



# SUPPLY CHAIN MANAGEMENT THIRUVANANTHAPURAM

## SPECIFICATION Distribution Transformer 22kV/433V, 100, 160 & 250 kVA

**APPLICABLE TO KSEBL**

**Rev#0.2**

DOC. NO.: **SCM-SPEC/XD/DT3**

EFF. DATE: **17-11-2021**

Number of Pages: 50

### Technical Committee

1. Chief Engineer- SCM
2. Deputy Chief Engineer -SCM
3. Executive Engineer TMR Thirumala
4. Executive Engineer TMR Pallom
5. Executive Engineer TMR Angamaly
6. Executive Engineer TMR Shoranur
7. Executive Engineer TMR Kannur
8. Executive Engineer(D)-O/o CE-SCM
9. Executive Engineer RITU Kochi



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Thiruvananthapuram  
Administered by TMRs | Kannur | Shoranur | Angamaly | Pallom | Thirumala

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### (i) Document Approval & Control Status

|           | Compiled by  | Verified by   | Approved by                              |
|-----------|--|---|--|
| Name      | <b>Mrs. Anitha Sugathan</b>  | <b>Mr. Sunil.K</b>  | <b>Mr. Sanal Kumar K</b>                 |
| Position  | Assistant Executive Engineer (O/o Chief Engineer, Supply Chain Management) | Executive Engineer(D) (O/o Chief Engineer, Supply Chain Management) | Chief Engineer (Supply Chain Management) |
| Date      | 31-3-2021  | 31-3-2021   | 31-3-2021                                |
| Signature | <b>Sd/-</b>  | <b>Sd/-</b>   | <b>Sd/-</b>                              |

### (ii) Revision Approval & Control Status

|           | Revised by   | Verified by   | Approved by                              |
|-----------|--|---|--|
| Name      | <b>Mrs. Anitha Sugathan</b>  | <b>Mrs. Binu.N</b>  | <b>Mrs. Presannakumari.C</b>             |
| Position  | Assistant Executive Engineer (O/o Chief Engineer, Supply Chain Management) | Executive Engineer(D) (O/o Chief Engineer, Supply Chain Management) | Chief Engineer (Supply Chain Management) |
| Date      | 17-11-2021   | 17-11-2021  | 17-11-2021                               |
| Signature | <b>Sd/-</b>  | <b>Sd/-</b>   | <b>Sd/-</b>                              |

### (iii) Amendments and History

| Sec. #                    | Rev. #     | Date              | History of Change   |
|---------------------------|------------|-------------------|---|
| <b>Clause 22 FITTINGS</b> | <b>0.1</b> | <b>17-6-2021</b>  | <b>Drain cum sampling valve is included in fittings as item xiv</b>                         |
| <b>Clause 22 FITTINGS</b> | <b>0.2</b> | <b>17-11-2021</b> | <b>One filter valve on upper side of the transformer is included in fittings as item xv</b> |



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## 1. Purpose

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **Distribution Transformer 22kV/433V, 100,160 and 250 kVA** in a professional manner.

## 2. Scope

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL., Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **Distribution Transformer 22kV/433V, 100,160 and 250 kVA** used in field by KSEBL.

## 3. Responsibility

**Executive Engineer(M), Office of Chief Engineer, Supply Chain Management** shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions.

## 4. Procedure For Revision

Modifications if any, in the technical Specification will be incorporated as **Revisions** . Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev No. 0.1, 0.2 etc .**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev No. 1.0, 2.0 etc .**

All the details regarding the revisions (both minor and major ) will be incorporated in “(ii)-**Amendments and history** “ above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer- SCM**. Those who notice any discrepancy or have any suggestion regarding revision , may bring the matter to the attention of Chief Engineer -SCM in writing or through e-mail id: [cescm@kseb.in](mailto:cescm@kseb.in)



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### **TECHNICAL SPECIFICATION FOR 22 kV/433-250V, 100, 160 & 250 (OUTDOOR TYPE), BEE ENERGY EFFICIENCY LEVEL 2 (1 STAR) 3-PHASE DISTRIBUTION TRANSFORMERS**

#### 1. SCOPE:

- i) This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3-phase 22 kV/433 - 250 V normal distribution transformers for outdoor use.
- ii) 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.
- iii) The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.
- iv) All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

#### 2. STANDARDS:

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

2.2

| Indian Standards       | Title  | International Standards |
|------------------------|--|-------------------------|
| IS -2026               | Specification for Power Transformers   | IEC 76                  |
| IS 1180 (Part-I): 2014 | Outdoor Type Oil Immersed Distribution Transformers upto and including 2500kVA,33kV-Specification  |                         |
| IS 12444               | Specification for Copper wire rod  | ASTM B-49               |
|                        | Guidelines for Specifications of Energy Efficient Outdoor type Three phase and Single phase Distribution Transformers by Central Electricity Authority |                         |
| IS-335/2018            | Specification for Transformer/Mineral Oil  | IEC Pub296              |
| IS-5                   | Specification for colors for ready mixed paints  |                         |
| IS -104                | Ready mixed paint, brushing zinc chromate, priming   |                         |

|           |  |                 |
|-----------|--|-----------------|
| IS-2099   | Specification for high voltage porcelain bushing   |                 |
| IS-649    | Testing for steel sheets and strips and magnetic circuits                                |                 |
| IS-3024   | Cold rolled grain oriented electrical sheets and strips                                  |                 |
| IS -4257  | Dimensions for clamping arrangements for bushings  |                 |
| IS -7421  | Specification for Low Voltage bushings   |                 |
| IS -3347  | Specification for Outdoor Bushings   | DIN 42531 to 33 |
| IS -5484  | Specification for Al Wire rods   | ASTM B - 233    |
| IS -9335  | Specification for Insulating Kraft Paper   | IEC 554         |
| IS -1576  | Specification for Insulating Press Board   | IEC 641         |
| IS -6600  | Guide for loading of oil Immersed Transformers   | IEC 76          |
| IS -2362  | Determination of water content in oil for porcelain bushing of transformer               |                 |
| IS -6162  | Paper covered Aluminium conductor  |                 |
| IS -6160  | Rectangular Electrical conductor for electrical machines                                 |                 |
| IS -5561  | Electrical power connector   |                 |
| IS -6103  | Testing of specific resistance of electrical insulating 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.  |                 |
|           | CBIP Manual on Transformer: Publication:317  |                 |

### 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 State of Kerala |
| ii)  | Maximum ambient air temperature (°C) | : | 55  |
| iii) | Minimum ambient air temperature(°C)  | : | -5  |
| iv)  | Maximum average daily ambient air    | : | 42  |

- |       |   |   |                 |
|-------|---|---|-----------------|
| v)    | temperature (°C)<br>Maximum yearly weighted average ambient temperature(°C) | : | 35              |
| vi)   | Maximum altitude above mean sea level :                                     |   | 1500 meters     |
| vii)  | Maximum Annual Rainfall (mm) :  |   | 5000            |
| viii) | Average Annual Rainfall (mm) :  |   | 3107            |
| ix)   | Specified operation range of temperature :                                  |   | 0°C to 55°C     |
| x)    | Limit of range of operation of temperature:                                 |   | 10° C to 60 ° C |
| xi)   | Limit of temperature range for storage and transport:                       |   | -10°C to 70°C   |
| xii)  | Relative humidity (%) :   |   | 50-99           |
| xiii) | Average no. of thunderstorm days/annum (Isoceraunic level):                 |   | 50              |
| xiv)  | Average number of dust storm days per annum:                                |   | 5               |
| xv)   | Average number of rainy days per annum :                                    |   | 120-140         |
| xvi)  | No. of months during which tropical monsoon conditions prevail :            |   | 6               |

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

#### 4. PRINCIPAL PARAMETERS:

**4.1** The transformers shall be suitable for outdoor installation with three phase, 50Hz, 22kV system in which the neutral is effectively earthed and they should be suitable for service with fluctuations in supply voltage upto plus 12.5% to minus 12.5%.

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

| SI.No. | Item                  | 22 kV Distribution Transformers |
|--------|-----------------------|---------------------------------|
| 1      | System voltage (Max.) | 24 kV                           |
| 2      | Rated Voltage (HV)    | 22 kV                           |
| 3      | Rated Voltage (LV)    | 433 -250 V*                     |
| 4      | Frequency             | 50 Hz +/-5%*                    |
| 5      | No. of Phases         | Three                           |
| 6      | Connection HV         | Delta                           |
| 7      | Connection LV         | Star (Neutral brought out)      |
| 8      | Vector group          | Dyn-11                          |
| 9      | Type of cooling       | ONAN                            |

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

| kVA rating | Audible sound levels(decibels) |
|------------|--------------------------------|
| 51-100     | 51                             |
| 101-300    | 55                             |



**5. TECHNICAL REQUIREMENTS:**

**CORE MATERIAL**

- 5.1 The core shall be stack / wound type of high grade Cold Rolled Grain Oriented steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.
- 5.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage. CRGO steel for core shall be purchased only from the approved vendors, list of which is available at <http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>
- 5.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. **The bidder shall furnish necessary design data in support of this situation.**
- 5.4 No-load current up to 200kVA shall not exceed 3% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 6% of full load current.

AND

No-load current above 200kVA and upto 2500kVA shall not exceed 2% of full load current and will be measured by energising the transformer at rated voltage and frequency. Increase of 12.5% of rated voltage shall not increase the no-load current by 5% of full load current.

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

**6. WINDINGS:**

**Material:**

- 6.1 HV and LV windings shall be wound from Double Paper / Super Enamel (SE) covered Aluminum conductor.
- 6.2 LV winding shall be such that neutral formation will be at top.
- 6.3 Inter layer insulation shall be Nomex /Epoxy dotted Kraft Paper.
- 6.4 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted.
- 6.5 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars (GTP Schedule I).
- 6.6 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 6.7 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

**7. TAPPING RANGES AND METHODS:**

- 7.1 No tappings required for transformers upto 100 kVA rating.
- 7.2 The tapping shall be as per provisions of IS: 1180 Part-I (2014).
- 7.3 Tap changing shall be carried out by means of an externally operated self-position switch and when the transformer is in de-energised condition. Switch position No.1 shall correspond

to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Arrangement for pad locking shall be provided. Suitable aluminum anodized plate shall be fixed for tap changing switch to know the position number of tap.

**8. OIL:**

- 8.1. The insulating oil shall comply with the requirements of IS 335:2018. Use of recycled oil is not acceptable. The specific resistance of the oil shall be as per IS 335:2018.
- 8.2. Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.
- 8.3. The oil shall be filled under vacuum.
- 8.4. The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

**9. INSULATION LEVELS:-**

| Sl. No. | Voltage (kV) | Impulse Voltage (kV Peak) | Power Frequency Voltage (kV) |
|---------|--------------|---------------------------|------------------------------|
| 1       | 0.433        | -                         | 3                            |
| 2       | 22           | 125                       | 50                           |

**10. LOSSES:**

- 10.1 The transformer of HV voltage up to 22kV, the losses shall be as below.

| Rating of the Transformer | Total losses (no-load + load losses at 75°C) at 50% of rated load (watts) | Total losses at 100% of rated load (watts) |
|---------------------------|---|--|
| 100 kVA                   | 498   | 1732                                       |
| 160 kVA                   | 703   | 2047                                       |
| 250 kVA                   | 1029  | 3076                                       |

- 10.2. The above losses are maximum allowable and there should not be any positive tolerance. Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above stated values. Offers with losses lower than the maximum allowable losses will be evaluated on total owning cost basis in accordance with methodology given in Annexure -I. Manufacturers are not allowed to have positive tolerance of losses on any declared values in GTP.

**11. TOLERANCES:**

- 11.1. No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values and also for no load losses offered in GTP.

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

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

- 13.1) The permissible temperature rise shall be as per IS: 1180 (Part-I):2014.
- 13.2) The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. **Bidder shall submit the calculation sheet in this regard.**

**14. PENALTY FOR NON PERFORMANCE:**

- 14.1. During testing at supplier's works or later during acceptance testing, if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.
- 14.2. Purchaser shall reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.



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

### 15. INSULATION MATERIAL:

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

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

### 16. TANK:

16.1.1 Transformer tank construction shall conform in all respect to clause 15 of IS 1180(Part-1): 2014.

16.1.2 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.

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

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

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

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

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

### PLAIN TANK:

16.2.1 The transformer tank shall be of robust construction, elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 5.0 mm for the bottom and top and not less than 3.15 mm for the sides for distribution transformers of more than 25 kVA and upto and including 100 kVA and 6mm and 4mm respectively above 100kVA. Tolerances as per IS1852 shall be applicable. Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/ sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion.

16.2.2 Under operating conditions the pressure generated inside the tank should not exceed 0.4kg/sq.cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above the oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747 for DT upto 63 kVA. For DT of 63 kVA and above rating, conservator shall be provided.

(i) The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank and middle portion.

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

| Horizontal length of flat plate | Permanent deflection |
|---------------------------------|----------------------|
|                                 |                      |

|                         |     |
|-------------------------|-----|
| Up to and including 750 | 5.0 |
| 751 to 1250             | 6.5 |
| 1251 to 1750            | 8.0 |
| 1751 to 2000            | 9.0 |

16.2.3 The tank shall further be capable of withstanding a pressure and a vacuum as per IS 1180 (Part I): 2014 and subsequent amendments.

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

**17. CONSERVATOR:**

- i. Transformers of rating 63 kVA and above with plain tank construction, the provision of conservator is mandatory.
- ii. When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug.
- iii. The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 500g of silica gel conforming to IS 3401 for transformers upto 200 kVA and 1kg for transformers above 200kVA.
- iv. The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- v. The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- vi. The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so 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 the sump level.

**18. SURFACE PREPARATION AND PAINTING:**

**(i) GENERAL**

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

18.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used with prior approval of purchaser.

**18.2. CLEANING AND SURFACE PREPARATION:**

a) 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.

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

#### PROTECTIVE COATING:

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

#### PAINT MATERIAL:

- i. Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site: Heat resistant paint (Hot oil proof) for inside surface
- ii. For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel/polyurethane base paint. These paints can be either air drying or stoving.

#### PAINTING PROCEDURE:

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

#### DAMAGED PAINTWORK:

- 18.6.1 Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.
- 18.6.2 Any damaged paint work shall be made good as follows:
  - 18.6.2.1 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
  - 18.6.2.2 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.
  - 18.6.2.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.
  - 18.6.2.4 The paint shade shall be as per Annexure-Paint which is attached herewith.

#### 18.7 DRY FILM THICKNESS:

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



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18.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

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

**The color of the finishing coats shall be dark admiral gray conforming to No. 632 of IS-5 of 1961/ No. 541 (Light Brown)**

### 18.8 TESTS FOR PAINTED SURFACE:

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

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

### 19 BUSHINGS:

- 19.1 HV bushings are to be mounted on the top cover of the tank on collars/turrets and not directly on tank cover. The LT bushing shall be mounted on the side of the tank.
- 19.2 For 22 kV- 24 kV class bushings and for 0.433 kV - 1 kV class bushings shall be used.
- 19.3 Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.
- 19.4 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.
- 19.5 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

| Voltage | Clearance      |                |
|---------|----------------|----------------|
|         | Phase to phase | Phase to earth |
| 22 kV   | 330mm          | 230mm          |
| LV      | 75mm           | 40mm           |

- 19.6 Arcing horns shall be provided on HV bushings.
- 19.7 Brazing of all interconnections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section-IX.
- 19.8 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.
- 19.9 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

### 20.0 TERMINAL CONNECTORS:

The LV and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors



shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561.

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

**22. FITTINGS:**

The following standard fittings shall be provided :

- i. Rating and terminal marking plates, non-detachable.
- ii. Earthing terminals with lugs - 2 Nos.
- iii. Lifting lugs for main tank and top cover
- iv. Terminal connectors on the HV/LV bushings (For bare terminations only).
- v. Thermometer pocket with cap-1 No.
- vi. Air release device
- vii. HV bushings - 3 Nos.
- viii. LV bushings -4 Nos.
- ix. Pulling lugs
- x. Stiffener
- xi. Radiators - No. and length may be mentioned (as per heat dissipation calculations)/corrugations.
- xii. Arcing horns on HT side - 3 No .
- xiii. Prismatic oil level gauge.
- xiv. Drain cum sampling valve
- xv. One filter valve on upper side of the transformer
- xvi. Oil filling hole having p. 1- $\frac{1}{4}$  " thread with plug and drain plug on the conservator.
- xvii. Silica gel breather
- xviii. Base channel 75mmx40mm upto 100kVA and 100mm X 50 mm above 100 kVA, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- xix. Explosion vent
- xx. Oil level gauge  
-5 °C and 90°C marking for non-sealed type Transformers

**23. FASTENERS:**

23.1 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.

23.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.

23.3 All nuts and pins shall be adequately locked.

23.4 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.

23.5 All bolts/nuts/washers exposed to atmosphere should be as follows.

- a) Size 12 mm or below - Stainless steel
- b) Above 12 mm- steel with suitable finish like electro galvanized with passivation or hot dip galvanized.

23. 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.

23.7 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.

23.8 Taper washers shall be provided where necessary.

23.9 Protective washers of suitable material shall be provided front and back of the securing screws.

**24. OVERLOAD CAPACITY:**

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

**25. TESTS:**

25.1 All the equipment offered shall be fully type tested by the bidder or his collaborator as per the relevant standards including the additional type tests. The type test must have been conducted on a transformer of same design **during the last five years** at the time of bidding. The bidder shall furnish attested copy of type test reports along with the offer. In case the offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type tests at his own cost in CPRI/NABL accredited laboratory in the presence of employers representative s) without any financial liability to employer in the event of order placed on him.

25.2 Special tests other than type and routine tests, as agreed between purchaser and bidder shall also be carried out as per the relevant standards.

25.3 The requirements of site tests are also given in this clause.

25.4 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.

25.5 The procedure for testing shall be in accordance with IS1180 (Part-1) : 2014 / 2026 as the case may be except for temperature rise test.

25.6 Dispatch of each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

**26.0 ROUTINE TESTS:**

26.1. Ratio, polarity, phase sequence and vector group.

26.2. No Load current and losses at service voltage and normal frequency.

26.3. Load losses at rated current and normal frequency.

26.4. The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted after the receipt of order.

26.5. Impedance voltage test.

26.6. Resistance of windings at each tap, cold (at or near the test bed temperature).

26.7. Insulation resistance.

26.8. Induced over voltage withstand test.

26.9. Separate source voltage withstand test.

26.10. Neutral current measurement-The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.

26.11. Oil samples (one sample per lot) to comply with IS 1866.

26.12. Measurement of magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.

26.13. Pressure and vacuum test for checking the deflection on one transformer of each type in every inspection.

26.14. Measurement of no load losses at rated frequency and 90%, 100% and rated maximum system voltage (24kV).

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

In addition to the tests mentioned in clause 26 following tests shall be conducted:

27.1. 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.



- 27.2. Impulse voltage test: with chopped wave of IS 2026 part-III. BIL for 11 kV shall be 75 kV peak.
- 27.3. Short circuit withstand test: Thermal and dynamic ability.
- 27.4. Air Pressure Test: As per IS -1180 (Part-1):2014.
- 27.5. Magnetic Balance Test.
- 27.6. Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.
- 27.7. Noise-level measurement.
- 27.8. Measurement of zero-phase sequence impedance.
- 27.9. Measurement of Harmonics of no-load current.
- 27.10 Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested as per IS 1180(Part 1) :2014 (4<sup>th</sup> revision) and subsequent amendments. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

| Horizontal length of flat plate (in mm) | Permanent deflection (in mm) |
|---|------------------------------|
| Upto and including 750                  | 5.0                          |
| 751 to 1250                             | 6.5                          |
| 1251 to 1750                            | 8.0                          |
| 1751 to 2000                            | 9.0                          |

- 27.11. Transformer tank together with its radiator and other fittings shall be subjected to pressure as per IS 1180(Part 1) :2014 (4<sup>th</sup> revision) and subsequent amendments. The permanent deflection of the flat plates after the excess pressure has been released, shall not exceed the figures for vacuum test.
- 27.12 Pressure relief device test: The pressure relief device shall be subject to increasing fluid pressure. It shall operate before reaching the test pressure as specified in the above class. The operating pressure shall be recorded. The device shall seal-off after the excess pressure has been released.
- 27.13. **Short Circuit Test and Impulse Voltage Withstand Tests:** The purchaser intends to procure transformers designed and successfully tested for short circuit and impulse test. In case the transformers proposed for supply against the order are not exactly as per the tested design, the supplier shall be required to carry out the short circuit test and impulse voltage withstand test at their own cost in the presence of the representative of the purchaser.
  - 27.13.1. The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.
  - 27.13.2. Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.
  - 27.13.3. It may also be noted that the purchaser reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating at purchaser cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the supplier.

**28. ACCEPTANCE TESTS**

28.1. **At least 10% transformers of the offered lot (minimum of one)** shall be subjected to the following routine/ acceptance test in presence of purchaser's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:1180 (Part-1): 2014 and IS:2026.

28.2. Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings on one transformer of each type in every inspection.

28.3. 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.

28.4. Temperature rise test on one unit of the total ordered quantity.

**29. TESTS AT SITE:** - The purchaser will conduct the following test on receipt of transformers in their store. The utility shall arrange all equipment, tools & tackle and manpower for the testing. The bidder will depute his representative to witness the same. All such test shall be conducted by utility not later than 10 days from receipt of transformers.

i) Megger Test

ii) Ratio test

iii) Loss measurement

iv) Impedance measurement

**30. INSPECTION:**

30.1. 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 these manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect of the raw materials:

\* Invoice of supplier.

\* Mill's certificate.

\* Packing list.

\* Bill of landing.

\* Bill of entry certificate by custom.

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

**31. INSPECTION AND TESTING OF TRANSFORMER OIL:**

31.1. To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil as per IS: 335, after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative.

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

31.2.1. Anytime during receipt of raw material and manufacture/ assembly whenever the purchaser desires.

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

31.3. The stage inspection shall be carried out in accordance with **Annexure-III (A)**.

31.4. After the main raw-material i.e. core and coil material and tanks are arranged and transformers are taken for production on shop floor and a few assembly have been completed, the firm shall intimate the purchaser in this regard, so that an officer for carrying out such inspection could be deputed, as far as possible within seven days from the date of intimation. During the stage inspection a few assembled core shall be dismantled to ensure that the laminations used are of good quality. Further, as and when the transformers are ready for despatch, an offer intimating about the readiness of transformers, for final inspection for carrying out tests as per relevant IS shall be sent by

the firm along with Routine Test Certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection. The proforma for pre delivery inspection of Distribution transformers is placed at **Annexure - III (B)**.

- 31.5. 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.
- 31.6. 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.
- 31.7. 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.
- 31.8. Purchaser shall have every right to appoint a third party inspection to carry out the inspection process.
- 31.9. The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser have every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.

**32. QUALITY ASSURANCE PLAN:**

- 32.1 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 equipment offered.
- 32.2 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 tests normally carried out on raw materials in the presence of bidder's representative, copies of test certificates.
- 32.3 Information and copies of test certificates as above in respect of bought out accessories.
- 32.4 List of manufacturing facilities available.
- 32.5 Level of automation achieved and list of areas where manual processing exists.
- 32.6 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.
- 32.7 List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports. These shall be furnished with the bid. Manufacturer shall possess 0.1 accuracy class instruments for measurement of losses.
- 32.8 Quality Assurance Plan (QAP) withhold points for purchaser's inspection.
- 32.9 The successful bidder shall within 30 days of placement of order, submit following information to the purchaser :
  - 32.9.1 List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
  - 32.9.2 Type test certificates of the raw materials and bought out accessories.
  - 32.9.3 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.



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32.9.4 ISI marking on the transformer is mandatory. As per Quality Control Order for Electrical Transformers- 2015, issued by Department of Heavy Industries, Government of India, the Standard / ISI marking on Distribution Transformers is mandatory and the product should be manufactured in compliance with IS 1180 Part-1: (2014).

### 33. DOCUMENTATION:

**The bidder shall furnish along with the bid**

- 33.1 The dimensional drawings of the items offered indicating all the fittings.
- 33.2 Dimensional tolerances.
- 33.3 Weight of individual components and total weight.
- 33.4 An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.
- 33.5 Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.
- 33.6 Typical general arrangement drawing showing both primary and secondary sides and end- elevation and plan of the transformer.
- 33.7 **Calculations for Flux Density, Over Fluxing, Short Circuit Thermal Ability, Heat Dissipation, Temperature Rise and Loss calculation of the offered transformer, along with the bid.**

### 34. PACKING AND FORWARDING:

- 34.1. The packing shall be done as per the manufacturer's standard practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.
- 34.2. The marking on each package shall be as per the relevant IS.

### 35. GUARANTEE

- 35.1 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 transformer fails within the guarantee period, the supplier will depute his representative within 15 days from date of intimation by utility for joint inspection. In case, the failure is due to the reasons attributed to supplier, the transformer will be replaced/repared by the supplier within 2 months from date of joint inspection.
- 35.2 The outage period i.e. period from the date of failure till unit is repaired/ replaced shall not be counted for arriving at the guarantee period.
- 35.3 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.

### 36. SCHEDULES:

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

**Schedule- I A : Guaranteed Technical Particulars**

**Schedule- I B : Additional Details**

**CHIEF ENGINEER (SCM)**



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### ANNEXURE - I

#### METHODOLOGY FOR COMPUTING TOTAL OWNING COST

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

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

**ANNEXURE - II -Paint**

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

|   | Surface Preparation              | Primer coat  | Intermediate under coat                 | Finish coat                                      | Total DFT      | Colour shade            |
|---|----------------------------------|--|---|--|----------------|-------------------------|
| Main tank, pipes, conservator tank, etc. (External surfaces)              | Blast cleaning Sa2½              | Epoxy base Zinc primer 30-40 micron  | Epoxy base Zinc primer 30-40 micron     | Aliphatic Polyurethane (PU Paint) (min 50 micron | Min 110 micron | 632 / 541 shade of IS:5 |
| Main tank, pipes (above 80 NB), conservator tank, etc (Internal surfaces) | Blast cleaning Sa2½              | Hot oil resistant, non-corrosive varnish or paint                            | --                                      | --   | Min 30 micron  | Glossy white for paint  |
| Radiator (External surfaces)  | Chemical / blast cleaning (Sa2½) | Epoxy base zinc primer 30-40 micron  | Epoxy base Zinc primer Min 30-40 micron | Aliphatic Polyurethane(PU Paint) (min)50 micron  | Min 110 micron | 632 / 541 shade of IS:5 |
| Radiator and pipes up to 80 NB (Internal surfaces)                        | Chemical cleaning if required    | Hot oil proof low viscosity varnish or hot oil resistant non corrosive paint | --                                      | --   | --             | Glossy white for paint  |



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### ANNEXURE - III

## PROFORMA FOR STAGE INSPECTION OF DISTRIBUTION TRANSFORMERS

### (A) GENERAL INFORMATION:

1. Name of firm : M/s.
2. Order No. and Date :
3. Rating-wise quantity offered :
4. Details of offer
  - a) Rating
  - b) Quantity
  - c) Serial Numbers
5. Details of last stage inspected lot:
  - a) Total quantity inspected
  - b) Serial Numbers
  - c) Date of stage inspection
  - d) Quantity offered for final inspection of
    - (a) above with date

### (B) Availability of material for offered quantity :

Details to be filled in

### (C) Position of manufacturing stage of the offered quantity:

- a) Complete tanked assembly
- b) Core and coil assembly ready
- c) Core assembled
- d) Coils ready for assembly
  - (i) HV Coils
  - (ii) LV Coils

### Note:

- i. A quantity of less than 100 Nos. shall not be entertained for stage inspection. If the awarded quantity is less than 100 Nos., then whole lot shall be offered in single lot.
- ii. The stage inspection shall be carried out in case :-
  - (a) At least 25% quantity offered has been tanked and
  - (b) Core coil assembly of further at least 30% of the quantity offered has been completed.
- iii. Quantity offered for stage inspection should be offered for final Inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

| Sl.No | Particulars  | As offered | As observed | Deviation and Remarks |
|-------|--|------------|-------------|-----------------------|
| (D)   | <b>Inspection of Core:</b><br>Core Material<br>(1) Manufacturer's Characteristic Certificate in respect of grade of lamination used. (Please furnish test certificate) |            |             |                       |
|       | (2) Remarks regarding Rusting and smoothness of core.  |            |             |                       |
|       | (3) Whether laminations used for top and bottom yoke are in one piece.   |            |             |                       |





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|   |   |   |   |   |   |   |   |   |   |    |    |    |  |
|---|---|---|---|---|---|---|---|---|---|----|----|----|--|
| <b>(II) Core Construction :</b>   |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (1) No. of Steps  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (2) Dimension of Steps  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| Step No.  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |  |
| <b>As offered:</b>  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| W mm  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| T mm  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| <b>As found:</b>  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| W mm  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| T mm  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (3) Core Dia (mm)   |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (4) Total cross Section area of core  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (5) Effective cross Sectional area of core  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (6) Clamping arrangement  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (i) Channel Size  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (ii) Bolt size and No.  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (iii) Tie Rods size and No.   |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (iv) Painting   |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (a) Channels  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (b) Tie Rods  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (c) Bolts   |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (7) Whether top yoke is cut for LV connection.  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (8) If yes, at 7 above, whether Reinforcement is done.  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| 9) Size of Support Channels provided for Core base and bottom yoke (Single piece of channels are only acceptable) This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided.<br>This will not be applicable for Amorphous core. For Amorphous core, core clamps with locking arrangement with tank base cover will be provided |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (10) Thickness of insulation provided between core base and support channel.  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (11) core length (leg center to leg center)   |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (12) Window height  |   |   |   |   |   |   |   |   |   |    |    |    |  |
| (13) Core height  |   |   |   |   |   |   |   |   |   |    |    |    |  |





# SUPPLY CHAIN MANAGEMENT

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|     |   |  |  |  |
|-----|---|--|--|--|
|     | (14) Core weight only (without channels etc.)                               |  |  |  |
| (E) | INSPECTION OF WINDING   |  |  |  |
|     | (I) Winding material  |  |  |  |
|     | (1) Material used for   |  |  |  |
|     | (a) HV winding  |  |  |  |
|     | (b) LV winding  |  |  |  |
|     | (2) Grade of material for   |  |  |  |
|     | (a) HV winding  |  |  |  |
|     | (b) LV winding  |  |  |  |
|     | 3) Test certificate of manufacturer (enclose copy) for winding material of: |  |  |  |
|     | (a) HV  |  |  |  |
|     | (b) LV  |  |  |  |
|     | CONSTRUCTIONAL DETAILS  |  |  |  |
|     | Size of Cross Sectional area of conductor for:                              |  |  |  |
|     | (a) HV winding  |  |  |  |
|     | (b) LV winding  |  |  |  |
|     | (2) Type of insulation for conductor of :                                   |  |  |  |
|     | a) HV winding   |  |  |  |
|     | (b) LV winding  |  |  |  |
|     | (3) Diameter of wire used for delta formation (mm)                          |  |  |  |
|     | (4) Diameter of coils in:   |  |  |  |
|     | a) LV winding   |  |  |  |
|     | i) Internal dia (mm)  |  |  |  |
|     | ii) Outer dia (mm)  |  |  |  |
|     | b) HV winding   |  |  |  |
|     | i) Internal dia (mm)  |  |  |  |
|     | ii) Outer dia (mm)  |  |  |  |
|     | (5) Current Density of winding material used for :                          |  |  |  |
|     | (a) HV  |  |  |  |
|     | (b) LV  |  |  |  |
|     | (6) Whether neutral formation on top.                                       |  |  |  |
|     | (7) HV Coils/ Phase   |  |  |  |
|     | a) Number   |  |  |  |
|     | b) Turns / coil   |  |  |  |
|     | c) Total turns  |  |  |  |
|     | (8) LV Coils/ Phase   |  |  |  |



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|-----|--|--|--|--|
|     | a) Number  |  |  |  |
|     | b) Turns / coil  |  |  |  |
|     | c) Total turns   |  |  |  |
|     | (9) Method of HV Coil Joints   |  |  |  |
|     | (10) Total weight of coils of  |  |  |  |
|     | a) LV winding (kg)   |  |  |  |
|     | b) HV winding (kg)   |  |  |  |
| (F) | INSULATION MATERIALS :   |  |  |  |
|     | (I) MATERIAL :   |  |  |  |
|     | 1) Craft paper   |  |  |  |
|     | a) Make  |  |  |  |
|     | b) Thickness (mm)  |  |  |  |
|     | c) Test Certificate of manufacturer (enclose copy).  |  |  |  |
|     | 2) Press Board   |  |  |  |
|     | a) Make  |  |  |  |
|     | b) Thickness (mm)  |  |  |  |
|     | c) Test Certificate of manufacturer (enclose copy).  |  |  |  |
|     | 3) Material used for top and bottom yoke and insulation                                      |  |  |  |
|     | (II) Type and thickness of material used: (mm)   |  |  |  |
|     | a) Between core and LV   |  |  |  |
|     | b) Spacers   |  |  |  |
|     | c) Inter layer   |  |  |  |
|     | d) Between HV and LV winding   |  |  |  |
|     | e) Between phases  |  |  |  |
|     | f) End insulation  |  |  |  |
| (G) | CLEARANCES : (mm)  |  |  |  |
|     | (1) Related to core and windings   |  |  |  |
|     | (2) LV to Core (Radial)<br>Between HV and LV (Radial)  |  |  |  |
|     | 3) (i) Phase to phase between HV Conductor   |  |  |  |
|     | (ii) Whether two Nos. Press Board each of minimum 1 mm thick provided to cover the tie rods. |  |  |  |
|     | 4) Thickness of locking spacers between LV coils (mm)  |  |  |  |

|     |   |  |  |  |
|-----|---|--|--|--|
|     | 5) Axial wedges between HV and LV coils / phase (Nos.)  |  |  |  |
|     | 6) No. of radial spacers per phase between HV coils   |  |  |  |
|     | 7) Size of duct between LV and HV winding (mm)  |  |  |  |
|     | <b>(II) Between core - coil assembly and tank : (mm)</b>  |  |  |  |
|     | 1) Between winding and body:  |  |  |  |
|     | a) Tank lengthwise  |  |  |  |
|     | b) Tank Breadth wise  |  |  |  |
|     | 2) Clearance between top cover and top yoke upto 100 kVA and between top cover and top most live part of tap changing switch for 200 kVA and above.   |  |  |  |
| (H) | <b>TANK :</b><br>(I) Constructional details :<br>1) Shape<br>2) Thickness of side wall (mm)<br>3) Thickness of top and bottom plate (mm)<br>4) Provision of sloping top cover towards HV bushing. |  |  |  |
|     | 5) Tank internal dimensions (mm)  |  |  |  |
|     | a) Length   |  |  |  |
|     | b) Breadth  |  |  |  |
|     | c) Height   |  |  |  |
|     | i) On LV side   |  |  |  |
|     | (ii) On LV side   |  |  |  |
|     | <b>(II) General details :</b>   |  |  |  |
|     | 1) Inside painted by varnish/ oil Corrosion resistant paint (please specify which type of coating done).  |  |  |  |
|     | 2. Gasket between top cover and tank  |  |  |  |
|     | (i) Material  |  |  |  |
|     | ii) Thickness (mm)  |  |  |  |
|     | (iii) Jointing over laps (mm)   |  |  |  |
|     | 3). Reinforcement of welded angle (specify size and No. of angle provided ) on side walls of tank.  |  |  |  |
|     | 4. Provision for lifting lugs   |  |  |  |
|     | a) Whether lugs of 8 mm thick MS Plate provided   |  |  |  |
|     | b) Whether reinforced by welded plates edge wise below the lug upto re- enforcing angle of the tank done.   |  |  |  |

|            |  |  |  |  |
|------------|--|--|--|--|
|            | 5. Pulling lug of MS plate   |  |  |  |
|            | <ul style="list-style-type: none"> <li>a) Nos.</li> <li>b) Thickness (mm)</li> <li>c) Whether provided on breadth side or length side</li> </ul> |  |  |  |
|            | 6) Provision of air release plug   |  |  |  |
|            | 7) Provision of galvanized GI Nuts Bolts with 1No.Plain and 1No.spring washer.   |  |  |  |
|            | 8) Deformation of length wise side wall of tank when subject to:   |  |  |  |
|            | a) Vacuum of (-)0.7kg/sqcm for 30 minutes.   |  |  |  |
|            | b) Pressure of 0.8 kg/sqcm for 30 minutes.   |  |  |  |
| <b>(I)</b> | <b>RADIATORS :</b>   |  |  |  |
|            | 1. Fin Radiators of 1.25 mm thick Sheet  |  |  |  |
|            | a) Dimension of each fin (LxBxT)   |  |  |  |
|            | b) Fins per radiator   |  |  |  |
|            | c) Total No. of radiators  |  |  |  |
|            | 2. Verification of manufacturer's Test certificate regarding Heat dissipation (excluding Top and Bottom) in w/sq m                               |  |  |  |
|            | 3. Verification of position of radiator with respect to bushing.   |  |  |  |
| <b>(J)</b> | <b>CONSERVATOR :</b>   |  |  |  |
|            | 1. Dimensions (L x D) (in mm)  |  |  |  |
|            | 2. Volume (m <sup>3</sup> )  |  |  |  |
|            | 3. Inside dia of Conservator tank pipe(mm)   |  |  |  |
|            | 4. Whether conservator outlet pipe is projected approx.20mm inside the conservator tank.   |  |  |  |
|            | 5. Whether arrangement made so that oil does not fall on the active parts.   |  |  |  |
|            | 6. Whether die cast metal oil level gauge indicator having three positions at (- 5° C, 30 ° C and 98 ° C) is provided.                           |  |  |  |
|            | 7. Whether drain plug and filling hole with cover is provided.   |  |  |  |
|            | 8. Inner side of the conservator Tank painted with-  |  |  |  |
| <b>(K)</b> | <b>BREATHER :</b>  |  |  |  |
|            | 1. Whether Die cast Aluminium body breather for silica gel provided.   |  |  |  |
|            | 2. Make  |  |  |  |
|            | 3. Capacity  |  |  |  |



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|            |   |  |  |  |
|------------|---|--|--|--|
|            | 1. Material whether of Brass Rods/ Tinned Copper.   |  |  |  |
|            | a) HV   |  |  |  |
|            | b) LV   |  |  |  |
|            | 2. Size (dia in mm)   |  |  |  |
|            | a) HV   |  |  |  |
|            | b) LV   |  |  |  |
|            | 3. Method of Star connection formed on LV side of 6mm thick(Should use Al./Cu. Flat bolted/ brazed with crimped lugs on winding alternatively for 63 and100 kVA ratings brazing is done covered with tubular sleeve duly crimped).<br>- Please state dimensions of Al/ Cu flat or tubular sleeve used. (mm) |  |  |  |
|            | 4. Method of Connection of LV winding to LV Bushing (end of winding should be crimped with lugs (Al/Cu)and bolted with bushing stud).   |  |  |  |
|            | 5. Method of Connection of HV winding to HV bushing (Copper joint should be done by using silver brazing alloy and for Aluminium, brazing rod or with tubular connector crimped at three spots).  |  |  |  |
|            | 6. Whether SRB P tube/insulated paper used for formation of Delta on HV.  |  |  |  |
|            | 7. Whether Empire sleeves used on the portion of HV winding joining to HV bushing.  |  |  |  |
|            | 8. Whether neutral formation is covered with cotton tape  |  |  |  |
|            | 3. Whether arrangement for studs for fitting of HV Bushing are in diamond shape (so that Arcing Horns are placed vertically).   |  |  |  |
|            | 4. Position of mounting of LV bushings.   |  |  |  |
|            | 5. Bushing Clearance:(mm)   |  |  |  |
|            | a) LV to Earth  |  |  |  |
|            | b) HV to Earth  |  |  |  |
|            | c) Between LV Bushings  |  |  |  |
|            | d) Between HV Bushings  |  |  |  |
| <b>(N)</b> | <b>TANK BASE CHANNEL /</b>  |  |  |  |
|            | <b>ROLLERS :</b>  |  |  |  |
|            | 1. Size of channel (mm)   |  |  |  |
|            | 2. Whether channels welded across the length of the tank  |  |  |  |
|            | 3. Size and type of roller (mm)   |  |  |  |



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|            |  |  |  |  |
|------------|--|--|--|--|
| <b>(O)</b> | <b>OIL :</b>   |  |  |  |
|            | 1. Name of supplier  |  |  |  |
|            | 2. Break down voltage of oil: (kV)   |  |  |  |
|            | i) Filled in tanked transformer  |  |  |  |
|            | ii) In storage tank (to be tested by Inspecting Officer).  |  |  |  |
|            | 3. Supplier's test certificate (enclose copy)  |  |  |  |
| <b>(P)</b> | <b>ENGRAVING :</b>   |  |  |  |
|            | 1. Engraving / punching Sl. No. and name of firm on top channel / clamp or on separate plate which is firmly welded to the top channel/ clamp. |  |  |  |
|            | i) On bottom of clamping channel of core-coil assembly.  |  |  |  |
|            | ii) Engraving of Sl. No. and name of firm on side wall and top cover of tank along with date of dispatch.                                      |  |  |  |
| <b>(Q)</b> | i) MS plate of size 125x125 mm welded on width side of stiffner  |  |  |  |
|            | ii) Following details engraved (as per approved GTP):  |  |  |  |
|            | (a) Serial Number  |  |  |  |
|            | (b) Name of firm   |  |  |  |
|            | (c) Order No. and Date   |  |  |  |
|            | (d) Rating   |  |  |  |
| <b>(R)</b> | <b>NAME PLATE DETAILS :</b>  |  |  |  |
|            | Whether Name Plate is as per approved drawing  |  |  |  |
| <b>(S)</b> | <b>Colour of Transformer</b>   |  |  |  |
|            | 1. Tank body colour shall be as per Annexure-Paint which is attached herewith  |  |  |  |
|            | 2. Conservator colour shall be as per Annexure-Paint which is attached herewith .  |  |  |  |
| <b>(T)</b> | <b>CHECKING OF TESTING FACILITIES:</b>   |  |  |  |
|            | (Calibration certificate also to be checked for its validity)  |  |  |  |
|            | <b>TESTS :</b>   |  |  |  |
|            | 1. No Load Current   |  |  |  |
|            | 2. No Load Loss  |  |  |  |
|            | 3.%Impedance   |  |  |  |



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|            |  |  |  |  |
|------------|--|--|--|--|
|            | 4. Load Losses   |  |  |  |
|            | 5. Insulation Resistance Test  |  |  |  |
|            | 6. Vector Group Test (phase relationship)  |  |  |  |
|            | 7. Ratio and Polarity test relationship  |  |  |  |
|            | 8. Transformer Oil Test (Break Down Voltage)   |  |  |  |
|            | 9. Magnetic Balance  |  |  |  |
|            | 10. Measurement of winding resistance (HV and LV both)   |  |  |  |
|            | 11. Induced over voltage withstand test (Double voltage and Double frequency)  |  |  |  |
|            | 12. Separate source power frequency With stand test at 28 kV for HV and 3 kV for LV (one minute).                          |  |  |  |
|            | 13. Air pressure/ Oil leakage Test   |  |  |  |
|            | 14. Vacuum test  |  |  |  |
|            | 15. Unbalanced current test  |  |  |  |
|            | 16. Temperature rise (Heat Run) test.  |  |  |  |
| <b>(U)</b> | We have specifically checked the following and found the same as per G.T.P./deviations observed as mentioned against each: |  |  |  |
|            | i) Rustlessness of CRGO laminations used   |  |  |  |
|            | ii) Core steps   |  |  |  |
|            | iii) Core area   |  |  |  |
|            | iv) Core weight  |  |  |  |
|            | v) Winding cross sectional area  |  |  |  |
|            | a) LV  |  |  |  |
|            | b) HV  |  |  |  |
|            | vi) Weight of windings   |  |  |  |
|            | vii) Clearance between winding and wall of tank (mm)   |  |  |  |
|            | a) Length-wise   |  |  |  |
|            | b) Breadth-wise  |  |  |  |
|            | viii) Clearance between top of yoke/ topmost live part of tap changer to tank cover.                                       |  |  |  |
|            | ix) Details of Neutral formation   |  |  |  |



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|  |                                       |  |  |  |
|--|---------------------------------------|--|--|--|
|  | x) Connections to bushings:           |  |  |  |
|  | a) LV                                 |  |  |  |
|  | b) HV                                 |  |  |  |
|  | xi) Slope of tank top                 |  |  |  |
|  | xii) Position of mounting of bushings |  |  |  |



**ANNEXURE - IV**

**PROFORMA FOR THE PRE-DELIVERY INSPECTION OF DISTRIBUTION TRANSFORMERS**

|    |  |  |  |
|----|--|--|--|
| 1. | Name of the firm   |  |  |
| 2. | Details of offer made  |  |  |
|    | (i) Order No. and Date   |  |  |
|    | (ii) Rating  |  |  |
|    | (iii) Quantity   |  |  |
|    | (iv) Sl. No. of transformers                                       |  |  |
| 3. | Date of stage inspection of the lot                                |  |  |
| 4. | Reference of stage inspection clearance                            |  |  |
| 5. | Quantity offered and inspected against the order prior to this lot |  |  |

**(A) ACCEPTANCE TESTS TO BE CARRIED OUT**

| Sl. No. | PARICULARS                                   | OBSERVATION             |
|---------|--|-------------------------|
| 1       | (a) Ratio Test                               | AB/an<br>BC/bn<br>CA/cn |
|         | (b) Polarity test                            |                         |
| 2       | No load loss measurement                     | W1<br>W2<br>W3          |
|         | TOTAL  |                         |
|         | Multiplying Factor                           |                         |
|         | CT   |                         |
|         | Watt meter                                   |                         |
|         | Total x MF                                   |                         |
|         | NET LOSS                                     |                         |
| 3       | Load loss measurement                        | W1<br>W2<br>W3          |
|         | Total  |                         |
|         | Multiplying Factors:-                        |                         |
|         | CT   |                         |
|         | Watt meter                                   |                         |
|         | PT   |                         |
|         | Total x MF                                   |                         |
|         | Loss at ambient temperature (watt)           |                         |
|         | Loss at 75°C (with calculation sheet) (watt) |                         |
| 4       | Winding Resistance                           |                         |



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|    |  |  |
|----|--|--|
|    | H.V.(In Ohms)  |  |
|    | (a) At ambient temperature of -----0C  | A-B  |
|    |  | B-C  |
|    |  | C-A  |
|    | (b) Resistance at 75°C   | A-B  |
|    |  | B-C  |
|    |  | C-A  |
|    | L.V.(In Ohm)   |  |
|    | (a) At ambient temperature of -----0C  | a-b  |
|    |  | b-c  |
|    |  | c-a  |
|    | (b) Per Phase resistance at 75°C   | a-n  |
|    |  | b-n  |
|    |  | c-n  |
| 5  | Insulation Resistance (M ohm)  | HV-LV  |
|    |  | HV-E   |
|    |  | LV-E   |
| 6  | Separate Source Voltage withstand test voltage:  |  |
|    | HV   | 28 kV for 60 secs.                               |
|    | LV   | 3 kV for 60 secs.                                |
| 7  | Induced over - voltage withstand test at double voltage and double frequency   | 100 Hz, 866 volts for 60 seconds.                |
| 8  | No load current at   |  |
|    | 90 % volts   |  |
|    | 110 % volts  |  |
| 9  | Unbalance current  |  |
| 10 | Vector group test  | Diagram and readings be shown in separate sheets |
| 11 | Percentage impedance at 75°C ( Please furnish calculation sheet)   |  |
| 12 | Transformer oil test ( Break down voltage)   |  |
| 13 | Oil leakage test   |  |
| 14 | Heat run test  | To be carried out<br>Once against the order      |
| 15 | Bushing clearance (mm)   | HV                      LV                       |
|    | (a)Phase to Phase  |  |
|    | (b) Phase to Earth   |  |
| 16 | Comments on compliance by the firm on the modifications done as per stage inspection clearance letter issued               |  |
| 17 | Whether fittings of the order have been verified.  |  |
| 18 | Whether aluminium die cast silicate breather with tin container is fitted on the transformers offered.                     |  |
| 19 | Whether engraving of Sl. No. and Name of firm on core clamping channel, side wall and top cover of tank has been verified. |  |
| 20 | Whether MS Plate of size 125x 125 mm welded on with side of stiffener  |  |
| 21 | Whether engraving of name of firm, Sl. No. and Rating of transformer, Order no. and date and Date                          |  |



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|    |  |  |
|----|--|--|
|    | of despatch on MS Plate.   |  |
| 22 | Copy of calibration certificates of metering equipments be enclosed. |  |

**ANNEXURE - V**

**POINTS TO BE SEEN/DIMENSIONS TO BE NOTED AT THE TIME OF DISMANTLING OF TRANSFORMERS:**

| Sl. No. | PARICULARS  | OBSERVATION |
|---------|---|-------------|
| 1       | Details of the transformer dismantled to physical verification  |             |
|         | (a) Rating ( KVA)   |             |
|         | (b) Sl.No.  |             |
| 2       | Whether GI Nut Bolts with one spring one plain washer provided for tightening the tank cover  |             |
| 3       | Details of gasket used between top cover and tank Material:   |             |
|         | (i) Thickness (mm)  |             |
|         | (ii) Type of joints   |             |
| 4       | Whether core is earthed properly with copper strip (one end should be tightened in between the core laminations and other end bolted on core camping channel) |             |
| 5       | Connections from winding to bushings ( describe the manner in which it has been done)   |             |
|         | (a) HV  |             |
|         | (b) LV  |             |
|         | (c) Formation of Star connection on LV side   |             |
| 6       | Working wire dia and cross sectional area;  |             |
|         | (a) HV  |             |
| (i)     | Dia (mm)  |             |
| (ii)    | Area ( sq mm)   |             |
|         | (b) LV  |             |
| (i)     | L x W x Nos. of layer   |             |
| (ii)    | Area ( sq mm)   |             |
| 7       | Thickness of press board (s) provided between HV rod to cover the tie rods  |             |
| 8       | Whether painted with oil and corrosion resistant Paint/ varnish   |             |
|         | (a) Inside of the tank  |             |
|         | (b) Inside of the conservator tank  |             |
|         | (c) Core clamping and core base channels  |             |
|         | (d) Tie rods  |             |
|         | (e) Core bolts  |             |
| 9       | Whether tie rods and core bolts insulated, if yes, material of insulation ,   |             |
| 10      | Whether flap on inner side of top cover provided to prevent direct falling of oil on core- coil assembly  |             |
| 11      | Method of joints  |             |
|         | (a) Between HV Coils  |             |
|         | (b) Between tap coils   |             |
|         | (c) For tap changer   |             |



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|    |   |  |
|----|---|--|
| 12 | Whether engraving of Sl. No. and name of firm done on bottom channel of core coil assembly.                         |  |
| 13 | Diameter of copper wire, used for formation of delta (should not be less than 1.5 times the dia of conductor). (mm) |  |
| 14 | Whether empire sleeves provided upto the end portion of HV winding joining to bushing                               |  |
| 15 | HV Coils:   |  |
|    | (a) Inner dia (mm)  |  |
|    | (b) Outer dia (mm)  |  |
| 16 | LV Coils:   |  |
|    | (a) Inner dia (mm)  |  |
|    | (b) Outer dia (mm)  |  |
| 17 | Core dia  |  |
| 18 | Core height including base channel and insulation in between (mm)   |  |
| 19 | Leg Center of core  |  |
| 20 | Clearances between  |  |
|    | (a)Core and LV (mm)   |  |
|    | (b) HV and LV (mm))   |  |
|    | (c)Phase to phase of HV Coils (mm)  |  |
|    | (d)Core coil assembly and tank body (mm)  |  |
|    | (i)Length- wise   |  |
|    | (ii)Width- wise   |  |
|    | (e) Top of yoke and top cover (mm)  |  |
|    | (f)Top most live part of tap changer and top cover.   |  |
| 21 | Weight of core only (Kg)  |  |
| 22 | Weight of windings (Kg)   |  |
|    | (a)LV   |  |
|    | (b)HV   |  |
| 23 | Whether core lamination are in one piece, used for  |  |
|    | (a)Bottom yoke  |  |
|    | (b) Top yoke  |  |
| 24 | Specific remarks regarding smoothness and rusting of core used  |  |
| 25 | Volume of oil filled ( to be done once against the order)   |  |
|    | (a)In conservator tank  |  |
|    | (b)In tank of the transformer   |  |
| 26 | Weight of transformer ( inclusive of all fittings, accessories, oil etc. complete)                                  |  |
| 27 | Inner dimensions of the tank  |  |
|    | (a) Length  |  |
|    | (b) Width   |  |
|    | (c) Height  |  |
|    | (i) LV side   |  |
|    | (ii) HV side  |  |
| 28 | Remark, if any:   |  |

Note: Please ensure that complete details have been filled in the proforma and no column has been blank.



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**SIGNATURE OF INSPECTION OFFICER**  
(With name and designation)

DATE OF INSPECTION:-

**SIGNATURE OF FIRM'S REPRESENTATIVE**  
(With name and designation)

**ANNEXURE - VI**

**SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION**

| Sl. No | Item                    | Source of Material | Place of Manufacture | Place of testing and inspection |
|--------|-------------------------|--------------------|----------------------|---------------------------------|
| 1      | Lamination              |                    |                      |                                 |
| 2      | Copper Conductor        |                    |                      |                                 |
| 3      | Insulated winding wires |                    |                      |                                 |
| 4      | Oil                     |                    |                      |                                 |
| 5      | Press boards            |                    |                      |                                 |
| 6      | Kraft paper             |                    |                      |                                 |
| 7      | MS Mates/Angles/Channel |                    |                      |                                 |
| 8      | Gaskets                 |                    |                      |                                 |
| 9      | Bushing HV/LV           |                    |                      |                                 |
| 10     | Paints                  |                    |                      |                                 |



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### ANNEXURE - VII

#### Check-list for Inspection of Prime quality CRGO for Transformers

During inspection of PRIME CRGO, the following points need to be checked by the Transformer manufacturer. Utility's inspector shall verify all these points during inspection:-

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

Review of documents:

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

Invoice of the Supplier

Packing List

Bill of Lading

Bill of Entry Certificate by Customs Dept.

Reconciliation Statement as per format below  
Certificate of Origin  
BIS Certification

**Format for Reconciliation/Traceability records**

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

Name of Manufacturer

Manufacturer test certificate No./date

| Serial No. | Details of package/job | Drawing Reference | Quantity Involved | Cumulative Quantity Consumed | Balance stock |
|------------|------------------------|-------------------|-------------------|------------------------------|---------------|
|            |                        |                   |                   |                              |               |

1 Inspection of PRIME CRGO Coils:

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

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

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

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

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

**Inspection Clearance Report would be issued after this inspection**

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

**4. Inspection at the time of core building:**





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

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

### Inspection Clearance Report would be issued after this inspection

#### 1. In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

##### 1. Review of documents:

1. Purchase Order (unpriced) to PRIME CRGO supplier/ Authorised Agency
2. Purchase Order (unpriced) to Core Cutter
3. Manufacturer test certificate
4. Invoice of the Supplier
5. Packing List
6. Bill of Lading
7. Bill of Entry Certificate by Customs Dept.
8. Reconciliation Statement as per format below
9. Certificate of origin
10. BIS Certification

#### Format for Traceability records as below:-

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

Name of Manufacturer

Manufacturer test certificate No./date

| Serial No. | Name of Customer | Details of package/job | Drawing Reference | Quantity Involved | Cumulative Quantity Consumed | Balance stock | Dispatch Details |
|------------|------------------|------------------------|-------------------|-------------------|------------------------------|---------------|------------------|
|            |                  |                        |                   |                   |                              |               |                  |

.1 Inspection of PRIME CRGO Coils: PRIME CRGO-Manufacturer's Identification Slip on PRIME CRGO Coils

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

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

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

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

### Inspection Clearance Report would be issued after this inspection

#### 3 Inspection of PRIME CRGO laminations:

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



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### Inspection Clearance Report would be issued after this inspection

a) Inspection at the time of core building:

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

### Inspection Clearance Report would be issued after this inspection

#### NOTE :-

- a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.
- 14.1 Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carry out necessary checks.

#### a) General

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

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

#### Sampling Plan (PRIME CRGO)

11 kV -1<sup>st</sup> transformer and subsequently at random 10% of Transformers (min. 1) offered for inspection.

DTs and other ratings -1<sup>st</sup> transformer and subsequently at random 2% of Transformers (min. 1) offered for inspection.

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

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

<http://apps.powergridindia.com/ims/ComponentList/Power-former upto 4kV-CMList.pdf>

**CHIEF ENGINEER (SCM)**

### **ANNEXURE VIII SCHEDULE - I A**

#### **GUARANTEED AND OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMERS**

| Sl. No. | Description   |  |
|---------|---|--|
| 1       | Make  |  |
| 2       | Name of Manufacture   |  |
| 3       | Place of Manufacture  |  |
| 4       | Voltage Ratio   |  |
| 5       | Rating in KVA   |  |
| 6       | Core material used and Grade  |  |
| (a)     | Flux density  |  |
| (b)     | Over fluxing without saturation (curve to be furnished by the manufacturer in Support of his claim) |  |
| 7       | Maximum temperature rise of   |  |
| (a)     | Windings by resistance method   |  |
| (b)     | Oil by thermometer  |  |
| 8       | Magnetizing ( no-load) current at   |  |
| (a)     | 90% Voltage   |  |
| (b)     | 100% Voltage  |  |
| (c)     | 110 % Voltage   |  |
| 9       | Core loss in watts  |  |
| (a)     | Normal Voltage  |  |
| (b)     | Maximum Voltage   |  |
| 10      | Resistance of windings at 20 ° C (with 5% tolerance)  |  |
| (a)     | HV Winding ( ohms)  |  |
| (b)     | LV Winding ( ohms)  |  |
| 11      | Full load losses ( watts) at 75 °C  |  |
| 12      | Total losses at 100% load at 75 °C  |  |
| 13      | Total losses at 50% load at 75°C  |  |
| 14      | Current density used for: ( Ampere/ sq mm)  |  |
| (a)     | HV Winding  |  |
| (b)     | LV Winding  |  |
| 15      | Clearances (mm)   |  |
| (a)     | Core and LV   |  |
| (b)     | LV and HV   |  |
| (c)     | HV Phase to phase   |  |
| (d)     | End insulation clearance to earth   |  |

|     |  |  |
|-----|--|--|
| (e) | Any point of winding to tank   |  |
| 16  | Efficiency at 75°C   |  |
| a)  | Unity P.F and  |  |
| b)  | 0.8.P.F  |  |
| 1)  | 125% load  |  |
| 2)  | 100% load  |  |
| 3)  | 75% load   |  |
| 4)  | 50% load   |  |
| 5)  | 25% load   |  |
| 17  | Regulation at:   |  |
| a)  | Unity P.F.   |  |
| b)  | 0.8.P.F 75°C   |  |
| 18  | % Impedance at 75°C  |  |
| 19  | Flash Test:  |  |
| i)  | HV 28 KV/50HZ for 1 minute   |  |
| ii) | LV 3 KV/ 50 Hz for 1minute   |  |
| 20  | Over potential Test (Double Voltage and Double Frequency for 1 minute) |  |
| 21  | Impulse test   |  |
| 22  | Mass of : (Kg)   |  |
| a)  | Core lamination ( minimum)   |  |
| b)  | Windings(minimum)  |  |
| c)  | Tank and fittings  |  |
| d)  | Oil  |  |
| e)  | Oil quantity ( minimum )( litre)                                       |  |
| f)  | Total Weight   |  |
| 23  | 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)                                       |  |
| 24  | Transformer:   |  |
| 1.  | Overall length x breadth x height ( mm x mm x mm)                      |  |
| 2.  | Tank length x breadth x height   |  |
| 3.  | Thickness of Plates  |  |
| a)  | Side Plate (min)   |  |
| b)  | Top & Bottom Plate (min)   |  |
| 4.  | Conservator Dimensions   |  |
| 25  | Radiation:   |  |
| 1.  | Heat dissipation by tank walls excluding top and bottom                |  |
| 2.  | Heat dissipation by cooling tube                                       |  |
| 3.  | Diameter and thickness of cooling tube                                 |  |
| 4.  | 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. |  |
| 26 | Inter layer Insulation provided in design for:   |  |
| 1. | Top and bottom layer   |  |
| 2. | In between all layer   |  |
| 3. | Details of end Insulation  |  |
| 4. | Whether wedges are provided at 50% turns of the HV coil  |  |
| 27 | Insulation materials provided  |  |
| a) | For Conductors   |  |
|    | (1) HV   |  |
|    | (2) LV   |  |
| b) | For Core   |  |
| 28 | Material and Size of the wire used   |  |
| 1) | HV Dia (mm) (SWG)  |  |
| 2) | LV   |  |
| a) | Strip size   |  |
| b) | No. of Conductors in parallel  |  |
| c) | Total area of cross section ( sq.mm)   |  |
| 29 | Whether the name plate gives all particulars as required in Tender   |  |
| 30 | Particulars of bushings HV/LV  |  |
| 1. | Maker's name   |  |
| 2. | Type IS-3347/IS-3099/IS7421  |  |
| 3. | Rating as per IS   |  |
| 4. | Dry power frequency voltage withstand test   |  |
| 5. | Wet power frequency voltage withstand test   |  |

### SCHEDULE - I B ADDITIONAL DETAILS

| Sl.No | Description     |       |  |
|-------|-----------------|-------|--|
| 1     | Core Grade      |       |  |
| 2     | Core diameter   | mm    |  |
| 3     | Gross core area | Sq cm |  |
| 4     | Net core area   | Sq cm |  |



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|    |   |          |  |
|----|---|----------|--|
| 5  | Flux density                                      | Tesla    |  |
| 6  | Mass of core                                      | Kg       |  |
| 7  | Loss per kg of core at the specified flux density | watt     |  |
| 8  | Core window height                                | mm       |  |
| 9  | Center to center distance of the core             | mm       |  |
| 10 | No. of LV Turns                                   |          |  |
| 11 | No. of HV turns                                   |          |  |
| 12 | Size of LV conductor bare/covered                 | mm       |  |
| 13 | Size of HV Conductor bar/covered                  | mm       |  |
| 14 | No. of parallels                                  |          |  |
| 15 | Current density of LV winding                     | A/sq mm. |  |
| 16 | Current density of HV winding                     | A/sq mm. |  |
| 17 | Wt. of the LV winding for Transformer             | Kg       |  |
| 18 | Wt. of the HV winding for Transformer             | Kg       |  |
| 19 | No. of LV Coils/Phase                             |          |  |
| 20 | No. of HV coils /Phase                            |          |  |
| 21 | Height of LV Windings                             | mm       |  |
| 23 | Height of HV winding                              | mm       |  |
| 24 | ID/OD of HV winding                               | mm       |  |
| 25 | ID/OD of LV winding                               | mm       |  |
| 26 | Size of the duct in LV winding                    | mm       |  |
| 27 | Size of the duct in HV winding                    | mm       |  |
| 18 | Size of the duct between HV and LV                | mm       |  |
| 29 | HV winding to LV winding clearance                | mm       |  |
| 30 | HV winding to tank clearance                      | mm       |  |
| 31 | Calculated impedance                              | %        |  |
| 32 | HV to earth creepage distance                     | mm       |  |
| 33 | LV to earth creepage distance                     | mm       |  |

**ANNEXURE - IX**

**PRICE VARIATION CLAUSE FOR ALUMINIUM WOUND DISTRIBUTION TRANSFORMERS**

The price quoted/ confirmed is based on the input cost of raw materials/ components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment up or down in accordance with the following formula.

$$P = \frac{P_0}{100} \left\{ 10 + 19 \frac{AL}{AL_0} + 30 \frac{ES}{ES_0} + 13 \frac{IS}{IS_0} + 4 \frac{IM}{IM_0} + 11 \frac{TO}{TO_0} + 13 \frac{W}{W_0} \right\}$$

**Wherein**

|                 |   |  |
|-----------------|---|--|
| P               | = | Price payable as adjusted in accordance with the above formula   |
| P <sub>0</sub>  | = | Price quoted/confirmed   |
| AL <sub>0</sub> | = | Price of LME CSP Average of Aluminium (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month one month prior to the date of tendering  |
| ES <sub>0</sub> | = | Price of CRGO Electrical Steel Lamination (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month one month prior to the date of tendering  |
| IS <sub>0</sub> | = | Price of HR coil of 3.15mm thickness (refer notes)<br>This price is as applicable for the month, one month prior to the date of tendering  |
| IM <sub>0</sub> | = | Price of Insulating Materials (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month, one month prior to the date of tendering   |
| TO <sub>0</sub> | = | Price of Transformer Oil (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month, one month prior to the date of tendering  |
| W <sub>0</sub>  | = | All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Government of India (Base 2001=100).<br>This index number is as applicable on the 1 <sup>st</sup> working day of the month, three months prior to the date of tendering |

For example if date of tendering (PQ Bid opening date) falls in December 2015, applicable prices of Aluminium (AL<sub>0</sub>), Transformer Oil (TO<sub>0</sub>), CRGO Steel Sheets (ES<sub>0</sub>) and insulating material (IM<sub>0</sub>) should be as on 1<sup>st</sup> November 2015 and All India average consumer price index number (W<sub>0</sub>) should be for the month of September 2015.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA (PVC)/DIST\_PWR\_TRF/\_\_\_/\_\_\_ one month prior to the date of tendering (PQ Bid opening date).

|    |   |  |
|----|---|--|
| AL | = | Price of LME CSP Average of Aluminium (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month <b>one</b> month prior to the date of delivery. |
| ES | = | Price of CRGO Electrical Steel Lamination (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month one month prior to the date of delivery.    |

|    |   |   |
|----|---|---|
| IS | = | Price of HR coil of 3.15mm thickness (refer notes)<br>This price is as applicable for the month, one month prior to the date of delivery.   |
| IM | = | Price of Insulating Materials (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month, one month prior to the date of delivery.  |
| TO | = | Price of Transformer Oil (refer notes)<br>This price is as applicable on the 1 <sup>st</sup> working day of the month <b>one</b> month prior to the date of delivery.   |
| W  | = | All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Government of India (Base 2001=100).<br>This index is as applicable on the 1 <sup>st</sup> working day of the month <b>three</b> months prior to the date of delivery. |

For example, if date of delivery in terms of clause given below falls in December 2015, applicable prices of Aluminium (AL), Transformer Oil (TO), CRGO Steel sheets (ES), HR Coil (IS) and insulating materials (IM) should be as on 1<sup>st</sup> November 2015 and All India average consumer price index number (W) should be for the month of September 2015.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/DIST\_PWR\_TRF/\_/\_ one month prior to date of delivery.

The date of delivery is the date on which the transformer is notified as being ready for inspection/ despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto) whichever is earlier.

**Notes:-**

- a) All prices of raw materials are exclusive of modvatable excise / CV duty amount and exclusive of any other central, State or local taxes, octroi etc. transformers manufacturers import some raw materials. The landed cost of these imported raw materials includes applicable customs duty but exclusive of modvatable CVD.
- b) Most of the prices are as on first working day of the month.
- c) Date of Tendering is the due date of tender submission.
- d) The details of prices are as under.

1. The price of Aluminium in Rs.MT is the average ex-works price of EC Grade Aluminium rods quoted by the primary producers conforming to specifications IS:5484 OR

Price of LME average Cash Seller Settlement price of primary Aluminium in US\$ per MT as published by London Metal Bulletin (LME) including premium for Aluminium ingot in US\$ per MT is converted in Indian Rs. / MT using exchange rate and adding appropriate customs duty.

2. The price of CRGO Electrical Steel Sheets suitable for Transformers of rating up to 10 MVA and voltage upto 33 kV (BEE & Energy efficiency levels as per IS 1180 (Part -1):2014 in Rs./MT) is the average price as quoted by processing centers of overseas mills and lamination suppliers which is same as applicable for power transformers (of rating above 10 MVA or voltage above 33 kV)

3. Price of Steel is the average retail price of HR coil 3.15 mm thickness as published by Joint Plant Committee (JPC) in Rs. / MT as on first working day of the month.

4. The average price of insulating materials (in Rs./Kg) of pre-compressed press boards of size 3mm and 10mm thick, 3200mm x 4100mm C& F price in free currency per MT converted into Indian Rupees with applicable exchange rates prevailing as on





## SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

Administered by TMRs | Kannur | Shoranur | Angamaly | Pallom | Thirumala

### TECHNICAL SPECIFICATION

Distribution Transformer 22kV/433 V, 100, 160 & 250 kVA

Doc. #: **SCM-SPEC/XD/DT3**

Rev. #: 0.2

Effective Date **17-11-2021**

1<sup>st</sup> working day of the month, as quoted by primary suppliers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

5. The price of Transformer Oil (in Rs./K.Ltr.) is the average price on ex-refinery basis as quoted by primary producers for supply in drums.

**CHIEF ENGINEER (SCM)**