

ANNEXURE-VI
TECHNICAL SPECIFICATION FOR
THREE PHASE 33/11 KV STEP DOWN POWER TRANSFORMERS
OF 8 MVA RATINGS

1. **SCOPE:**

The specification covers the design, manufacture testing and inspection before dispatch and delivery at places anywhere in Discom-EZ as per list of consignee area stores. The specification covers oil immersed, naturally air cooled (type ON), outdoors type, three phase, 50 Hz, 33/11 KV step down power transformers of 8 MVA capacity.

2. **APPLICABLE STANDARDS:**

- (A) Unless otherwise modified in the specification, the transformers shall comply with the requirement of ISS: 2026 (latest issue) or any equivalent International Standards and REC specification 2/1973 and ISS: 2099 (latest issue) or any equivalent International Standards. The bushings used shall conform to ISS: 2099 (latest issue) or any equivalent International Standards except as modified herein.
- (B) **Type:** - The transformers shall be double wound, three phase oil immersed, oil natural cooled (type 'ON'), core type suitable for outdoor installation in tropical climate and shall be insulated with minimum DPC insulation on HV & LV windings. Insulation should be of temperature class as per the temperature rise stipulated in this specification.

Climatic Conditions

i)	Peak outdoor temperature:	50°C
ii)	Maximum oil temperature: Attainable	(50°C + 45°C) 95°C under max temperature & max. Load condition
iii)	Maximum relative humidity:	95%(sometime approaches saturation point)
iv)	Minimum relative humidity:	10%
v)	Average No. Of thunderstorm	40 days
vi)	Average number of rainy days per annum	90 days
vii)	Number of months of tropical Monsoon conditions	3 months
viii)	Average annual rainfall	125 cm
ix)	Wind pressure	100 Kg/m ²
x)	Altitudes not exceeding	1000 meters.

(C) **Design and standardization:**

- i) The transformers and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. All apparatus shall also be designed to ensure satisfactory operation under such sudden variations of load and voltage as may be met with under working conditions on the system, including those due to short circuits.

- ii) The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the equipment keeping in view the requirement of Indian Electricity Rules.
- iii) All material including bought out items like bushings, oil radiators, conductor and insulating materials used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variation of temperature and atmospheric conditions arising under working conditions without undue distortion or deterioration or setting up of undue stresses in any part and also without affecting the strength and suitability of the various parts for the work which they have to perform.
- iv) Corresponding parts liable to replacement shall be interchangeable.
- v) Cast iron shall not be used for chambers of oil filled apparatus or for any part of the equipment, which is in tension or subject to impact, stresses or where corrosion due to acidity or sludging is likely to occur. This clause is not intended to prohibit the use of suitable grades of cast iron for parts where service experience has shown it to be satisfactory e.g. large valve bodies.
- vi) All outdoor apparatus, including bushing insulators with their mounting shall be designed so as to avoid external pockets in which water can collect and internally air could trap.
- vii) All taper pins used in any mechanism shall be of the split type complying with IS:2593 or any equivalent International Standards for these items.
- viii) All connections and contacts shall be of ample section and surface for carrying continuously the specified currents without heating and fixed connection shall be secured by bolts or set screw of common size adequately locked against vibration. Lock nuts shall be used on stud connections carrying current.
- ix) All apparatus shall be designed to minimize the risk of accidental short circuit caused by animals, birds or vermin.

3. STANDARD RATINGS:

The standard ratings shall be 8000 KVA, with off load taps.

4. CONTINUOUS MAXIMUM RATING:

The transformers shall have a continuous maximum rating at the specified normal ratio, frequency and temperature rises.

- (a) All transformers shall be capable of operation continuously in accordance with IS loading guide at their continuous maximum rating and at any ratio without exceeding temperature rise.
- (b) Transformers with tapping ranges extending more than 9% below normal voltage shall meet the temperature rise limits specified in IS:2026 or any equivalent International Standards. On other tapings, they shall operate continuously without injurious heating. The loading of the transformers is to be in accordance with IS:6600 - guide for loading of oil immersed transformers natural cooled units or any equivalent International Standards.

- (c) The transformers shall be capable of operation without danger at other than rated voltage and frequency in accordance with clause 4.3 and 4.4 of IS:2026 (Part I) 1977 or any equivalent International Standards.

5. MAXIMUM TEMPERATURE RISE:

The maximum temperature rise in each transformer tested at its continuous maximum rating shall not exceed the following limit with reference to ambient air temperature.

- i) Temperature of oil by thermometer: 45°C
ii) Temperature of winding by test resistance: 50°C

6. NO LOAD VOLTAGE RATIO:

The no load voltage ratio corresponding to the principal tapping shall be 33,000/11,000 volts.

7. MAXIMUM CURRENT DENSITY:

The current density for HV and LV winding should not exceed 2.5 Amps/mm².

8. FLUX DENSITY: OVER FLUXING:

- (A) **Flux density** should not be more than 1.55 Tesla at the rated voltage and frequency.
(B) **Over fluxing** - Requirement in this regard shall be governed by the provision contained in clause 3.1.7 of manual on transformer Section 'A' (Revised 1987) of CBIP. According to this, over fluxing the transformer continuously for over fluxing factor up to 1.1. In addition to this requirement, operation of power transformer without any danger/damage up to 60 Sec. for over fluxing factor of 1.25.

9. MAXIMUM GUARANTEED NO LOAD AND LOAD LOSSES:

The losses shall not exceed the value given below:

Rating in MVA	No Load losses (In KW)	Load losses at 75°C (In KW)
8.0 MVA	5.5	40.0

The losses specified above are maximum permissible value and no plus tolerance would be allowed. One unit will be required to undergo for loss measurement by independent agency like ERDA Baroda etc. before commencement of supply.

9.1 Guarantee and penalty for losses of power transformers, Capitalisation of transformer losses

- 9.1 (a) The no load losses in Kilo watts at rated voltage and rated frequency and the total losses in Kilo watts at rated full load current and rated frequency at 75° C shall be guaranteed under penalty for each transformer. For the purpose of penalty computations, the figures of the no load and the load losses will be compared with corresponding guaranteed figures.
(b) The penalties shall be separately evaluated from:

- i) The excess of the test figures of the no load loss in KW over the corresponding guaranteed value and
- ii) The excess of the test figures of the load loss in KW over the corresponding guaranteed value.

No tolerance shall be permitted over the guaranteed figures for computation of penalty.

- (c) The penalties shall be calculated at the rate of Rs.40, 000/- per KW for the excess of no load loss and at the rate of Rs16, 000/- per KW for the excess of load losses. For fraction of a KW, the penalties shall be applied on prorata basis. If the test figures of the losses are less than the guaranteed values, no bonus will be allowed.
- (d) The tenderers must clearly specify whether the losses quoted are FIRM or subject to IS tolerance. In case of any ambiguity, loading as per IS tolerance shall be considered for price comparison purpose.
- (e) The power transformers in each rating with lowest losses would be given preference:

While the tenderers may offer their own design, it may be noted that the transformer losses at 75° C should not exceed the prescribed limit indicated above in para-9.

- (f) As mentioned in (e) the power transformers in each rating with the lowest losses would be given preference. For fair comparison of different offers, it is essential that the tenderer should quote Firm losses. No load and load losses quoted by the firm shall be capitalized for comparison of prices.

10. OIL:

Transformer oil to be used for first filling shall comply with the specification indicated hereunder. Generally as per IS: 335-1993 (4th revision) or any equivalent International Standards & REC specification No.39/1985 except in so far as values indicated separately as per Board's specification for EHV Grade Oil.

(A) New oil:

Insulating oil for Transformers & Switchgears shall be as per ISS-335-1993 (4th revision) or any equivalent International Standards incorporating up to date amendment and additional characteristics as incorporated below. It will be pure hydrocarbon mineral oil, clean and sufficiently free from moisture and of other foreign matter likely to impair its properties.

The test results for the characteristics of the oil when tested in accordance with ISS 335-1993 (4th revision) or any equivalent International Standards incorporating up to date amendment and additional characteristic required by us shall be as hereunder: -

S. No	Schedule of Characteristics (Clause 5.1 & 9.1 of ISS)	Requirement of transformer oil	Reference to Test methods as per ISS-335-1993 read with latest amendment or Equivalent International Standard
1.	Appearance	Oil shall be clear & transparent, Free from suspended Matter or sediments.	A representative & sample of oil shall be examined In 100 mm thick Layer at 27°C
2.	Density at 29.5°C (Max.)	0.89 g/cm ³	IS:1448-1977

S. No	Schedule of Characteristics (Clause 5.1 & 9.1 of ISS)	Requirement of transformer oil	Reference to Test methods as per ISS-335-1993 read with latest amendment or Equivalent International Standard
3.	Kinematics Viscosity (Max.) at 27°C	27 cst	IS:1448-1976
4.	Interfacial tension At 27°C (Min.)	0.04 N/m	IS:6104-1971
5.	Pour point (Max.)	(-) 6°C	IS:1448-1970
6.	Water Content (Max.)	50 ppm	IS:13567 – 1992
7.	Flash Point Pensky Marten (Closed)(Min.)	140°C	IS:1448-1970
8.	Neutralization value (a) Total acidity (Max.) (b) Inorganic acidity/ Alkalinity	0.03 mg KOH/gm NIL	IS:1448-1967 IS:1448-1967
9.	Corrosive Sulpher	Non-corrosive	Annexure-B
10.	Electric Strength (Break down voltage) (a) New unfiltered oil (Min.) (b) New oil after filtration (Min)	30 KV (rms) 60 KV (rms)	IS:6972-1972
11.	Dielectric dissipation factor (Tan delta) at 90°C (Max)	0.002	IS:6262-1971
12.	Specific resistance (resistivity) a) At 90°C (Min) b) At 27°C (Min)	35x10 ¹² Ohm-cm. 1500x10 ¹² Ohm-cm.	IS:6103-1971
13.	Oxidation stability a) Neutralization value After oxidation (Max.) b) Total sludge after Oxidation (Max.)	0.40 mg KOH/gm. 0.10% by weight	Annexure-C of IS:335-1993
14.	S.K.Value	under consideration	Annexure-C of IS:335-1993

15.	<p>AGEING CHARACTERISTICS Ageing characteristics after accelerated ageing (open beaker method with copper catalyst).</p> <p>a) Specific resistance (resistivity)</p> <p>i) At 27°C (Min.)</p> <p>ii) At 90°C (Min.)</p> <p>b) Dielectric dissipation factor (Tan Delta) at 90°C (Max.)</p> <p>c) Total acidity (Max.)</p> <p>d) Total sludge value (Max.)</p>	<p>2.5x10¹² Ohm-cm</p> <p>0.2x10¹² Ohm-cm</p> <p>0.20</p> <p>0.05 mgKOH/gm.</p> <p>0.05% by weight</p>	<p>IS:12177-1987 (Method – A)</p> <p>IS:6103-1971</p> <p>IS:6262-1971</p> <p>IS:1448-1967</p> <p>Annexure -A of IS:12177</p>
16.	Presence of oxidation Inhibitor	The oil shall contain anti oxidant additives	IS:13631: 1992

(B) Characteristics of oil in the transformer:

The important characteristics of the transformer oil after it is filled in the transformer (within 3 months of filling) shall be as follows:

S.No.	Characteristics	Specification
1.	Electric strength (breakdown voltage)	40 KV (Min.)
2.	Dielectric dissipation factor (tan delta at 90°C)	0.01 (Max.)
3.	Specific resistance (Resistivity) at 27°C	10 x 10 ¹² Ohm.cm
4.	Flash point, P.M. (closed)	140°C (Min.)
5.	Interfacial tension at 27°C	0.03 N/m (Min.)
6.	Neutralization value (total acidity)	0.05 mg KOH/g (Max.)
7.	Water content PPM	35 (Max.)

11. TAPS:

11.1 Off-load tap transformers shall have taps ranging from +3% to -9% in steps of 3% each on HV winding for HV variation, to give normal 11 KV on LV side.

11.2 The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle will be provided with a locking arrangement alongwith tap position, indication and direction for operation, thus enabling the switch to be operated and locked in position. Tap operation shall result in simultaneous positive change on all three phase, with spring loaded snap action and ensure positive pressure contact.

12. WINDING CONNECTIONS & VECTORS:

12.1 The primary winding shall be connected delta and secondary winding star as per vector symbol Dy.11 (IS: 2026) or any equivalent International Standards so as to produce positive

displacement of 30° from the primary to the secondary vector of the same phase (vector rotation assumed counter-clock wise).

12.2 The neutral point of the secondary (LV winding) is intended for solidly earthed system and should be brought out to a separate insulated terminal, enabling external insertion of a current transformer in the earth lead to be connected wherever required.

12.3 All windings of transformers shall have uniform insulation when tested in accordance with ISS: 2026/1977 or any equivalent International Standards. The minimum basic impulse withstands level of windings for 1.2/50 micro sec.full wave shall be as given below: -

- i) 11 KV - 75 KV Peak
- ii) 33 KV - 170 KV Peak

13. PERCENTAGE IMPEDANCE AND TOLERANCE (OTHER THAN NO LOAD AND LOAD LOSSES) SHALL BE AS UNDER: -

a) **Percentage impedances** - Percentages impedance value for power transformers at 75°C on principal tap shall be as follows:

Rating	Percentage impedance value at 75°C
8000 KVA	7.15

b) Tolerance

Item	Tolerance
Voltage ratio at no load On principal tapping	the lower of the following values: a) (+ / -) 0.5% of the declared ratio b) A percentage of the declared ratio equal to 1/10 of actual percentage impedance voltage at rated current
Impedance voltage at Rated current (Principal tapping & Other tapping)	Requirement in this regard shall be governed by the provision indicated in IS:2026 (Part-IV) – 1977 Para 3.1.4.1 for principal tapping and as per Provisions contained in Para 3.1.4.2 for other tapping or any equivalent International Standard.
No load current	(+) 30% of the declared no load current

14. TRANSFORMER TANK:

The main tank of the transformer shall be made of good quality steel sheet of adequate thickness to provide sturdy and robust construction to withstand extreme pressure conditions. The internal and external surfaces including oil filled chambers and structural steel work to be painted shall be shot or sand blasted to remove all rust and scale of foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant, oil insoluble, insulating varnish. Steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of color distinct from primary and final two coats of glossy oil and weather resisting paint in accordance with the color shade as

specified. All paints shall be carefully selected to withstand extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. The minimum thickness of outside painting of tank shall be 20 microns and the total thickness shall be minimum 80 microns. The main tank exclusive of all accessories but with radiators shall be suitable to withstand application of vacuum up to 760 mm of HG. Adequate reinforcement shall be provided for this purpose and to withstand vibration.

14.1 **Pressure Test:**

One transformer tank shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m² (5lb/sq.in) whichever is lower, measured at the base of the tank and will be maintained for one hour during stage inspection. The permanent deflection of flat plates, after the excess pressure has been released shall not exceed the figure specified below:

Horizontal length of flat Plate (in mm)	Permanent deflection (in mm.)
Up to and including 750	5
751 to 1250	6.5
1251 to 1750	8
1751 to 2000	9.5
2001 to 2250	11
2251 to 2500	12.5
2501 to 3000	16
Above 3000	19

14.2 **Conservator:**

- (i) A conservator complete with sump and drain valve shall be provided in such a position so as not to obstruct the electrical connections of the transformer having a capacity between highest and lowest visible levels to meet the requirement of expansion of the total oil volume in the transformer and cooling equipment from the minimum ambient temperature of (-) 5°C to 95°C. The minimum indicated oil level shall be with the feed pipe from the tank covered with not less than 15 mm depth of oil and the indicated range of oil level shall be minimum to maximum.
- (ii) If the sump is formed by extending the feed pipe inside the conservator, this extension shall be for at least 25 mm.
- (iii) One oil gauge magnetic type with provision for low levels alarm shall be mounted on conservator to indicate the minimum normal and maximum level as given below:

Minimum	(-) 5°C
Normal	30°C
Maximum	100°C
- (iv) One prismatic type oil indicator should also be provided on the conservator.

- (v) One end flange of the conservator shall be bolted into position so that it can be removed for cleaning purpose.
- (vi) The oil connection from transformer tank to the conservator vessel shall be arranged at a rising angle of 3 to 9° to the horizontal up to gas and oil actuated relay.
- (vii) Each conservator vessel shall be fitted with a aluminum die cast breather in which Silica gel (at least three Kg.) is the dehydrating agent and designed so that:
 - (a) The passage of air is through silica gel.
 - (b) The external atmosphere is continuously in contact with silica gel.
 - (c) The moisture absorption indicated by a change in colour of the tinted crystals can be observed from distance.

Breathers shall be mounted at approximately 1400 mm. Above ground level.

14.3 **Radiators:**

Arrangement for good quality sufficient number of radiators should be made to meet out the requirement of temperature rise. Following should also be given due consideration:

- (i) Belting of radiators to avoid vibration
- (ii) The gasket should be square in shape with holes for fixing radiators. Round shape gasket may be avoided.
- (iii) Radiator valve must indicate open and close direction clearly.
- (iv) Radiators must be supplied in separate packing with serial number of transformer clearly indicated on packing with paint
- (v) Air release valve provided on radiator should not be of PVC material. It must be of cast iron duly cut in with thread for easy release of air.

14.4 **Galvanising:**

- (a) Galvanizing where specified should be applied by the hot dipped process or by electro-galvanizing process, for all the parts other than steel, which shall consist of a thickness of 610 Gms. zinc per square meter of surface. The zinc coating shall be smooth, clean and of uniform thickness and free from defects or sharp edge. The preparation of galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material. The quality will be established by tests as per IS: 2633 or any equivalent International Standards. Alternative to galvanizing, aluminizing shall also be considered
- (b) All drilling, punching, cutting and bending and welding of parts shall be completed and all burrs shall be removed before the galvanizing process is applied.
- (c) Surface, which is in contact with oil, shall not be galvanized or Cadmium plated.

15. **FINISH:**

Before painting or filling with oil, all ungalvanised parts shall be completely clean and free from rust, scale and grease and all external surface cavities on castings shall be filled by metal deposition.

- (b) The interior of all transformer tanks and other oil filled chambers and internal structural steel works shall be cleaned and all scale and rust by shot blasting or other approved methods. This should be read alongwith clause 14 regarding requirement of painting of transformer tank.
- (c) Except for nuts, bolts and washers, which may have to be removed for maintenance purposes, all external surfaces shall receive a minimum of three coats of paint.
- (d) The primary coat shall be applied immediately after cleaning. The second coat shall be of oil, heat and weather resisting nature and preferable of a shade or color easily distinguishable from the primary and final coats shall be applied after the primary coat has been touched up where necessary. The final coat shall be of a glossy oil, heat and weather resisting non-fading, **BATTLE SHIP GREY** paint of shade No.631 of IS: 5. Primer paint shall be red oxide zinc chrome as per IS: 104, intermediate and final coats of grey paint shall be as per IS: 2032 or any equivalent International Standards.
- (e) Nuts, bolts and washers, which may have to be removed for maintenance purposes, shall receive minimum of one coat of paint after erection.
- (f) The spacing of the bolt centers on the tank and its cover should be so designed that the gaskets when pressed after bolting leave no room for either ingress of moisture or leakage of oil during transportation or normal service or full load and guaranteed temperature rise conditions.

16. CORE:

The core shall be constructed from high grade, non-ageing, low loss cold rolled super grain oriented silicon steel lamination of HI-B grade steel or better. All stipulations under clause-8 be considered while selecting material of core.

(I) Magnetic circuit

- (a) The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or of the earth clamping structure and the production of flux components at right angles to the plane of the laminations, which may cause local heating.
- (b) Every care shall be exercised in selection, treatment and handling of core steel to ensure that so far as is practicable from distortion, burrs or sharp edge.
- (c) Although the oxide/silicate coating given on the core steel is generally adequate, laminations can be insulated by the manufacturers if considered necessary.
- (d) All ducts shall be provided wherever necessary to ensure adequate cooling and efficient heat transfer. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts nor permit local hot spots. Where the magnetic circuit is divided into pockets by cooling ducts parallel to the planes of the lamination or by insulating material above 0.25 mm thick tinned copper strip bridging pieces shall be inserted to maintain electrical continuity conductivity between pockets.
- (e) The framework and clamping arrangement shall be earthed in accordance with Clause-19 (II) of this Technical Specification.

(II) Construction of Cores

- (a) All parts of the cores shall be of robust design capable of withstanding any shocks to which they may be subjected to during lifting, transport, installation and service.
- (b) All steel sections used for supporting the core shall be thoroughly sand blasted and shot blasted after cutting, drilling and welding.
- (c) Adequate provision shall be made to prevent movement of the core and winding relative to the tank during transport and installation or while in service.
- (d) The supporting framework of the cores shall be so designed as to avoid the pressure of pockets, which would prevent complete emptying of the tank through the drain valve or cause trappings of air during oil filling.

17. TERMINAL ARRANGEMENT:

17.1 The transformers shall be fitted with shaded porcelain bushings of outdoor type suitable for solder less connectors on HV as well as LV side. The HV/LV bushing shall not be provided with arcing horns. Aluminum bushing stems and aluminum metal parts will not be accepted.

17.2 The bushings shall be filled with transformer oil, EHV grade, which shall be of non-oil communicating type with small aperture of 2 mm diameter. The HV/LV bushings shall have the characteristics as per IS: 2099 (latest issue) or any equivalent International Standards. LV neutral bushing requirement is identical to LV line bushing in all respect.

The electrical characteristics of bushing insulators shall be in accordance with IS: 2099 (latest issue) or any equivalent International Standards as amended from time to time. All type and routine tests shall be carried out in accordance with IS:2099-1986 or any equivalent International Standards. The test voltages for various tests as stipulated in IS:2099-1986 are reproduced below:

Nominal System Voltage	Rated Voltage of the Bushing	Visible discharge test	One minute wet & dry withstand (Impulse Voltage)	Lightning impulse withstand test
KV	KV	KV	KV	KV
11	12	9	28	75
33	36	27	70	170

17.3 Dimensions of the LV 12 KV bushings including the neutral (11 KV side) shall conform to IS:3347 (Part-III) or any equivalent International Standards and those of the 36 KV bushing (33KV side) shall conform to IS:3347 (Part-V) or any equivalent International Standards. Requirement of creepage distance of minimum 23 mm. Per KV of rated voltage of bushing as per provision contained in Para 7 of IS:2099-1993 or any equivalent International Standards.

17.4 Terminal connector shall be provided both for HV and LV terminal suitable for holding Raccoon Conductor up to capacity of 5 MVA and Dog/Panther conductor for 8 MVA transformers. It should be flat in shape. Its current capacity should be 600 Amps.

17.5 Bushing studs of 33 & 11KV should be of copper and conforming to IS: 3347 or any equivalent International Standards.

18. VIBRATIONS AND NOISE:

Every care shall be taken to ensure that the design and manufacture of all transformers and accessories shall be such as to reduce noise and vibration to the level obtained in good modern practice.

The manufacturers will ensure that the noise level shall not be more than 3 Db above the NEMA standard publication TR-1.

19. INTERNAL EARTHING ARRANGEMENT:

(I) General:

All metal parts of the transformer with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at some fixed potential.

(II) Earthing of core clamping structure :

The top main core clamping structure shall be connected to the tank body by a copper strip. The bottom clamping structure shall be earthed by one or more of the following methods:

- (a) By connection through vertical tie rods to the top structures.
- (b) By direct metal-to-metal contact with the tank base maintained by the weight of the core and the windings.
- (c) By a connection to the top structures on the same side of the core as the main earth connection to the tank.

(III) Earthing of magnetic circuit

- (a) The magnetic circuit shall be earthed to the clamping structure at one point only through a disconnectable link placed in an accessible position beneath an inspection opening in the tank core. The connection to the link shall be on the same side of that core and the main earth connection.
- (b) Magnetic circuits having an insulated sectional construction shall be provided with separate link for each individual section. When oil ducts or insulating barriers parallel to the plane of the laminations divide one magnetic circuit into two or more electrically separate parts, the ducts or barriers shall be bridged in accordance with Clause-16 (ii) and the magnetic circuit shall not be regarded as being of sectional construction.

(IV) Size of earthing connections:

All earthing connections with the exception of those from the individual cell clamping rings shall have a cross sectional area of not less than 0.8 sq.mm. Connections inserted between laminations of different section of core as per above (III) b shall have a cross sectional area of not less than 0.2 sq.mm.

(V) Leads from winding to bushing and intercake connection:

The leads from winding to bushing and intercake connection should be rigid enough to withstand normal vibration and transportation shocks and short circuit stresses. They should be spaced in such a way that necessary clearances are maintained not only in air but also with oil medium at the lowest permissive electrical strength as per relevant ISS over the period of normal service.

20. ELECTRICAL CLEARANCE:

The clearance in air between live conductive parts and live conductive part and earthed structure shall be as follows: -

Voltage	Medium	Clearance phase to phase	Clearance phase to earth
11000	Air	280 mm	205 mm
33000	Air	350 mm	320 mm

21. PARALLEL OPERATION:

The transformers of the same service voltage shall be suitable for parallel operation, the load being shared in proportion to the capacities and percentage impedance volts, which will be within that specified in the ISS or any equivalent International Standards

22. OVER LOAD CAPACITY:

- (a) Each transformer shall be capable of carrying sustained over loads as stated in ISS: 6600 or any equivalent International Standards
- (b) **Type of load:** - The transformer will supply a mixed power and lighting load with Varying power factor from 0.6 lag to 0.8 lead due to capacitors.

23 PERFORMANCE WARRANTY:

The manufacturer shall among other things warranty the following: -

- (i) Quality and strength of material used, both electrical and mechanical.
- (ii) Satisfactory operation during the warranty period of 30 months from the date of receipt at Stores or 24 months from the date of commissioning. This period will be reckoned from the day all accessories are received enabling assembly testing, commissioning and commercial operation of transformers.
- (iii) Performance figures are to be supplied by tenderer in the schedule of guaranteed particulars. In schedule of GUARANTEED TECHNICAL PARTICULARS, all details as required in IS:2026 or any equivalent International Standards shall be given.

24. TOLERANCE:

The tolerance of guaranteed performance figures shall be as specified in the Clause 11.1 as per latest version of IS: 2026 or any equivalent International Standards, except for the no load and load losses which is firm and shall not exceed guaranteed values.

25. WHEELS AND AXLES:

The transformers of 8000 KVA rating shall be provided with 4 Nos. flanged wheels suitable for use on a 1435 mm gauge Rail track. These wheels shall be suitable for being turned through an angle of 90° and locked in that position when the tank is jacked up. Other transformers shall be provided with 4 Nos. Bi-directional flat roller suitable for use on a 1000 mm. Gauge Rail track.

26. FITTINGS & ACCESSORIES:

Unless otherwise specified in the order, the following standard fittings as detailed in Schedule X attached shall be provided. The fittings shall be in accordance with the details to the extent these are specified in IS: 2026 or any equivalent International Standards.

- (i) Inspection cover is needed to inspect tapping connections of bushings, tapping connections of tap changer and to inspect core-earthing connection.

- (ii) Rating plate.
- (iii) Diagram plate with tap position and relative HV/LV voltage.
- (iv) Two earthing terminals.
- (v) Lifting lugs.
- (vi) 4 jacking pads
- (vii) Conservator with top filled cap and bottom drain valve.
- (viii) Dehydrating breather of required sizes in Aluminum Die. Casting with minimum three Kg. silica gel.
- (ix) Connecting pipe with valve and Buchholz relay.
- (x) Radiator with top air release plug and connected valves and bottom for connection to main tank. Air release valve should not be of PVC material. It should be of cast iron duly cut in with thread for easy release of air.
- (xi) HV - 3 bushings
- (xii) LV - 4 bushings
- (xiii) Off circuit tap switch with lock and 2 keys.
- (xiv) Thermometer (dial type) with one contact for alarm pocket for sensor of thermometer (dial type) with one contact for alarm complete with provision for its mounting is needed.
- (xv) Magnetic oil level gauge indicating three position of oil marked as follows:
 - Minimum - (-5°C)
 - Normal - (30°C)
 - Maximum - (100°C)
- (xvi) Oil filling hole and cap.
- (xvii) Air release device on tank top.
- (xviii) Pressure relief device through explosion vent diaphragm with fresh equalizer pipe air release plug. Please see foot note indicated in Schedule X "Schedule of Fittings".
- (xix) Gas and oil actuated relay.
- (xx) 2 filter valves (top valve, lower valve to be used also as drain valve). Locking arrangement should be provided on each valve to avoid theft of transformer oil by welding 'U' shape flat over each valve.

27. TESTS AND INSPECTION:

27.1 Type test:

The Purchaser intends to procure transformers whose design is successfully type tested for short circuit, lightning impulse test, loss measurement test and heat run test from an independent agency of national/international repute like CPRI, Bhopal/Bangalore, National Test House, Ghaziabad, ERDA, Baroda or to any recognized and reputed International Laboratory and or Institution.

The tenderers are required to carry out type test. The expenses to be incurred towards the following tests shall be borne by them. This may be kept in mind while quoting the price.

Type test includes following tests: -

- (i) Short circuit withstand test as per clause 16.11 Part-I IS:2026 or any equivalent International Standards. The requirement with regard to ability to withstand short circuit shall be governed by clause-8 and demonstration of ability to withstand short circuit shall be governed by clause-9 of IS:2026(Part-I)1977 or any equivalent International Standards. Accordingly, the symmetrical short circuit current to be used for the design and tests shall be governed by the Table-4 (IS:2026-Part-I 1977) or any equivalent International Standards and shall be 1000 MVA for the subject power transformers (highest system voltage 36 KV). The quantity preference would be given to those manufacturers who have carried out thermal ability test of 2 sec. after the dynamic withstand test of 9 shots of 0.5 seconds.
- (ii) Lightning impulse withstand test as per Clause-13 Part-III IS:2026 or any equivalent International Standards.
- (iii) Temperature rise test as per Clause-4 Part-II IS:2026 or any equivalent International Standards. One transformer of each rating shall be type tested at some independent laboratory of National/International repute like CPRI, ERDA etc. for temperature rise as per relevant ISS. However, the rise shall not be more than 50⁰C for winding and 45⁰C for oil above the ambient temperature.
- (iv) Loss Measurement Test – With value of No Load and Load Losses obtained at 75⁰C.

27.2 **Stage inspection:** The purchaser intends to ensure the quality of raw material being used and workmanship during course of manufacturing of power transformers. At time of core coil assembly, two representatives of purchaser will be deputed to carry out stage inspection. Only after clearance of stage inspection manufacturer will proceed further (tanking of core coil etc.) and will be required to offer transformer for pre-delivery final inspection.

27.3 **Routine Test:** - The following tests in addition to those listed in IS:2026 or any equivalent International Standards shall be carried out for routine tests. These tests are required to be carried out by the supplier at the supplier's cost on each and every unit manufactured by them and report shall be forwarded to Chief Project Director (D) office at the time of offering transformer for pre-delivery final inspection.

- (i) **Oil leakage test** - All the tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air/oil of a viscosity not greater than that of insulating oil conforming to IS: 335 or any equivalent International Standards at an ambient temperature and subjected to a pressure equal to the normal pressure plus 35 KN/m² (5lb/sq.in) measured at the base of the tank. This pressure shall be maintained for a period not less than 10 minutes during which time no leakage shall occur
- (ii) Di-electric test on transformer oil.
- (iii) Checking for pre-shrinkages - The transformer will be dried out for 16 hours at temperature between 80 to 100⁰C. The active parts shall be tightened and height of assembled unit shall be measured. The difference between two measurements shall not be less than two percent as compared to height measured at normal temperature.

(iv) Measurement of magnetizing current at low voltage i.e. 440V.

27.4 **Acceptance Test:** - The Purchaser/Representative at the firm's works shall witness the following tests:

1. All the routine tests as mentioned in 27.3 on each and every offered transformer.
2. Further, the Purchaser's Inspector reserves the right to carry out any other test for acceptance of offered transformers as per relevant specifications.

27.5 **Inspection:** 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.

The Purchaser has all the rights to conduct the test including type tests at his own cost by an independent agency where never there is dispute regarding the quality of supply or interpretation of test results. In the event of failure of transformers in such tests, the expenses incurred in testing and cost of transformer etc. shall be to the Supplier's account.

28. TEST REPORTS ON THE ANALYSIS OF RAW MATERIALS:

The tenderer shall indicate the source(s) of raw materials(s) called for in Schedule-VI and enclose test certificates and report on the analysis of electrolytic copper used for the winding and the steel used for core insulation material as also bought out items from sub-suppliers.

The quality of material used in prototype transformer, which has passed the type tests, shall be the same in all the ordered transformers. In case it is found that inferior quality of material is used, the transformer shall not be accepted.

Chief Engineer (S&P-EZ)
MPPKVV Co. Ltd., Jabalpur

ANNEXURE - VII

SCHEDULE OF FITTINGS

1. Rating and terminal marking plate
 - i) Purchase order number and date to be indicated on rating plate.
 - ii) Serial number of transformer to be indicated in rating plate.
 - iii) Mention copper winding to be made on the rating plate
2. H.V. Bushings oil filled bushings –
(Non oil communicating type with 2 mm aperture in the base diaphragm and top air release device where applicable)
3. L.V. Bushings, stud in porcelain bushing 11KV bushings shall be provided with arcing horns.
4. Earthing terminals 2 Nos.
5. Tank Lifting lugs 2 Nos.
6. Jacking pads 4 Nos.
7. Silica gel dehydrating breather (with three Kg. minimum gel content In aluminium die cast container).
8. Conservator with oil filling cap drain valve with plug & magnetic oil level gauge with alarm contacts.The oil level gauge shall have three positions of oil marked as follows :
 - a) Minimum (-5°C)
 - b) Normal (30°C)
 - c) Maximum (100°C)
9. Pressure relief device through Explosion vent diaphragm.
10. Gas and oil actuated relay with 2 contacts.
11. Thermometer (dial type) with one contact for alarm. Pocket for sensor of thermometer (dial type) with one contact for alarm complete with provision for its mounting.

12. Filter valves top and bottom (lower valve to be used as drain valve which should be able to drain oil completely).
13. Air release device
14. Bi-metallic connecting clamps for
 - (i) HV Studs - 3 Nos.
 - (ii) LV Studs - 4 Nos.
15. Axles and wheels : The transformers of 5000 KVA rating shall be provided with 4 Nos. flanged wheels suitable for use on a 1435 mm gauge Rail track .These wheels shall be suitable for being turned through an angle of 90° and locked in that position when the tank is jacked up.1600KVA and 3150 KVA transformers should be provided With bi-directional flat roller suitable for use on 1000 mm gauge Rail track.
16. Thermometer pocket
17. Detachable radiators with top and bottom shut off valves and air release plug on each radiator top.
18. a) Winding temperature indicator : These shall be with one set of contacts with : housed in M.B. transformers for alarm and trip. : box with flexible : leads and require : electrical : connectors.
- b) Oil temperature indicator with one contact for alarm
19. Inspection cover to inspect tapping connections of bushings, tapping connections of tap changer and to inspect core earthing connection.
20. W.P. Terminal box alarm and trip contacts with requisite connector.
- 21.
22. Off-Load circuit tap changing switch with indicator, handle and locking device with taps ranging from (+) 3% to (-) 9% in steps of 3% on HV side for HV variation. Direction for rotation marked limit stopper on extreme position.

NOTE FOR SL.NO.9

Pressure Relief Device

A safety valve of the chimney type with an equalizer Pipe interconnecting the top of the conservator and upper most Part of the safety valve shall be provided to prevent rise of oil in the safety valve pipe. A stop cork should also be provided in the interconnecting pipe. An air release cork shall also be fitted in a convenient position.

The safety valve pipe shall preferably take off from the side of the transformer near to the tank cover and not from the top of the tank cover. This is with a view to prevent the gases forming in the tank from rising into the safety valve pipe and thereby passing the gas and oil actuated relay (defeating its purpose) and for avoiding the necessity for providing a bottom diaphragm from the safety valve pipe which would be necessary in case it takes off from the tank cover. In case explosion vent is taken out from the top of transformer cover plate, a oil level gauge at the lower portion of explosion vent is to be provided to ensure that diaphragm fixed at lower portion of explosion vent is intact.

DATE

SIGNATURE WITH SEAL OF TENDERER

PLACE

NAME

STATUS

ANNEXURE – VIII

Capitalization of Transformer Losses:-

The following no load loss and load loss factors shall be used to capitalize the power transformer losses:-

- (i) No load losses : Rs. 40,000/- per KW
- (ii) Load losses : Rs. 16,000/- per KW

No load loss and load losses quoted by the tenderers shall be capitalized for comparison of prices.

Executive Engineer (Purchase)
O/o Chief Engineer (S&P-EZ) Jabalpur

ANNEXURE-IX

PRICE VARIATION CLAUSE FOR COPPER WOUND DISTRIBUTION TRANSFORMERS
COMPLETE WITH ALL ACCESSORIES AND COMPONENTS
(Of ratings upto 10 MVA and voltage up to 33 KV)
supplied against domestic contracts

This price variation clause is applicable for 'Copper Wound Distribution Transformers', with rating upto 10 MVA and voltages upto 33 KV. The clause is to be used for domestic contracts. A separate price variation clause IEEMA/ PVC/DIST-CU/DE/2003 has been evolved for above types of Transformers supplied against export/deemed export contracts under special imprest licensing scheme.

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:

$$P = \frac{P_o}{100} \left(13 + 23 \frac{C}{C_o} + 27 \frac{ES}{ES_o} + 9 \frac{IS}{IS_o} + 5 \frac{IM}{IM_o} + 11 \frac{TB}{TB_o} + 12 \frac{W}{W_o} \right)$$

Wherein,

P = Price payable as adjusted in accordance with above formula.

Po = Price quoted/confirmed.

Co = Average LME settlement price of copper wire bars.

ESo = The price is as applicable for the month, two months prior to the date of tendering
C&F price of CRGO 'M4' grade Electricals Steel Sheets
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

ISo = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)'
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of tendering.

IMo = Price of insulating Materials

This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

TBo = Price of Transformer Oil Base Stock

This price is as applicable on the 1st working day of the month, two months prior to the date of tendering.

Wo = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100)

This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in May 2004, the applicable prices of Copper Wire Bars (Co) and Transformer Oil Base Stock(TBo) should be for the month March 2004, where as the applicable price of CRGO Steel Sheets (ESo) and Insulating Material (IMo) should be as on 1st April 2004 and wholesale price index number for 'Iron & Steel' (ISo) should be for the week

ending first Saturday of February 2004 and all India average consumer price index no. (Wo) should be for the month of February 2004.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/TRF/ / prevailing as on first working day of the month.....i.e., one month prior to the date of tendering.

- C = Average LME settlement price of copper wire bars.
The price is as applicable for the month, two months prior to the date of delivery.
- ES = C&F price of CRGO 'M4' grade Electricals Steel Sheets
This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.
- IS = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)'
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of delivery.
- IM = Price of insulating Materials
This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.
- TB = Price of Transformer Oil Base Stock
This price is as applicable on the 1st working day of the month, two months 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, Govt. of India (Base 1982 = 100)

This index number is as applicable on the first working day of the month, three months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2004, the applicable prices of Copper Wire Bars (C) and Transformer Oil Base Stock (TB) should be for the month October 2004; where as applicable prices of CRGO Steel Sheets (ES) and Insulating material (IM) should be as on 1st November 2004 and wholesale price

index number for "Iron & Steel" (IS) should be for the week ending first Saturday of September 2004 and all India average consumer price index no. (W) should be for the month of September 2004.

The date of delivery is the date on which the transformer is notified as being ready for inspection/ dispatch (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 major raw materials like Copper, CRGO Steel Sheets, TOBS and Insulating pressboard etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under :-

1. The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars for one month prior to the month of the circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

2. The price of CRGO 'M4' grade Electricals Steel (in Rs./MT) is the average C&F price in US \$ per MT converted into Indian Rupees with applicable exchange rate prevailing as on 1st working day of the month, as quoted by primary producers. This price is landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3. The wholesale price index number for 'Iron & Steel' is as published by the Office of Economic Advisor, Ministry of Industry Govt. of India, New Delhi with base 1993-94=100. This wholesale price index number is being published weekly on provisional basis. However, the same gets finalized after eight weeks and is normally available after two months. Therefore, we are considering in our calculations this final index for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as Al, IM are published for the corresponding month.

4. The average price of Insulating materials (in Rs./Kg.) of pre-compressed pressboards of size 3mm and 10mm thick, 3200 mmX4100 mm C&F price in free currency per MT converted into Indian Rupees with applicable exchange rates prevailing as on 1st 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 TOBS is C&F price (in Rs./K.Ltr) for N-60 grade Oil as published in ICIS-LOR bulletin for the 1st week of the previous month. This price is normally published in US \$ per US Gallon, which is converted in Rs./K.Ltr with applicable exchange rate prevailing on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

(d) Some purchasers are purchasing oil immersed Transformers from manufacturers without first filling of oil. Oil for first filling is procured and filled by the purchasers. For such supplies PVC formula excluding Oil will apply as under:-

$$P = \frac{P_o}{89} \left(13 + 23 \frac{C}{C_o} + 27 \frac{ES}{ES_o} + 9 \frac{IS}{IS_o} + 5 \frac{IM}{IM_o} + 12 \frac{W}{W_o} \right)$$

Where description of P, Po, C, ES,IS,IM,W etc. remains same as mentioned earlier.

NOTE:- Any change in formula from IEEMA, shall be implemented automatically.

SCHEDULE -III

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

S.No.	Particulars	Rating 8MVA
1.	Continuous Max. Rating (MVA)	
2.	Normal Ratio of transformation	
3.	Method of Connection (Vector Group)	
4.	Max.Hot Spot Temp. (Ambient air temp. Shall be taken as 50°C).	
5.	Max. Oil Temp. (Ambient air temp. Shall be taken as 50°C).	
6.	Max.winding Temp. (Ambient air temp. Shall be taken as 50°C). (1.55 Tesla)	
7.	Maximum flux density in iron at normal voltage & frequency. (a) Cores - Kilo lines per Sq.Cm. (b) Yokes - -do- (c) Grade of core lamination	
8.	Type of transformer	
9.	Core: - (a) Core Material (i) Grade (ii) Thickness of lamination used (b) No. of steps (c) Dimensions of each core steps. (i) Breadth of step (ii) Thickness of step (d) Core diameter (e) Core length (leg center) (f) Window height (g) Details of insulation between bottom of core & Base Channel (h) Core height (inclusive of Base Channel and insulation in between (i) Gross core area	

- (j) Effective core area
 - (k) Nos. & Dimensions of steel channel used for clamping of core
 - (l) Size & No. of
 - (i) Core bolts
 - (ii) Tie rods
 - (m) Painting of core channel
 - (n) Whether yoke is cut or holes are made for LV connections. If yes, whether enforcement is done. Also indicate details of reinforcement.
 - (o) Size of support channel for Core base (cut channels are not acceptable).
10. Magnetizing current (% of rated current and at -9% tap).
11. Maximum current density in windings (2.5 A/mm^2)
- (a) Higher voltage
(Amps per sq.mm.)
 - (b) Lower voltage
(Amps per sq.mm.)
12. Windings
- (a) Material and type -
 - (i) H.V.
 - (ii) L.V.
 - (b) Size and cross section of winding wires without insulation for
 - (i) H.V.
 - (ii) L.V.
 - (c) Size and cross section of winding wires with insulation
 - (i) H.V.
 - (ii) L.V.
 - (d) Type of insulation of
 - (i) H.V. Winding
 - (ii) L.V. winding
 - (e) Internal & external diameter of
 - (i) H.V. Coil
 - (ii) L.V. Coil

- (f) No. of coils/phase
 - (i) H.V.
 - (ii) L.V.
- (g) Total No. of turns per coil
 - (i) H.V. Coil
 - (ii) L.V. Coil
- (h) Method of connection of winding ends to bushing terminals
 - (i) LV winding to bushing
 - (ii) HV winding to bushing
 - (iii) Formation of Star point
 - (iv) Star point to bushing
 - (v) Formation of delta
- (i) Resistance/phase at 75°C
 - (i) H.V.
 - (ii) L.V.
- (j) Height of H.V. Coil
- (k) Height of L.V. Coil
- (l) Turn Ratio H.V / L.V
 - For tap I (+3)
 - II Normal
 - III (-3)
 - IV (-6)
 - V (-9)
- 13. Fixed losses at normal ratio at 75°C (KW)
(Max.)
- 14. Load losses at normal ratio at 75°C (KW)
(Max.)
- 15. Total losses at normal ratio at 75°C (KW)
(Max.)
- 16. Whether above losses are maximum without
any tolerance
- 17. Impedance voltage at normal ratio between HV
& LV windings at 75°C.
- 18. Impulse test level of HV & LV windings
- 19. Efficiency at normal ratio (at 75°C).
 - (i) Unit power factor and
 - (ii) 0.8 Power Factor at 50%, 75% and full
load

20. Regulation as percentage of normal voltage (at 75°C) at Unity P.F. and at 0.8 P.F.
21. Maximum out of balance force in winding on short circuit with external reactance as zero.
22. Insulation material:
Insulation material used & its thickness:
 - a) Between core & LV
 - b) Spacers
 - c) Inter layer
 - d) Between HV & LV winding
 - e) Between phase
 - f) End insulation
23. Clearance in mm.:
 - a) L.V. to core (Radial)
 - b) Between HV & LV (Radial)
 - c) Phase to phase between HV conductor (with min. of 2x1 mm Press Board to cover the rods).
 - d) Between winding & body
 - e) End insulation
 - f) Thickness of locking spacers between HV coils.
 - g) Axial wedges between H.V and L.V coils
 - h) Clearance between top cover and top yoke.
 - i) No. of radial spacers/phase
 - (i) H.V.
 - (ii) L.V.
 - j) Size of duct between L.V & H.V
24. Method of clamping of core & also whether clamping arrangements by steel sections or by wooden block.
25. Type of quality of steel/wood used in the transformer for insulation purpose.
26. Tank
 - (a) Shape
 - (b) Thickness of tank sheets in mm.:

- (i) Top & Bottom
 - (ii) Side walls
 - (iii) Collar
 - (c) External dimensions of tank in mm.
 - (i) Length (l)
 - (ii) Breadth (b)
 - (iii) Height at middle
27. Bushing:
- (a) Characteristics:
 - (i) Dry withstand voltage
 - H.V.
 - L.V.
 - (ii) Wet withstand voltage
 - H.V.
 - L.V.
 - (iii) Impulse flash over voltage
 - H.V.
 - L.V.
 - (b) Material of bushing rods
 - H.V.
 - L.V.
 - (c) Size of bushing rods
 - H.V.
 - L.V.
 - (d) Bushing clearance shortest on both HV & LV side
 - (i) Phase to phase
 - (ii) Phase to earth
28. Conservator
- (a) Dimensions
 - (b) Volume of oil
 - (c) Thickness of sheet in mm.
29. Radiators:
- (a) Nos. of Radiator
 - (b) Nos. of fins per radiator
 - (c) Size of fin
 - (d) Thickness in mm.

30. Oil to be filled in:
 - (a) Grade characteristics as per Specification
 - (b) Transformer tank
 - (i) Volume (in Ltrs.)
 - (ii) Weight (in Kgs.)
 - (c) Conservator
 - (i) Volume (in Ltrs.)
 - (ii) Weight (in Kgs.)
 - (d) Total oil filled in transformer
 - (i) Volume (in Ltrs.)
 - (ii) Weight (in Kgs.)
31. Overall dimension of transformer (In mm.)
 - (a) Length
 - (b) Breadth
 - (c) Height
32. Dimension of transformer arranged for transport (In mm.)
 - (a) Length
 - (b) Breadth
 - (c) Height
33. Engraving of S.No. & Name of firm :
 - (a) On bottom of core clamping channel
 - (b) Side wall & top cover of tank
 - (c) Date of dispatch on the tank
34. Weight of bare windings in Kg.
 - (a) H.V.
 - (b) L.V.
35. Weight of insulated winding in Kg.
 - (a) H.V.
 - (b) L.V.
36. Weight of core & windings assembly
37. Weight of core only
38. Weight of tank & fittings including radiators but without oil.
39. Weight of complete transformer including all fitting & oil.
40. Weight of detachable accessories/ fittings.

41. Weight of complete transformers arranged for transportation (MT).
42. Colour of transformer
43. Reference to type test reports for tendered rating of Transformer with tapping with place and date where tested
 - (a) Short circuit test report No. & Date
 - (b) Lightning impulse test report no. & Date and place
 - (c) Loss measurement with place, date etc.
 - (d) Temperature rise test with place, date etc.
44. Whether tap range of Off Load tap changer is from (+) 3% to (-) 9% in steps of 3% on HV side of transformer.
45. Size of contact of tap changers
46. Material of contact of tap changer