

# **Technical Specification**

## **LT Transformer**

**[Technical Specification for 5 star rated (Energy efficiency level 2), 11/0.433kV, 3 Phase, 50 Cycle, LT Transformer of rating 250kVA and 100kVA]**

### **1.0 SCOPE:**

This specification covers design, engineering, manufacturing, shop testing, packing, dispatch, transportation inclusive of insurance & delivery for site basis, unloading, handling, storming, transportation at site upto foundation, oil filling & treatment, erection, testing & commissioning, civil works, supply of external cables & terminations as required, inspection and testing at works before supply of 3 phase 50Hz, core type, outdoor type, oil filled 11/0.433kV, 250kVA/100KVA transformers confirming to 5 star rating (energy efficiency level 3) of IS: 1180 (Part1): 2014 and IS: 2026 of as amended from time to time for outdoor use. 2x250KVA transformers are intended to be used in 220kV stations & 1x100MVA transformer is intended to be used in 110kV or 66kV stations.

It is not intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects of high standards of engineering, design and workmanship and latest revisions of relevant standards 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 judgement 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 bidders 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, manufacture 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.

The transformers shall be manufactured strictly as per specification, without any deviations.

### **2.0 General information:**

Bidders while specifying shall note that the owner may propose to insist on short circuit test as per Clause No. 16.11 of IS: 2026 (Part-1) & dielectric test as per IS: 2026. The type test certificate for the similar equipment not older than 5 years as on the last date of submission of Bid shall be furnished, otherwise owner may insist on conducting type test at the cost of contractor.

### **3.0 Qualifying requirements:**

Please refer Section-7 of bid documents.

#### 4.0 STANDARDS:

The transformer, accessories and associated equipments shall conform in all respects to the relevant Indian/International Standards, with latest amendments thereof unless other wise specified herein.

| <b>Indian Standard</b>        | <b>Title</b>   | <b>International and internationally recognized standards</b> |
|-------------------------------|--|---|
| IS:2026 (Part 1 to 5, 8 & 10) | Specification for Power Transformers   | IEC: 60076  |
| IS:1180 (Part1):2014          | Outdoor distribution transformer upto and including 2500KVA  |   |
| IS:12444                      | Specification for copper rod   | ASTM B-49   |
| IS:335/1993                   | Specification for transformer oil  | BS148, D-1473, D1533—1934, IEC 60296                          |
| IS:5/1944                     | Specification for colours for ready mixes colours  |   |
| IS:104/1979                   | Ready mixed paint, brushing zinc chromate, priming   |   |
| IS:2099/ 1986                 | Specification for high voltage porcelain bushing   | IEC - 60137, BS-223   |
| IS:649/1997                   | Testing for steel sheets and strips and magnetic circuits.   |   |
| IS:4257                       | Dimensions for clamping arrangements for bushings.   |   |
| IS:7421                       | Specification for low Voltage bushings   |   |
| IS:3347 (Parts I to IV)       | 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 60076   |
| IS:2362                       | Determination of water content in oil for porcelain bushing of transformer, by Karl fischer test method. |   |
| IS: 6160/197 1                | Rectangular electrical conductor for electrical machines.  |   |
| IS: 5561/197 0                | Electrical power connector.  |   |

|                                 |  |             |
|---------------------------------|--|-------------|
| IS: 6103/1971                   | Testing of specific resistance of electrical insulating liquids.                         |             |
| IS:6262/ 1971                   | Method of test for power factor and dielectric constant of electrical insulating liquids |             |
| IS:6792/1992                    | Determination of electrical strength of insulating oil.                                  |             |
| IS: 10028/1985 (Parts I to III) | Insulating and maintenance of transformers.  |             |
| IS: 10028                       | Selection, installation & maintenance of transformers.                                   |             |
| IS: 3401                        | Silica gel   |             |
| IS 3024                         | Grain orientated electrical steel sheets and strips                                      |             |
| IS 16585                        | Amorphous core material  |             |
| IS 191                          | Copper   |             |
| IS 1897                         | Copper strip for electrical purpose  |             |
| IS 7404 (Part1)                 | Paper covered copper conductors  |             |
| IS 13730                        | Specification for winding wires  |             |
| IS 2147                         | Degrees of protection provided by enclosures for low voltage switchgear and control gear |             |
| IS 4253                         | Cork & rubber  |             |
| IS 2705                         | Current Transformers   | IEC - 61869 |
| IS 778                          | Gun metal gate, globe and check valves for general purpose                               |             |

Materials conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the bidders who wish to offer material conforming to other standards, the bidder shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Five copies of such standards with authentic English translations shall be furnished along with the offer.

## **5.0 SYSTEM DETAILS:**

The transformers shall be suitable for outdoor installation with 3Phase, 50 Hz, 11kV System in which the neutral is effectively earthed and the same shall be suitable for service under fluctuations in supply voltage up to 12.5% permissible under Indian Electricity Rules and the frequency variation of -5% and +2% (47.5Hz to 51.0Hz).

## **6.0 CLIMATIC CONDITIONS:**

The material used in the construction of the Distribution transformers shall be suitable for use under the following climatic conditions.

- a. Ambient Air Temperature - 5° C to 50°C:

- b. Relative Humidity - 0 to 100%
- c. Altitude - A height above sea level not exceeding 1000m (3300ft)

**7.0 The transformers shall conform to the following Technical parameters.**

| Sl. No. | Item  | 11kV Distribution transformers |
|---------|---|--------------------------------|
| 1       | Type  | Two winding                    |
| 2       | Service   | Outdoor                        |
| 3       | System voltage (max)  | 12kV                           |
| 4       | Rated voltage - HV  | 11kV                           |
| 5       | Rated voltage (No load) - LV                                  | 433V                           |
| 6       | Rated Frequency   | 50Hz                           |
| 7       | Number of Phases  | Three                          |
| 8       | Rating  | 250kVA/100kVA                  |
| 9       | Connection - HV   | Delta                          |
| 10      | Connection - LV   | Star (Neutral brought out)     |
| 11      | Vector group  | Dyn11                          |
| 12      | Type of cooling   | ONAN as per IS 2026            |
| 13      | % impedance at 75°C   | 4.5%                           |
| 14      | Overload  | As per IS: 6600                |
| 15      | Maximum temperature rise over 50°C ambient                    |                                |
|         | a) Oil (Temperature rise measurement by thermometer)          | 50°C                           |
|         | b) Winding temperature rise measurement by resistance method) | 55°C                           |

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

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

**8.0 TECHNICAL PARAMETERS:**

**a) PERCENTAGE IMPEDANCE:**

The Percentage Impedance shall be 4.5% for transformers of 100KVA and 250KVA as per IS 1180 (Part 1): 2014 with tolerance as per IS: 2026.

**b) TEMPERATURE RISE:**

The permissible temperature rise shall not exceed the limits of 55°C when measured by resistance method for transformer winding and 50°C measured by the thermometer for top oil when tested in accordance with IS 2026 (part 2).

**c) INSULATION LEVELS:**

| Sl. No. | Voltage (kV) | Impulse Voltage<br>(kV Peak) | Power Frequency<br>Voltage (kV rms) |
|---------|--------------|------------------------------|-------------------------------------|
| 1       | 0.433        | –                            | 3                                   |
| 2       | 11           | 75                           | 28                                  |

**9.0 DESIGN & CONSTRUCTION:**

**9.1 Core material: CRGO/Amorphous metal**

**a) CRGO Material:**

- i) The core shall be of high grade Cold Rolled Grain annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The complete design of core must ensure permanency of the core losses with continuous working of the transformers. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.
- ii) Core clamping for CRGO:
  - 1) MS channel shall be used on top and bottom.
  - 2) Core Channel on LV side to be reinforced at equidistance, if holes/cutting is done for LT lead in order to avoid bending of channel.
  - 3) MS Channels shall be painted with varnish or hot oil resistant paint.
- iii) The transformer core shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall furnish necessary design data in support of this situation.
- iv) The nominal flux density in any part of the core shall not exceed 1.69 Tesla at 1.0 p.u. voltage and 1.9 Tesla at 1.1 p.u. voltage. The vendor shall furnish necessary design data in support of this stipulation.
- v) No load current shall not exceed 3% of full load current and will be measured by energizing the transformer at 433 volts, 50c/s on the secondary. Increase of secondary voltage of 433 volts by 12.5% shall not increase the no load current beyond 6% of full load current. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of  $a_n$ ,  $b_n$ ,  $c_n$  voltage will be carried out. Clamping and Tie-rods shall be made from HT steel & shall be parkarised.

**b) AMORPHOUS METAL:**

- i) The core shall be high quality Amorphous ribbons having very low loss formed into wound cores of rectangular shape, bolted together to the frames firmly to prevent vibration or noise. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the flux density allowed in the design shall be clearly stated in the offer. Curve showing the properties of the metal shall

- be attached with the offer.
- ii) Core clamping for Amorphous metal Transformers.
    - 1) Core clamping shall be with top and bottom U-shaped core clamps made of sheet steel clamped HT steel tie rods for efficient clamping.
    - 2) MS core clamps shall be painted with varnish or oil-resistant paint.
    - 3) MS rods shall be used as tie rods.
    - 4) Suitable provision shall be made in the bottom core clamp/bottom plate of the transformer to arrest movement of the active part.
  - iii) The transformer core shall be suitable for over fluxing (due to combined effect of voltage and frequency) upto 12.5% without injurious heating at full load conditions and shall not get saturated. The Bidder shall furnish necessary design data in support of this situation.

Flux density should not be more than 1.38 Tesla for Amorphous core.

- iv) No load current shall not exceed 2.5% of full load current and will be measured by energizing the transformer at 433 volts, 50 c/s on the secondary. Increase of voltage of 433 volts by 12.5% shall not increase the no load current by beyond 5% of full load current. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of  $a_n$ ,  $b_n$ ,  $c_n$  voltage will be carried out.
- v) The unbalance current in the neutral shall not be more than 2% of the rated current.

**Note: "Equal weightage shall be given to the transformers with Amorphous metal core & CRGO".**

## **9.2 WINDINGS:**

- 9.2.1 The winding of the transformer shall be connected in delta on the primary side and in star on the secondary side, so as to produce, a positive phase displacement of 30 degrees from the primary to the secondary vectors of the same phase. The neutral of the LT windings shall be brought out to a separate terminal. The vector group shall be Dyn11.
- 9.2.2 The conductor shall be electrolytic copper, free from scales and burrs. Super enamel covered copper conductor or double paper covered copper conductor shall be used.
- 9.2.3 Current density for HV & LV shall not be more than 2.5A/Sq.mm.
- 9.2.4 The manufacturer shall use appropriate HV/ LV winding cross-section so as to comply with the maximum losses at 50% load and at 100% load and temperature rise limits specified. The design details shall be furnished along with the GTP.

## **9.3 TANK:**

The internal clearance of tank shall be such that, it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.  
All joints of tank and fittings shall be oil tight and no bulging should occur during service.

Inside of tank shall be painted with varnished/hot oil resistant paint. Top cover of the tank shall be slightly slopping 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.

The rating and serial Nos of the transformer shall be embossed/punched on the tank of transformer/on transformer name plate, in addition to name plate details of transformer fitted to the transformer tank.

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 KPTCL.

The transformer tank shall be of robust construction and shall be built up of electrically tested welded mild steel top and bottom plates of thickness 5.00mm (3.15mm for 25kVA) and 3.15mm for the side wall thickness.

Suitable reinforcement by welded angle shall be provided on all the outside walls on the edge of the tank. The permanent deflection shall not be more than 5mm up to 750mm length and 6mm up to 1250mm length and 8mm up to 1750mm length when transformer tank without oil is subjected to Air pressure test as per IS:1180.

- a) Plain tank shall be capable of withstanding a pressure of 80kPa and vacuum 250mm of mercury (for 100kVA), 500mm of mercury (for 250kVA) without any deformation.
- b) Lifting lugs:  
4 Nos of welded heavy duty lifting lugs of M.S. Plate 8mm thick suitably reinforced by vertical supporting flat welded edgewise below the lug on the side wall shall be provided.
- c) Pulling Lugs:  
4 Nos. of welded heavy duty pulling lugs of M.S plate 8 mm thick shall be provided to pull the transformer horizontally.
- d) Top Cover Fixing Bolts & Gasket:  
Gaskets shall be made of Synthetic rubber or synthetic rubberized cork resistant to hot transformer oil confirming to IS 11149/Type C as per IS-4253 Part-II shall be placed between top cover plate and tank.
- e) Tolerance on tank dimensions shall be limited to -5% to + 10%.
- f) The radiators (1.25mm thick) can be tube type/fin type/pressed steel type to achieve the desired cooling & the same shall be capable of giving continuous rated output without exceeding the specified temperature rise.
- g) The tenderer shall submit the cooling calculation along with No. of radiators to be provided and type of fixing radiators to the transformer tank.
- h) The guaranteed temperature rise of oil and winding shall be found by conducting temperature rise test.



#### **9.4 CONSERVATOR:**

Conservators shall be provided on transformers of rating 100KVA and above

When a conservator is fitted, the oil gauge and dehydrating breathing device shall be fixed to the conservator which shall also be provided with a drain plug and a filling hole (1¼ nominal size thread) with cover. The capacity of the conservator shall be designed keeping in view the total quantity of oil and its contraction & expansion due to temperature variations.

- a) Prismatic oil level indicator shall be provided on the side which will be fully covered detachable flange with single neoprene gasket and tightened with M.S. bolts and nuts.
- b) The inside diameter of the pipe connecting the conservator to the main tank shall be within 20 to 50 mm and it should project into the conservator in such a way that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to - 5° C) should be above sump level.
- c) The pipe from conservator tank connecting to main tank shall be sloping so that the oil falling from the pipe shall not fall directly on the active parts and shall fall on the side walls only.
- d) The conservator shall be provided (except for 25KVA) with the drain plug and filling hole with cover. In addition, the cover of the main tank shall be provided with an air release plug (except for 25KVA).
- e) Conservator shall be provided in such a position as not to obstruct the electrical connection to the transformer.

#### **9.5 BREATHERS :**

Breather joints shall be of bolted type. It shall have die cast Aluminium body and inside container for Silicagel shall be of tin.

The breather shall have an inspection window to view the condition of the silicagel.

#### **9.6 TERMINAL ARRANGEMENT:**

- a) Bushing terminals shall be provided with suitable terminal connectors of approved type & Size for cable/overhead conductor termination of HV side & cable termination on LV side.
- b) The neutral terminals of 433V winding shall be brought out on a bushing along with the 433V phase terminals to form a 4-wire system for the 433V. Additional neutral bushing shall also be provided for earthing.

#### **9.7 CABLE BOXES:**

Whenever cable connections are required, suitable cable boxes shall be provided & shall be air insulated. They shall be of sufficient size to accommodate cables & shall have removable side/top cover to facilitate cable



termination & inspection. Cable boxes shall be dust & vermin proof.

### **9.8 MARSHALLING BOX:**

A Metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate oil & winding temperature indicators, terminal blocks, etc. It shall have a degree of protection of IP 55 as per IS: 13947.

### **9.9 OFF CIRCUIT TAP CHANGING EQUIPMENT:**

The tap changer switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

- a. Tappings shall be provided on HV voltage windings for variation of HV voltages as under.
  - Voltage Ratio : 11000/433V
  - No. of tap positions : 7
  - Range of variation : +5% to -10% in steps of 2.5% for variation of HV
- b. Tap changing shall be carried out by means of an externally operated self position switch and when the Transformer is in de-energized condition.
- c. Switch position No.1 shall be marked as 1 (High) shall correspond to the maximum voltage tap position, switch position No.3 shall be marked as 3 (normal) shall correspond to normal voltage tap position, switch position No. 7 shall be marked as 7 (Low) shall correspond to the minimum voltage tap position.
- d. Each tap change shall result in variation of 2.5% in voltage.
- e. Provision shall be made for locking the tap switch handle in position.

### **9.10 BUSHINGS:**

- I. For 11KV, 12KV Bushings (confirming to IS: 2099) shall be used and for 433 volts, 1.1KV terminal Bushings confirming to IS: 7421 shall be used. Bushings of the same voltage class shall be inter-changeable. The dimensions of Bushings shall be as per IS-3347. Creepage distance shall not be less than 25mm/KV as per IS: 2099.
- II. Brazing of all internal connections – All jumpers from windings to bushing shall have a cross section larger than the winding conductor. Silver brazing alloy to be used.
- III. The minimum phase to phase and phase to earth external clearances for HV & LV Bushings shall be as follows:

|             | External (air) Minimum clearances |                | Air clearances in Cable Box |                |
|-------------|-----------------------------------|----------------|-----------------------------|----------------|
|             | Phase to phase (in mm).           | Phase to earth | Phase to phase (in mm).     | Phase to earth |
| HV Bushings | 255                               | 140            | 130                         | 80             |
| LV Bushings | 75                                | 40             | 25                          | 20             |

### 9.11 TANK BASE CHANNEL:

- a) For 250 KVA transformers 100 x 50mm channel shall be used
- b) For 100 KVA transformers 75 x 40mm channel shall be used

Stiffeners (flats) shall be provided to tank base channels, along the length of the tank.

### 9.12 TERMINAL MARKING PLATE AND RATING PLATES:

The transformer shall be provided with a Anodized Aluminium/Stainless steel plate securely fixed on the outer body showing the relative physical position of the terminal and their markings. This shall be in accordance with IS: 1180(Part 1):2014. The transformers shall be provided with rating plate furnishing the information as specified in IS-1180(Part 1):2014

The Serial No., month and year of delivery shall be indicated on the rating plate. The rating plate shall be engraved type but not painted. These shall be punch marked on the transformer tank and also on the top cover.

## 10.0 LOSSES & IMPEDANCE:

The losses and impedance for various ratings of transformers of 11KV class shall be within the permissible limits. These losses are the maximum permissible.

| Rating (KVA) | Max. Losses at 50% loading (watts) | Max. Losses at 100% loading (watts) | Impedance % (subject to tolerance as per IS:2026) |
|--------------|------------------------------------|-------------------------------------|---|
| 250          | 920                                | 2700                                | 4.5   |
| 100          | 435                                | 1500                                | 4.5   |

#### A. TOLERANCE:

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

#### B. PENALTY FOR NON PERFORMANCE:

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.

Purchaser shall reject the entire lot during the test at suppliers works, if the temperature rise exceeds the specified values.

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

#### **11.0 TRANSFORMER OIL:**

The oil supplied with transformer shall be unused & have the parameters for unused new oil conforming to IEC: 60296 while tested at oil contractor's premises, no inhibitors shall be used in oil, 10% extra oil shall be supplied for topping up after commissioning in non-returnable containers suitable for outdoor storage.

#### **12.0 FITTINGS:**

The fittings on the transformers shall be as under.

- 1) Rating and Terminal marking plate - 1 No.
- 2) Earthing terminals minimum M12 - 2 Nos.  
with nuts should be provided on the tank
- 3) Lifting lugs for the complete transformer as well as for core & winding assembly - 4 Nos.
- 4) Cap for oil filling (on conservator) - 1 No.
- 5) Drain cum sampling valve (  $\frac{3}{4}$ " nominal thread size) with cover preferably steel with plug.
- 6) Conservator with drain plug and oil filling hole with blanking plate - 1 No.
- 7) Thermometer pocket - 1 No.
- 8) Air release plug on main tank.
- 9) Platform mounting channels.
- 10) Unidirectional flat rollers.
- 11) Inspection holes.
- 12) Pressure relief device or explosion vent.
- 13) Buchholz relay (for transformer above 200kVA).
- 14) Dehydrating breather: Silicagel breather with oil seal.

15) Oil level guage shall be provided indicating 3 positions of oil marked as below:

Minimum (-) - 5 degree C  
30 degree C  
Maximum (+) - 90 degree C

- 16) Off circuit tap switch with handle shall be provided with locking arrangement.
- 17) HV & LV bushings - 3 Nos. of HV bushings and 4 Nos. of LV bushings shall be provided with terminal connectors.
- 18) Winding temperature indicator.
- 19) Oil temperature indicator
- 20) Marshalling Box housing WTI & OTI.
- 21) Radiators.
- 22) Filter valve - 20mm dia shall be provided on the upper side of the tank.

**Note:** The fitting listed above are only indicative & any other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

### **13.0 SPARE PARTS:**

The list of spares for outdoor type transformers covered under this section shall be specified in section-1 (General).

In addition, the bidder shall also recommend optional spare parts & maintenance equipments necessary for 3 years of successful operation of the equipment. The prices of these shall be indicated in respective schedules & these shall not be considered for the purpose of evaluation.

### **14.0 TESTS:**

Type tested transformer shall be offered. The type test reports shall not be older than Five (5) years as on the last date of submission of bid.

#### **a) For Transformers manufactured in India:**

- i. The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii. The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation

body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

**b) For Transformers manufactured Abroad:**

- i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

In case of in-house type tested imported equipment of foreign OEM, the term “Purchasing Utility” covers the foreign Utility who has purchased that equipment

**14.1 Inspection&Testing:**

The contractor shall draw up & carry out a comprehensive inspection & testing program during manufacture & commissioning of the transformer. The programme shall be duly approved by the owner.

**14.2 Inspection:**

**14.3 Tank&Accessories:**

- a) Physical dimensional check of transformer tank & accessories.
- b) Crack- detection of major strength weld seams by dye penetration test.

**14.4 Core:**

- a) Physical inspection & check of quality of varnish, if used.
- b) Sample testing of core material for checking specific loss, bend properties, magnetization characteristics and thickness.
- c) Check on completed core measurement of iron loss, check for any hot spot by exciting the core so as to include the designed value of flux density in the core.
- d) HV Test

**14.5 Insulating-Material:**

- a) Sample checks for physical properties of the material
- b) Check for dielectric strength
- c) Check for the reaction of hot oil on insulating material.

14.6 Winding:

- a) Sampling checks on winding conductor for mechanical properties & electrical conductivity & on insulation covering.
- b) Sample check on 'insulation paper for pH value, bursting strength, Electric strength.

14.7 Assembled Transformer:  
Check complete transformer against approved outline drawing provision for all fittings, finish etc.,

14.8 Oil:

All standard tests in accordance with relevant standards shall be carried out on oil samples taken from the transformer before & after testing of the transformer. The contractor shall also prepare a comprehensive inspection & testing programme for all bought out sub-contracted items & shall submit the same to the owner for approval. Such programme shall include the following components:

- a) Bushings
- b) Marshaling Box
- c) Tap changer switch

**15.0 Factory test:**

15.1 All standard routine tests in accordance with latest issue of IS:2026 shall be carried out on each transformer.

15.2 In addition to all type & routine tests, following special tests shall also be carried out on one transformer of each rating as per IS: 2026.

- a) Determination of sound levels - IS:2026 (Part 10)
- b) No load current at 112.5% voltage- IS-1180 (part1)
- c) BDV & Moisture content of oil in the transformer - IEC 60296

15.3 All auxiliary equipment shall be tested as per the relevant IS. Test Certificates shall be submitted for bought out items.

15.4 High voltage withstand test shall be performed on auxiliary equipment & wiring after complete assembly.

15.5 Tank Tests:  
a) Routine Tests: As per CBIP Manual on Transformers.

- b) Type Tests: As per CBIP Manual on Transformers.  
 i) Vacuum Tests: As per CBIP Manual on Transformers.  
 ii) Pressure Tests: As per CBIP Manual on Transformers.
- 15.6 In addition to the above, the following checks should be carried out at manufacturer's works before dispatch for all transformers :
- a) Check for interchangeability of components of similar transformer & for mounting dimensions.
- b) Check for proper packing & preservation of accessories like radiators, bushings, explosion vent, dehydrating breather, conservator, etc.
- c) Check for proper provision to arrest the movements of core & winding assembly inside the transformer.
- 15.7 The contractor shall submit a detailed inspection & testing programme for field activities, covering areas right from the receipt of material stage upto commissioning stage as per IS: 1886 - code of practice for \*installation & maintenance of transformers. The indicative checks & tests are given below.
- a) Physical checks on each transformer on receipt at site for any damage or short supply
- b) Tests on oil samples.
- c) Oil leakage test.
- d) Physical checks for colour of silica in breather.
- e) Check for oil level in breather housing, conservator tank, etc.
- f) Check for correct operation of all protections & alarms.
- g) Insulation Resistance Measurement for Main Winding, Control wiring etc.
- h) Continuously observe the transformer operation at no load for 24 hours.

## 16.0 TOLERANCES:

Unless otherwise specified herein, the values of different parameters of the transformers supplied shall be within the tolerance permitted in the IS-2026 on the guaranteed values. Positive tolerance is not applicable for losses.

## 17.0 FINISHING:

The exterior of the transformer tank and other ferrous fittings shall be thoroughly cleaned, scrapped/sand blasted and given a priming coat and two finishing coats of durable oil, weather resistance paints or enamel. The colour of finishing coats for transformers shall be as follows, as per IS: 5.

- |                |                            |
|----------------|----------------------------|
| a) For 100 KVA | } Light grey shade No. 631 |
| b) For 500 KVA |                            |

## 18.0 GUARANTEED TECHNICAL PARTICULARS:

The guaranteed technical particulars as per Annexure I & II to be filled and submitted by the Tenderer. The transformers to be supplied against this order



shall have the value as per Technical specifications. Any deviation in GTP mentioned should be brought in the tender clause by clause.

#### **19.0 DOCUMENTARY EVIDENCE:**

The successful bidder shall have to furnish the routine test certificates along with the central excise gate pass and the purchase invoices for the purchase of CRGO sheet, core material, oil, bushings, steel (required for fabrication of the transformer tank) etc., at the time of routine testing of the fully assembled transformer.

#### **20.0 TESTING FACILITY:**

The supplier shall have adequate testing facility to conduct the routine tests.

#### **21.0 QUALITY ASSURANCE PLAN:**

In respect of raw materials such as core stamping, winding, conductor, insulating paper and oil, the manufacturer shall use these materials manufactured/supplied by the standard manufacturers and furnish the manufacturers test certificates as well as the proof of purchase from these manufacturers (excise gate pass) for information of corporation.

The bidder shall invariably furnish following information along with his offer, failing which his offer, shall be liable for rejection.

Statement giving list of important raw materials including but not limited to:

- a) Core material
- b) Winding material
- c) Insulation paper and press boards.
- d) Transformer oil
- e) Bushings
- f) Tanks, conservator and radiators

Names of sub supplier for the raw materials, List of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Bidder's representatives, copies of test certificates.

1. List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspections.
2. Special features provided in the equipment to make it maintenance free.
3. List of testing equipment available with the bidder for final testing of transformers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. The limitations shall be very clearly brought out in the relevant schedule i.e., schedule of deviations from specified test requirements.

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

- a) List of raw materials as well as bought out accessories and the names of sub suppliers selected from those furnished along with offer.
- b) Type test certificates of the raw material and bought out accessories.
- c) Quality Assurance Plan (QAP) withhold points for purchaser's inspection. The quality assurance plans and hold points shall be discussed between the purchaser and supplier before the QAP is finalized.

The supplier shall submit the routine test certificate of bought out items and raw material, at the time of routine testing of the fully assembled Transformer.

## **22.0 DOCUMENTATION:**

- 22.1 All drawings shall conform to International standards organization (ISO) 'A' Series of drawing sheet/Indian standards specification IS:656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in SI Units.
- 22.2 The manufacture of the equipments shall be strictly in accordance with the approved drawings and no deviation shall be permitted without written approval of the Purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the suppliers risk.

The supplier shall furnish all the details of constructional feature showing the details of all the items in the plan, sectional elevation and the side elevation and indicate these details/dimensions.

- 22.3 The supplier shall furnish the magnetization characteristic curve for the core material of the transformer.
- 22.4 Two sets of the type test reports shall be submitted by the supplier before commencement of supply.
- 22.5 Approval of drawings / work by KPTCL shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirement of the latest revision of applicable standards, rules and codes of practices. The equipments shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of supply and KPTCL shall have the power to reject any work or materials which in his judgment is not in full accordance there with.

## **23.0 PACKING AND FORWARDING:**

Each consignment shall be accompanied by a detailed packing list containing the following information.

- a) Name of the Consignee.

- b) Details of Consignment.
- c) Destination.
- d) Total weight of consignment
- e) Signs showing upper / lower side of the crate.
- f) Bill of Materials including contents of each package.

The monogram/name of the firm shall be blanked on the top cover of the Transformer.

#### **24.0 PUNCH MARKING OF TRANSFORMER SERIAL NO.**

The serial No. of the Transformer shall be punch marked on the transformers tank and also on the top cover in addition to that indicated on the name plate as per relevant clause.

**Annexure - I****GUARANTEED TECHNICAL PARTICULARS FOR DISTRIBUTION TRANSFORMER****(To be furnished by the manufacturer)**

| <b>Sl. No.</b> | <b>Description</b>   |  |
|----------------|--|--|
| 1              | Make   |  |
| 2              | Name of Manufacturer   |  |
| 3              | Place of Manufacture   |  |
| 4              | Reference standard   |  |
| 5              | Service (indoor/outdoor)   |  |
| 6              | Voltage Ratio  |  |
| 7              | Rating in kVA  |  |
| 8              | Rated Frequency (Hz)   |  |
| 9              | Number of phases   |  |
| 10             | Vector group   |  |
| 11             | a) Core Material used and Grade  |  |
|                | b) Flux density  |  |
|                | c) Over fluxing without saturation (Curve to be furnished by the manufacturer in support of his claim) |  |
| 12             | Maximum temperature rise of:   |  |
|                | a) Winding by resistance method (°C)   |  |
|                | b) Oil by thermometer (°C)   |  |
| 13             | Magnetizing (No-load) current at :   |  |
|                | a) 90%   |  |
|                | b) 100%  |  |
|                | c) 110%  |  |
| 14             | Core loss in watts   |  |
|                | a) Normal voltage  |  |
|                | b) Maximum voltage   |  |
| 15             | Resistance of windings at 20°C (with 5% tolerance)   |  |
|                | a) HV Windings (ohms)  |  |
|                | b) LV Windings (ohms)  |  |
| 16             | Full load losses (watt) at 75°C  |  |
| 17             | Total losses at 100% load at 75°C  |  |
| 18             | Total losses at 50% load at 75°C   |  |
| 19             | Current density used for : (Ampere/Sq.mm)  |  |
|                | a) HV Winding  |  |
|                | b) LV winding  |  |
| 20             | i) Clearances : mm (in oil)  |  |
|                | a) Core and LV   |  |
|                | b) LV & HV   |  |

|    |  |  |
|----|--|--|
|    | c) HV Phase to Phase   |  |
|    | d) End insulation clearance to earth   |  |
|    | e) Any point of winding to tank  |  |
|    | ii) Clearances : mm (in air)   |  |
|    | a) HV - Phase to Phase<br>Phase to Earth   |  |
|    | b) LV - Phase to Phase<br>Phase to Earth   |  |
| 21 | Efficiency at 75°C (@ Unity P.F. and 0.8 P.F.)                                       |  |
|    | a) 125% load   |  |
|    | b) 100% load   |  |
|    | c) 75% load  |  |
|    | d) 50% load  |  |
|    | e) 25% load  |  |
| 22 | Regulation at :  |  |
|    | a) Unity P.F. and  |  |
|    | b) 0.8 P.F. at 75°C  |  |
| 23 | % Impedance at 75°C  |  |
| 24 | Tap changing gear:   |  |
|    | a) Make  |  |
|    | b) Type of tap changer   |  |
|    | c) Step voltage  |  |
|    | d) Total tap range (+) percent to (-) percent  |  |
|    | e) Tappings provided at  |  |
| 25 | Permissible overloading  |  |
| 26 | Noise level when energized at normal voltage<br>and normal frequency at no-load (db) |  |
| 27 | Insulation level in kV   |  |
|    | a) Nominal system voltage (NSV)  |  |
|    | b) Highest system voltage (HSV)  |  |
|    | c) Power frequency withstand voltage   |  |
|    | d) Lightning impulse withstand voltage   |  |
| 28 | Mass of : (kg)   |  |
|    | a) Core lamination (minimum)   |  |
|    | b) Windings (minimum)  |  |
|    | c) Tank and fittings   |  |
|    | d) Oil   |  |
|    | e) Oil quantity (minimum ) (litre)   |  |
|    | f) Total weight  |  |
| 29 | Oil Data:  |  |
|    | 1. Quantity for first filling (minimum) (litre)                                      |  |
|    | 2. Grade of oil used   |  |
|    | 3. Maker's name  |  |
|    | 4. BDV at the time of filling (kV)   |  |
|    | 5. Water content at the time of filling (in PPM)                                     |  |
| 30 | Transformer:   |  |

|    |   |  |
|----|---|--|
|    | a) Overall length x breadth x height (mm x mm x mm)   |  |
|    | b) Tank length x breadth x height   |  |
|    | c) Thickness of plates for  |  |
|    | i) Side plate (min)   |  |
|    | ii) Top and bottom plate (min)  |  |
|    | d) Conservator dimensions   |  |
| 31 | Radiation:  |  |
|    | a) Heat dissipation by tank walls excluding top and bottom  |  |
|    | b) Heat dissipation by cooling tube   |  |
|    | c) Diameter and thickness of cooling tube   |  |
|    | d) Total radiating surface in square metre  |  |
|    | e) Whether calculation sheet for selecting cooling area to ensure that the transformer is capable of giving continuous rated output without exceeding temperature rise is enclosed. |  |
| 32 | Inter layer insulation provided in design for :   |  |
|    | a) Top and bottom layer   |  |
|    | b) In between all layer   |  |
|    | c) Details of end insulation  |  |
|    | d) Whether wedges are provided at 50% turns of the HV coil.   |  |
| 33 | Insulation materials provided   |  |
|    | a) For conductors   |  |
|    | i. HV   |  |
|    | ii. LV  |  |
|    | b) For core   |  |
| 34 | Material and size of the conductor used and current density   |  |
|    | a) HV Dia (mm) SWG  |  |
|    | b) LV i) Strip size   |  |
|    | ii) No. of conductors in parallel   |  |
|    | iii) Total area of cross section (all particulars as required in tender).   |  |
|    | c) Current density - HV<br>LV   |  |
|    | d) Material of winding conductor  |  |
| 35 | Whether the name plate gives all particulars as required in tender  |  |
| 36 | Particulars of bushings HV/LV   |  |
|    | a) Maker's name   |  |
|    | b) Type   |  |

|    |  |  |
|----|--|--|
|    | c) Current Rating (Amps)/Voltage rating (kV)   |  |
|    | d) Dry power frequency withstand voltage (kV rms)  |  |
|    | e) Wet power frequency withstand voltage (kV rms)  |  |
|    | f) Lightning impulse withstand voltage (kVp)   |  |
|    | g) Creepage distance (mm)  |  |
| 37 | Type of insulation used in   |  |
|    | a) HV windings   |  |
|    | b) LV windings   |  |
| 38 | Type of insulation used on   |  |
|    | a) Core bolts  |  |
|    | b) Core bolt washers   |  |
|    | c) Core laminations  |  |
| 39 | Vacuum to which the tank can be subjected without distortion (torr)                          |  |
| 40 | Weight of insulated conductor  |  |
|    | a) HV  |  |
|    | b) LV  |  |
| 41 | a. Weight of core  |  |
|    | b. Tolerance   |  |
| 42 | Weight of complete Transformer for transport   |  |
| 43 | Period for which this design of transformer has been in commercial use.                      |  |
| 44 | Reactance of windings at 75°C/ph<br>a. HV      b. LV   |  |
| 45 | Resistance of windings at rated current and frequency<br>a. HV      b. LV                    |  |
| 46 | Type & size of Gas operated relay and whether supervisory alarm and trip contacts provided.  |  |
| 48 | Temperature indicators<br>a) Oil temperature indicator      b) Winding temperature indicator |  |
|    | i) Make & type   |  |
|    | ii) Permissible setting ranges for alarm & trip  |  |
|    | iii) No. of contacts   |  |
|    | iv) Current rating of each contact   |  |
| 49 | Ratio and type of CT used for winding temperature  |  |
|    | a) Ratio   |  |
|    | b) Type  |  |
| 50 | No. of Breathers provided (Nos.)   |  |
| 51 | Type of dehydrating agent used for breathers   |  |
| 52 | a) Type , make and number of pressure  |  |



|    |   |  |
|----|---|--|
|    | relief device   |  |
|    | b) Minimum pressure at which the device operates, Kg/cm <sup>2</sup>                          |  |
| 53 | Valves - sizes and numbers required/fitted  |  |
|    | a) Drain cum sampling valve   |  |
|    | b) Fitter valve   |  |
| 54 | Characteristics of insulating oil to be used  |  |
|    | a. Appearance   |  |
|    | b. Density (Max) at 20° C   |  |
|    | c. Kinematic viscosity (max)  |  |
|    | d. Interfacial tension  |  |
|    | e. Flash point (Min)  |  |
|    | f. Neutralization value   |  |
|    | i) Total acidity (Max)  |  |
|    | ii) Inorganic acidity/Alkalinity  |  |
|    | f. Pour point (max)   |  |
|    | g. Corrosive sulphur  |  |
|    | i. Electric strength (break down voltage (min) with 2.5mm gap)                                |  |
|    | i) New Unfiltered oil as in received condition.   |  |
|    | ii) After filtration.   |  |
|    | j. Dielectric dissipation factor (tan delta) at 90°C (Max)                                    |  |
|    | k. Water content (Max)  |  |
|    | l. Specific Resistance (Min) (Resistivity)  |  |
|    | i) At 90°C (min)  |  |
|    | ii) At 27°C (min)   |  |
|    | m. Oxidation Stability  |  |
|    | i) Neutralization value after oxidation (Max.)  |  |
|    | ii) Total sludge after oxidation (Max.)   |  |
|    | n. Ageing characteristics after accelerated ageing (Open breaker method with copper catalyst) |  |
|    | a) Resistivity at 27°C  |  |
|    | b) Resistivity at 90°C  |  |
|    | c) Dielectric loss factor (tan delta) at 90°C   |  |
|    | d) Total acidity mg KOH/g   |  |
|    | e) Sludge Content (Max.)  |  |
|    | o. Presence of oxidation inhibitor (Percent by weight)  |  |
| 55 | Date of commencement of production of distribution transformer at the factory of the supplier |  |

**Signature & Seal of the Tenderer**

## Annexure - II

### GUARANTEED TECHNICAL PARTICULARS FOR DISTRIBUTION TRANSFORMER

| SL. NO. | PARTICULARS                               |  |
|---------|---|--|
| 1.      | Tank                                      |  |
|         | a) Wall thickness (mm).                   |  |
|         | b) Top/bottom plate thickness (mm)        |  |
|         | c) Welding of plates                      |  |
|         | d) Side wall joints                       |  |
|         | e) General                                |  |
|         | i) Reinforcement for walls                |  |
|         | ii) Limits for permanent deflection       |  |
|         | iii) Channel (bore) (mm)                  |  |
| 2.      | Core (Magnetic circuit)                   |  |
|         | a. Top yoke (single sheet) Thickness (mm) |  |
|         | b. Channel liner                          |  |
|         | c. Core wrapper                           |  |
|         | d. Core clamping                          |  |
|         | e. Core dimensions                        |  |
|         | i) Height (window)                        |  |
|         | ii) Core diameter                         |  |
|         | iii) Limb centre                          |  |
|         | f. No load current (% of FL current)      |  |
|         | g. No load loss in watts                  |  |
|         | h. Core material and grade                |  |
|         | i. Core fixing bolt Ø (mm)                |  |
|         | j. Tie rod insulation paper (mm)          |  |
| 3.      | Winding (Electrical circuit)              |  |
|         | a. Conductor material                     |  |
|         | b. Conductor insulation                   |  |
|         | i) HV winding                             |  |
|         | ii) LV winding                            |  |
|         | c. Conductor size                         |  |
|         | i) HV winding (sq. mm)                    |  |
|         | ii) LV winding (sq.mm)                    |  |
| 4.      | Phase barrier board (press board)         |  |
|         | a. Spacer between HV & LV coils           |  |
|         | b. Coil end insulation (mm)               |  |
|         | c. Coil packing screw                     |  |
|         | d. HV jumper & delta formation            |  |
|         | e. LV jumper (mm)                         |  |
|         | f. HV termination (bushings)              |  |
|         | g. LV termination (bushings)              |  |
|         | h. Spacers                                |  |

|    |  |  |
|----|--|--|
|    | i. Load loss at 50% and 100% load in watts |  |
|    | j. Percentage of impedance 75°C            |  |
|    | k. Neutral current at full load in %       |  |
| 5. | a. Coil packing                            |  |
|    | b. Tapping lead (Cu mm)                    |  |
|    | c. Neutral current                         |  |
|    | d. Breather (Silica gel)                   |  |

**Note:** The following shall be specifically confirmed:

1. Whether the offer conforms to the limits of impedance mentioned in the specification.
2. Whether the offer conforms to the limits of temperature rise mentioned in the specification.
3. Whether the losses of the transformers offered are within the limits specified.
4. Whether the transformers offered is already type tested for the design and test reports enclosed.

**Signature & Seal of the Tenderer.**

