owning cost

Annex-I

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

Note:

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

Annexure-Paint

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

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

Schedule II

**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/Copper			
3.	Insulated winding wires			
4.	Oil			
5.	Press boards			
6.	Kraft paper			
7.	MS plates/ Angles/Channels			
8.	Gaskets			
9.	Bushing HV/LV			
10.	Paints			

Annexure -A

Check-list for Inspection of Prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points needs to be checked by the Transformer manufacturer.

Utility's inspector shall verify all these points during inspection:-

i) **In case PRIME CRGO cutting is at works of Transformer Manufacturer:**

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/Authorised Agency
Manufacturer's test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of Origin

BIS Certification

Format for Reconciliation/Traceability records

Packing List No./date /Quantity of PRIME CRGO received

Name of Manufacturer

Manufacturer test certificate No./date

Serial No.	Details of Package/Job	Drawing reference	Quantity Involved	Commulative Quantity Consumed	Balance Stock

(i).1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils

Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging}.

Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.

ISI logo sticker on packed mother coil and ISI logo in Material TC.

- 2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3. Inspection of PRIME CRGO laminations: Transformer manufacturer will maintain records for traceability of laminations to prime CRGO coils and burr/bow on laminations shall be measured. Utility can review these records on surveillance basis.

4. Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/ rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in A.2.2 above.

Above tests shall be witnessed by Utility. In case testing facilities are not available at Manufacturer's work, the sample(s) sealed by Utility to be sent to approved labs for testing.

Inspection Clearance Report would be issue after this inspection

(i) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/ Authorised Agency

Purchase Order (unpriced) to Core Cutter

Manufacturer test certificate

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Deptt.

Reconciliation Statement as per format below

Certificate of origin

BIS Certification

Format for Traceability records as below:-

Packing List No./date /Quantity of PRIME CRGO received

Serial No.	Name of consumer	Details of Package/Job	Drawing reference	Quantity Involved	Commulative Quantity Consumed	Balance Stock	Dispatch

(ii) .1 Inspection of PRIME CRGO Coils:

PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils

Visual Inspection of PRIME CRGO Coils offered as per packing list (for verification of coil details as per Test certificate & healthiness of packaging).

Unique numbering inside of each sample of PRIME CRGO coil and verification of records to be maintained in the register for consumption of CRGO coil.

ISI logo sticker on packed mother coil and ISI logo in Material TC.

2.2. During inspection of PRIME CRGO, surveillance testing of sample shall be carried out for Stacking Factor, Permeability, Specific watt loss at 1.5 Tesla and/or 1.7 Tesla, thickness depending on the grade of PRIME CRGO and aging test etc. applicable as per relevant IS/ IEC standard, Tech. Spec., MQP and Transformer manufacturer plant standard.

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations:

Transformer manufacturer representative will inspect laminations and issue their internal Inspection Clearance Report. Inspection will comprise of review of traceability to prime CRGO coils, visual Inspection of PRIME CRGO laminations and record of burr/bow. After clearance given by transformer manufacturer, Utility will issue an Inspection Clearance Report after record review. If so desired by Utility, their representative may also join transformer manufacturer representative during this inspection.

Inspection Clearance Report would be issued after this inspection

vi) Inspection at the time of core building:

Visual Inspection of PRIME CRGO laminations. In case of suspected mix-up/rusting/decoloration, samples may be taken for testing on surveillance basis for tests mentioned in B.2.2.

Inspection Clearance Report would be issued after this inspection

NOTE:-

a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.

- 14.1 Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

a) General

If a surveillance sample is drawn and sent to TPL (if testing facility not available with the manufacturer), the Transformer manufacturer can continue manufacturing at their own risk and cost pending TPL test report on PRIME CRGO sample drawn. Decision for acceptance of PRIME CRGO shall be based upon report of the sample drawn.

These checks shall be read in-conjunction_ with approved Quality Plan, specification as a whole and conditions of contract.

Sampling Plan {PRIME CRGO}

33 / 11 kV

-1st transformer and subsequently at random 10% of

Transformers (min. 1) offered for inspection.

DTs and other ratings

-1st transformer and subsequently at random 2% of

Transformers (min. 1) offered for inspection.

NOTE:- One sample for each lot of CRGO shall be drawn on surveillance basis.

CRGO has to be procured only from POWERGRID approved vendors. List of such vendors is available at the following website. Since the list is dynamic in nature, the site may be checked from time to time to see the list of approved vendors.

<http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>