

**TECHNICAL SPECIFICATION FOR OUTDOOR TYPE 16 KVA, 11KV/250 V, SINGLE PHASE (Level-1 as per amended BIS) OIL IMMERSED COMPLETELY SELF PROTECTED (CSP) DISTRIBUTION TRANSFORMERS**

**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 16 KVA, 11KV/250V, single phase Completely Self Protected (CSP) distribution transformers for outdoor use.
- 1.2 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 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.

**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.

<b>Indian Standards</b>	<b>Title</b>	<b>International and Internationally recognised standards</b>
IS 2026 (Part-I to IV)	Specification for Power Transformers	IEC-76
IS1180 (Part 1 and 2)	Outdoor Three Phase Distribution Transformers	
IS 335	Specification for Transformer Oil	BS 148/ASTM D1275, D1533, IEC Pub 296
IS 3070	Specification for Lightning Arresters	IEC 99-1
IS 6600	Guide for loading of oil immersed transformers	IEC 76
IS 2099	High Voltage Porcelain Bushings	IEC 137
IS 9335	Specification for Insulating Kraft Paper	IEC 554
IS 1576	Specification for Insulating Press Board	IEC 641
IS 5	Specification for colors for ready mixed paints	
IS 13947 (Part 2)	Specification for LT Circuit Breaker	IEC 947-2
IS 12444	Specification for Copper wire rod	ASTM B-49
IS 104	Ready mixed paint, brushing zinc chromate, priming	
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 5484	Specification for Al Wire rods	ASTM B - 233
IS 2362	Determination of water content in oil for porcelain bushing of transformer	
IS 6162	Paper covered aluminum 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

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 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)  | Max 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 (meters)           | : | To be specified by 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

#### 4 PRINCIPAL PARAMETERS:

- 4.1 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%.
- 4.2 The transformer shall conform to the following specific parameters. Rated HV side value (11 kV or  $11/\sqrt{3}$  kV) shall be specified in the detailed bill of quantity by purchaser.

Sl.No.	ITEM	SPECIFICATION
1.	System voltage (max)	7/ 12 kV
2.	Rated voltage HV	$11/\sqrt{3}$ or 11 kV
	Rated voltage LV	230 V*
3.	Frequency	50 Hz +/- 5%
4.	No. of Phases	Single
5.	Type of cooling	ONAN

\*The voltage level can be specified as 240/250 volts as per the requirements of the purchaser.

#### 4.3 INSULATION LEVELS

Voltage volts	Impulse Voltage (kV Peak)	Power Frequency (kV)
433	-	3
11000	95	28

#### 5 TECHNICAL REQUIREMENTS:

##### 5.1 CORE MATERIAL:

- 5.1.1 Transformer core shall be stack core type construction using new and high quality cold rolled grain oriented (CRGO) steel with heat resistant insulating coating. The minimum weight of core lamination, for different type of transformers, shall be as follows:-

Sl No.	Particulars of Transformers	Min Guaranteed weight (Kg)
1.	CRGO Core Rectangular (Core Type)	48

**The max allowable flux density shall be not more than 1.69 tesla.**

- 5.1.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage.
- 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 **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.**

## **5.2 WINDINGS:**

- 5.2.1 HV and LV windings shall be wound from Al. conductors covered with double paper/enamel. The inter layer insulation shall be of nomex/epoxy resin dotted kraft paper.  
The minimum weight of Al Conductor, for different type of transformers, shall be as follows-

Sl No.	Particulars of Transformers	Min Guaranteed weight (Kg)
1.	CRGO Core Rectangular (Core Type)	28

**The max allowable current density shall be not more than 1.4 Amp/sq mm.**

- 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 1.1 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 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 27 °C when tested as per IS 6103.

The minimum weight of Oil, for different type of transformers, shall be as follows:-

SI No.	Particulars of Transformers	Min Guaranteed weight (Kg)
1.	CRGO Core Rectangular (Core Type)	40.0

- 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 rates shall not exceed the maximum total loss values.
- 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, 25 KVA as per **Energy Efficiency Level-1 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.**

## **7 PERCENTAGE IMPEDANCE:**

- 7.1 The percentage impedance of single phase transformer at rated frequency and at 75°C shall be as per table-9 of IS 1180 Part-1 2014.

## **8 TEMPERATURE RISE:**

- 8.1 The temperature rise over ambient shall not exceed the limits given below:
- 8.2 Top oil temperature rise measured by thermometer : 35°C
- 8.3 Winding temperature rise measured by resistance method : 40°C
- 8.4 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, 1.1 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 & LV bushings shall be fixed on side walls of the transformers
- 10.5 The bushing rods and nuts shall be of brass/stainless steel.
- 10.6 The HV bushings shall not have arcing horns.
- 10.7 Bushings shall be marked with manufacturer's name, month and year of Manufacture.
- 10.8 **Bushings shall be min 40 mm above the upper yoke level.**

## **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 CRCA/Mild Steel Sheet. The min tank sheet thickness, for different type of transformers, shall be as follows:-

Sl No.	Particulars of Transformers	Min Thickness of top & Bottom sheet (mm)	Min Thickness of side sheet (mm)
1.	CRGO Core Rectangular (Core Type)	5.0	3.15

- 12.4 The tank shall be capable of withstanding a pressure of 1 kg/cm<sup>2</sup> (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 -1180 (Part-1) 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 25<sup>o</sup> 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 Nitrile/ 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.

12.20 Unique number, provided by the purchaser, has to be punched on the inside wall of 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.

### **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:**The transformer tank body shall be painted with **dark green colour**.

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. However, where ever airless spray is not possible, conventional spray shall be used with prior approval of Purchaser.

## **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.
- 14.2.2 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).
- 14.2.3 The pressure and volume of the compressed air supply for blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination to ensure that the cleaning process is not impaired.
- 14.2.4 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 Heat resistant paint (Hot oil proof) for inside surface / varnish.
- 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.

**14.6 DAMAGED PAINTWORK:**

- 14.6.1 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 employed.
- 14.6.2 Any damaged paint work shall be made good as follows:
- 14.6.2.1 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- 14.6.2.2 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.
- 14.6.2.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

**14.7 DRY FILM THICKNESS:**

- 14.7.1 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.
- 14.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer s recommendation.
- 14.7.3 Particular attention must be paid to full film thickness at edges.
- 14.7.4 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 (minimum )
1.	Thermo setting paint	inside	01	30 microns
		outside	01	60 microns
2.	<b>Liquid paint</b>			
	a) Epoxy (primer)	outside	01	30 microns
	b) Polyurethane base (Finish coat)	outside	02	25 microns each
	c) Hot oil paint / Varnish	inside	01	35 / 10 microns

**14.8 TESTS:**

- 14.8.1 The painted surface shall be tested for paint thickness.
- 14.8.2 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.

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

**15 RATING AND TERMINAL PLATES:**

- 15.1 There shall be a rating plate on the transformer containing the information given in the relevant Indian Standard. The HV winding terminals shall be marked 1U and 1N for  $11/\sqrt{3}$  kV HV winding. In case of 11 kV HV winding the terminal shall be marked as 1U 1V or as per purchaser s requirement. The corresponding secondary terminal shall be marked as 2u and 2n.

**16 PRESSURE RELEASE DEVICE:**

- 16.1 The transformer shall be equipped with a self sealing pressure release device designed to operate at a minimum pressure of 8 PSI (0.564 kg/ cm<sup>2</sup>). The pressure release device shall be provided in the low voltage terminating portion of the tank above top oil level. Alternatively a self ventilating type top cover can be provided.

**17 FITTINGS:**

- 17.1 The following standard fittings shall be provided :
  - 17.1.1 Two earthing terminals.
  - 17.1.2 Two lifting lugs.
  - 17.1.3 HT side neutral earthing strip.
  - 17.1.4 Rating and terminal marking plates.( Non detachable type)
  - 17.1.5 Metal oxide lightning arrester 9 kV, 5kA.
  - 17.1.6 Pressure relief device or self ventilating cover
  - 17.1.7 Circuit Breaker operating mechanism.
  - 17.1.8 Oil immersed LT circuit breaker (If internal), along with operating rod.
  - 17.1.9 HV fuse links.
  - 17.1.10 Signal light.

17.1.11 HV bushings.

17.1.12 LV bushings.

17.1.13 HV and LV terminal connectors.

17.1.14 Top cover fixing clamps.

17.1.15 Mounting lugs - 2 Nos.

17.1.16 Bird guard.

17.1.17 LV earthing arrangement.

17.1.18 Any other fitting necessary for satisfactory performance of the product.

**NOTE : OIL DRAIN VALVE IS NOT TO BE PROVIDED**

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

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

**20 PROTECTION: (for CSP transformers ) INTERNALLY MOUNTED, 'LT' BREAKER ON THE 'LV' SIDE OF THE TRANSFORMER:**

- 20.1 The transformer shall be completely self protected type as per the provision of CEA guidelines with the partial modification of employing LT Breaker on LT side of transformer only. All LT faults after the breaker shall be cleared by this breaker.
- 20.2 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.
- 20.3 The internal breaker is to be accomplished by connecting the breaker in series between the secondary winding and the secondary bushings. The breaker shall be located in the same oil as the core and coil assembly so that the bimetal are sensitive to the temperature of oil as well as the load current.
- 20.4 Arrangements shall be provided to enable **the circuit breaker to be closed and opened manually standing on ground.**
- 20.5 The cross section of the current carrying parts of the breaker shall withstand the full load current at a current density not more than 2.5 A/sq.mm (for additional mechanical strength the area should be more).
- 20.6 The circuit breaker shall have short circuit rating of 2.5 kA and shall conform to IS 13947.

**21. TESTS:**

- 21.1 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 issued from CPRI/ERDA/NTH. Offers without type test reports will be treated as non-responsive.
- 21.2 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards.
- 21.3 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.
- 21.4 The procedure for testing shall be in accordance with IS 1180/2026 as the case may be except for temperature rise.

- 21.5 Before despatch each of the completely assembled transformer shall be subjected to the routine tests at the manufacturers works.

**22 ROUTINE TESTS:**

- 22.1 Ratio, polarity tests.
- 22.2 No load current and losses at service voltage and normal frequency.
- 22.3 Load losses at rated current and normal frequency.
- 22.4 Impedance Voltage test.
- 22.5 Resistance of windings cold (at or near the test bed temperature).
- 22.6 Insulation resistance.
- 22.7 Induced over voltage withstand test.
- 22.8 Separate source voltage withstand test.
- 22.9 Breaker coordination test.
- 22.10 Oil sample test (one sample per lot) to comply with IS 1866.
- 22.11 Air pressure test on empty tank as per IS 1180

**23 TYPE TESTS TO BE CONDUCTED ON ONE UNIT:**

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

- 23.1 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.
- 23.2 Impulse voltage withstand test: As per IS 2026 part-III. Basic insulation level (BIL) for 11 kV shall be 95 kV peak instead of 75 kV.
- 23.3 Air pressure test: As per IS 1180 part-II.
- 23.4 Short circuit withstand test: Thermal and dynamic ability.
- 23.5 Oil samples (Post short circuit and temperature rise test)
- 23.6 Noise level measurement.
- 23.7 Permissible flux density and over fluxing withstand test.
- 23.8 Type test certificates for the tests carried out on prototype of same specifications shall be submitted along with the bid.

23.9 The purchaser may select the transformer for type tests randomly.

**24.10 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 accordance with the IS. 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 from ERDA/CPRI/NTH only.

24.11 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.

24.12 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.

24.13 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.

## **25 TESTS AT SITE:**

25.1 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.

## **26 ACCEPTANCE TESTS:**

26.1 The transformers shall be subjected to the following routine/ acceptance test in the presence of purchaser s representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS 1180 and IS 2026.

26.2 Checking of mass, dimensions, fitting and accessories, tank sheet thickness, oil Quality, material, finish and workmanship as per GTP/QA plan and contract drawings.

26.3 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.

26.4 All tests as specified in clause 22.

**27 INSPECTION:**

27.1 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 :

27.1.1 Invoice of supplier.

27.1.2 Mill s certificate.

27.1.3 Packing List.

27.1.4 Bill of landing.

27.1.5 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.

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

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

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

27.2.3 At finished stage i.e. transformers are fully assembled and are ready for dispatch.

27.3 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.

27.4 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.

- 27.5 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.
- 27.6 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.
- 27.7 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.
- 27.8 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 penalize the manufacturer, which may lead to blacklisting among other things.

## **28 QUALITY ASSURANCE PLAN:**

- 28.1 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.

- 28.2 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.
- 28.3 Information and copies of test certificates as above in respect of bought out accessories.
- 28.4 List of manufacturing facilities available.
- 28.5 Level of automation achieved and list of areas where manual processing exists.
- 28.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- 28.7 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.
- 28.8 Quality assurance plan with hold points for purchaser's inspection.
- 28.9 The successful bidder shall within 30 days of placement of order, submit following information to the purchaser.
  - 28.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
  - 28.9.2 Type test certificates of the raw materials and bought out accessories.
- 28.10 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.
- 28.11 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformer -2015, issued by Dept. of Heavy Industries, the Standard/ISI marking on Distribution Transformer is mandatory and the product should be manufactured in compliance with IS 1180 Part-1 : (2014).

## **29 DOCUMENTATION:**

- 29.1 Completely dimensioned drawings indicating general arrangement and details of fittings, clearances and winding details shall accompany the tender.

- 29.2 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.

### **30 PACKING and FORWARDING:**

- 30.1 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.
- 30.2 The marking on each package shall be as per the relevant IS.

### **31 MANADATORY SPARES:**

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

### **32 GUARANTEE:**

- 32.1 The manufacturers of the transformer shall provide a guarantee of 60 months from the date of receipt of transformer at the stores of the Utility. In case the DT fails within the guarantee period the the supplier will depute is representative within 15 days from the date of the intimation by utility for joint inspection. In case the failure is due to the reasons attributed to supplier, the transformer will be replaced/ repaired by the supplier within 45 days of date of intimation with a roll over guarantee.
- 32.2 The outage period i.e. period from the date of failure till unit repaired/replaced shall not be counted for arriving at the guarantee period.
- 32.3 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.

16. Minimum Weights of core, coil and conductor in offered 10 KVA Transformers shall be as follows:

Sl No.	Particulars of Transformers	Min Guarante ed weight of core(Kg)	Min Guaranteed weight of winding(Kg)	Min Guaranteed weight of oil(Kg)	Min Thickness of top & Bottom sheet (mm)	Min Thickness of side sheet (mm)
1.	CRGO Core Rectangular (Core Type)	48	28	40	5.0	3.15

**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.**

**33 L.T. Bushing Bus Bar Arrangement**

- This arrangement will include 2 nos. Aluminum Strips of size 160x25x4 mm each, one no. Bakelite strip of size 500x40x6 mm & 2 nos. Al. Lugs (16 mm<sup>2</sup>).
- External phase to phase clearance of Aluminum strips provided on L.T, side (as per Drawing) shall be min 100 mm.
- Al. Strips & Al. Lugs shall be drawn from EC grade Aluminum rods confirming to specification IS-5484-1978 or latest amendment thereof.
- Aluminum strips shall be bolted to L.T Bushing Rods with Nut- Bolt of Brass material.
- Aluminum lugs shall be bolted to Aluminum strips with good quality M.S. galvanized Nut-Bolts of size 12 mm as per IS specifications.

**34 External HT fuse unit** : This unit shall be provided on HT Bushing of the transformer as per enclosed drawing :-

**34.1** This unit will include –

- (a) 2 H.T. connectors of Aluminum material & size 12 mm each
- (b) 2 nos. Glass Fiber strips size 170x40x6 mm each
- (c ) 2 nos. H.T. Bras Rod size 12 mm each.

**34.2** External phase to phase clearance of Glass Fiber strips shall be min 255 mm.

**34.3** Glass Fiber strips should be made of good quality Glass Fiber material, which should be capable to withstand high voltages of 28 KV.

**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.**