TECHNICAL SPECIFICATION FOR 5 MVA POWER TRANSFORMERS

1.0 Scope:

This specification covers the design, manufacture, testing, supply, delivery at site according to the following specifications of the following transformer.

- 5000 KVA 33/11 KV Power Transformers fitted with on load tap changer

The material should be guaranteed for satisfactory operation for Five years from the date of receipt of material in stores

It is not the intent to specify completely herein all the details of the design and construction of equipment. However the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation upto the Bidder's guarantee, 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 there with. 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.

2.0 Standards :

The transformers shall conform in all respects to IS-2026/1977 (with latest Amendments) / IEC 600 76 –1993 (with latest Amendments if any) except where specified otherwise. Equipment meeting any other authoritative standard which ensures an equal or better quality than the standards mentioned above will also be acceptable. In such a case, a copy of standard (English version) followed should be enclosed with the tender. Acceptability of any alternative standard is at the discretion of purchaser

The finished Power Transformer, oil, bushings, tap changer etc., that are used in manufacturing of transformer shall conform in all respects to the relevant Indian Standard Specifications / IEC Standards, with latest amendments as indicated below.

Indian Standard	**Title**	**International & Internationally recognized standard**
IS-2026/1977	Specification for Power transformers Part I to IV	IEC – 600 76 –1993 – Power Transformers – Part 1 to 5. IEC 60 071
IS : 335/1993	New insulating oils Electrical Clearances	
IS-3347 and IS 2099/1986	Bushings for alternating voltages above 1000V.	
IS 8468-1977	Specification for on load Tap changer	
IS 3639	Specification for fittings and accessories for Power Transformer	

IS 6600	Specification for loading of Power Transformer	

2.1 **CONFLICT OF STANDARDS :**

Equipment conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above would also be acceptable. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English Translations, shall be furnished along with the offer. In case of conflict the order of precedence shall be (i) IS (ii) IEC (iii) Other standards. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail.

3.0 **CLIMATIC CONDITIONS :**

As noted in clause No.23 of General Terms & Conditions the Power Transformer to be supplied against this Specification shall be suitable for satisfactory continuous operation under the following climatic conditions.

i)	Location	At various locations in the state of Andhra Pradesh
ii)	Max. ambient air temperature (deg.C)	50
iii)	Min. ambient air temperature (deg.C)	7.5
iv)	Average daily ambient air temperature (deg.C)	35
v)	Max. Relative Humidity (%)	100
vi)	Max. altitude above mean sea level (Meters)	1000
vii)	Average Annual rainfall (mm).	925
viii)	Max. wind pressure(kg/sq.m.)	200
ix)	Isoceraunic level (days per year)	50
x)	Seismic level (Horizontal accn.)	0.3 g.

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

4.0 **PRINCIPAL PARAMETERS :**

4.1 **Design and Standardisation :**

4.1.1 The transformer 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 the load and voltage as may be met with under working conditions on the system, including those due to short circuit.

4.1.2 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 requirements of Indian Electricity Rules.

4.1.3 All materials used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature, and atmospheric conditions arising under working conditions without undue distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of various parts for the work for which they have to perform.

4.1.4 Corresponding parts liable for replacement shall be interchangeable.

4.1.5 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. 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 eg. large valve bodies, unless otherwise specified.

4.1.6 All out-door apparatus, including bushing insulators with their mountings, shall be designed so as to avoid pockets in which water can collect.

4.1.7 Means shall be provided for easy lubrication of all bearings and where necessary of any mechanism or moving parts that are not oil immersed.

4.1.8 All mechanism where necessary shall be constructed of stainless steel, brass or gun metal to prevent sticking due to rust or corrosion.

4.1.9 All taper pins used in any mechanism shall be of the split type complying with IS No. 2393 (latest version) for these items.

4.1.10 All connections and contacts shall be of sample section and surface for carrying continuously the specified currents without undue heating and fixed connections shall be secured with bolts or set screws of ample size, adequately locked. Lock nuts shall be used on stud connections carrying current.

4.1.11 All apparatus shall be designed to minimize the risk or accidental short circuit caused by animals, birds or vermin.

4.2 GALVANISING:

4.2.1 Galvanising shall be applied by hot-dip process or by electro galvanising process for all parts other than steel wires and shall consist of a thick ness of zinc coating equivalent to not less than 610 gm zinc per square meter of surface. The zinc coating shall be smooth clean and of uniform thickness and free from defects. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material. The quality will be established by tests as per IS:2630 (latest version). (Alternatively to galvanizing, aluminising may also be considered).

4.2.2 All drilling, punching, cutting, bending and welding of parts shall be completed and all burrs shall be removed before the galvanising process is applied.

4.2.3 Galvanising of wires shall be applied by the hot-dip process and shall meet the requirements of the relevant IS. The zinc coating shall be smooth, clean and uniform thickness and free from defects. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of wire.

4.2.4 Surfaces which are in contact with oil shall not be galvanized or cadmium plated

4.3 LABLES:

4.3.1 Lables shall be provided for all apparatus such as relays, switches, fuses contained in any cubicle or marshaling kiosk.

4.3.2 Descriptive lables for mounting indoors or inside cubicles and kiosks shall be of material that will ensure permanence of lettering. A matt or satin finish shall be provided to avoid dazzle from reflected light. Lables mounted on dark surface shall have white lettering on a black background. Danger notices shall have red lettering on a white back ground.

4.3.3 All plates shall be of noncorrosive material.

4.3.4 Lables shall be attached to panels with brass screws or with stool screws which have received rust preventive treatment or those can be stuck with araldite also.

4.4 BOLTS & NUTS :

4.4.1 Steel bolts and nuts exposed to atmosphere with suitable finishes like cadmium plated or zinc plated passivity shall be used for diameters above 6 mm

4.4.2 All nuts and pins shall be locked in position with the exception of those external to the transformer. Bolts and nuts external to the transformers shall be provided with double flat washer and one spring washer.

4.4.3 On out-door equipment, all bolts, nuts and washers in contact with non-ferrous parts which carry current shall be of phosphor bronze where the transfer of current is through the bolt.

4.4.4 If bolts and nuts are placed so that they are in accessible by means of ordinary spanners, suitable special spanners shall be provided by the supplier.

4.5 **CLEANING AND PAINTING:**

4.5.1 Before painting or filling with oil in case of Transformer, all un-galvanised parts shall be completely clean and free from rust, scale and grease and all external rough surface cavities on castings shall be filled by metal deposition.

4.5.2 The interior of all transformer tanks and other oil filled chambers and internal structural steel work shall be cleaned of all scale and rust by shot-blasting or other approved method. These surfaces shall be painted with hot oil resisting epoxy paint. Minimum paint thickness shall be 40 microns.

4.5.3 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.

4.5.4 The primary coat shall be applied immediately after cleaning. The second coat shall be of an oil and weather resisting nature and preferably of a shade or colour easily distinguishable from the primary and final coats shall be applied after the second coat has been touched up where necessary. **The final coat shall be of a glassy, oil and weather resisting non-fading paint of shade No. 631 of IS.5. primer paint shall be readymade zinc chrome as per IS-104 intermediate and final coats of paint shall be as per IS-2932.**

4.5.5 Nuts, bolts and washers, which may have to be removed for maintenance purposes shall receive a minimum of one coat of paint after fixation.

4.5.6 All interior surfaces of mechanism chambers and kiosks except those which have received anti-corrosion treatment shall receive three coats of paint applied to the thoroughly cleaned metal surface. The final coat shall be of a light coloured anti-condensation mixture.

4.5.7 Any damage to paint work incurred during transport and erection shall be made good by the supplier by thoroughly cleaning the damaged portion and applying

the full number of coats of paint that had been applied before the damage was occurred.

4.5.8 The paint work shall be guaranteed for a minimum period of 5 years from the date of receipt of the equipment.

4.5.9 One coat of additional paint shall be given at site by the supplier. Supplier shall supply the requisite quantity of paint.

5.0 TECHNICAL REQUIREMENTS:

5.1 OIL:

5.1.1 The transformers and all associated equipment shall normally be supplied along with the fresh filled oil. The oil shall conform as per IS : 335/1993_with latest amendment and it shall be free from moisture and have uniform quality throughout.

To ascertain the quality of the Transformer oil, the original manufacturer's test report shall be submitted at the time of inspection. Also arrangements should be made for testing of transformer oil, after taking of the sample from the manufactured transformer and tested in the presence of AP_PDCL's representatives or in an independent laboratory CPRI/ ERADA at the discretion of AP_PDCL

5.1.2 Oil filled in transformers. The important characteristic of the transformer oil after it is filled in the transformer (within 3 months of filling) shall be as follows:

Sl.No	Characteristics	Specification
1.	**Electric strength (BDV) (2.5mm gap)**	**30 KV (minimum) RMS**
2.	**Dielectric dissipation factor (Tan delta) at 90^{o} C**	**0.01 (max)**
3.	**Specific resistance (resistivity) at 27^{o}C (Ohm-cm)**	**$1500x10^{12}$ (min)**
4.	**Flash point pensky – Marton**	**140 Deg. C (min) (closed)**
5.	**Inter facial tension at 27 Deg C**	**0.04 N/M (min)**
6.	**Neutralisation value (total acidity) (maximum)**	**0.03 mg KOH/gm (max)**
7.	**Water content PPM**	**35 (max)**

5.1.3 **Prevention of Acidity:**

The design and all materials and process used in the construction of the transformers shall be such as to reduce to a minimum the risk of the development of acidity in the oil. Special measures, such as nitrogen sealing or the use of inhibited oil, shall not be resorted to.

5.1.4 **Electrical Characteristics and Performance:**

Type of transformers and operating conditions, transformers shall be oil immersed and naturally cooled, core type and shall be suitable for out-door installation, and

shall be provided with conservator vessels. The type of cooling shall be as stated in the relevant specifications.

5.1.5 **CONTINUOUS MAXIMUM RATING AND OVERLOADS:**

Transformers shall comply as regards to rating temperature rise and overload with the appropriate requirements of IS 2026 when operating with ONAN cooling. Transformers shall be capable of operation continuously in accordance with IS loading guide at their C.M.R and at any ratio irrespective of the direction of flow of power and with voltage of the untapped winding maintained at the voltage stated in the ordering schedule.

5.1.6 Transformers having tapping ranges extending not more than 5 percent below the nominal voltage shall operate on the principal / tapping without exceeding the limits laid down in IS-2026 for oil temperature rise and winding temperature rise as measured by resistance. On the other tappings, they shall operate continuously without injurious heating.

5.1.7 Transformers except where stated below with tapping ranges extending more than 5 percent below the nominal voltage, shall meet the temperature rise limits specified in IS 2026 on all tappings on which the rated current is not more than 95 percent of the maximum rated current on the lowest voltage tapping. On other tappings, 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.

5.1.8 The transformers may be operated without danger on any particular tapping at the rated KVA provided that the voltage does not vary by more than $\pm$ 10% of the voltage corresponding to the tapping.

Note: Operation of a transformer at rated KVA at reduced voltage may give rise to excessive losses and temperature rise.

5.2 **VOLTAGE RATIO :**

5.2.1 The voltage between phases on the higher and lower voltage winding of each transformer measured at no load and corresponding to the normal ratio of transformation shall be those stated in the ordering schedule. Means shall be provided for varying the normal ratio of transformation in accordance with the clause 5.35 voltage control on load type.

5.3 **ELECTRICAL CONNECTIONS :**

Transformers shall be connected in accordance with the IS group symbol Dy 11.

5.4 **FREQUENCY :**

The transformers shall be suitable for continuous operation with frequency variation of $\pm$ 3% from normal 50 C/S without exceeding specified temperature rise.

5.5 **DUTY UNDER FAULT CONDITIONS :**

5.5.1 Except where modified below, it is to be assumed that the amount of generating plant simultaneously connected is such that normal voltage will be maintained on one side of any transformer when there is a short circuit between phases or phase to earth on the other side. Any transformer may be directly connected to an underground cable or over head transmission line and switched into and out of service together with its associated transmission line.

5.5.2 All Transformers shall be capable of withstanding without any damage to external short circuit between phases and phase to ground according to IS: 2026 or its latest version.

5.6 **LOSSES**

5.6.1 The maximum loss of each transformer shall be as indicated below:

The fixed losses should be as low as is consistent with normal design, reliability and economical use of material. **The offers for transformers with higher losses will be liable for rejection.**

	5 MVA
No load losses	**4500W (max.)**
Load losses at 75°C	**25000 W (max.)**

5.6.2 **Penalty for excessive losses :** During testing if it is found that actual measured losses are more than the values quoted by the bidder, the purchaser will have right to exercise one of the following options :

a) Reject the complete lot

b) Penalty shall be recovered from the Bidder at double the loss rate as specified below. For Fraction of a KW evaluation will be on prorata basis.

No load losses : Rs. 2,17,515 per KW

Load losses : Rs.28,772 per KW

c) The purchaser reserves the right to reject any transformer, if during tests at supplier's works, the tested no load losses and total losses, exceed the corresponding maximum guaranteed values.

d) The purchaser reserves the right to test any one transformer from each lot offered for inspection/supply in any independent laboratory of national repute for the purpose of testing the no load and load losses. The entire expenses for the same shall be borne by the firm and results obtained shall be considered and applicable in all the supplies

e) The supplier shall provide, along with the tender, design, details of core assembly showing the constructional details, core diameter, net/gross sectional area of the core assembly etc. The information must also be given in respect of voltages per turn at principal tap for normal voltages. The loss curves for type /grade of steel laminations being used for core shall also be provided along with the tender documents.

5.6.3 **Tolerance :**

S.No	**Item**	**Tolerance**
I.	Voltage ratio at principal tapping	The lower of the following a) $\pm$ 0.5% of the declared ratio b) A percentage of the declared ratio equal to $1/10^{th}$ of the actual %

		impedance voltage at rated current.
II.	Impedance voltage at rated current (Principal tapping)	The tolerance on percentage impedance at principal tapping and all other taps, tolerance will be applicable as per IS – 2026.
III.	No load current	+30% of the declared no load current.

5.7 **REGULATION AND IMPEDANCE :**

The impedance voltage at normal ratio of transformation and normal rating shall be 7.15% for 5.0 MVA transformers. The tolerance as per IS. The impedance value measured on any other tapping shall not exceed the value measured on the principal tapping by more than 10% impedance.

5.8 **TEMPERATURE :**

The Power Transformers shall be suitable for installation at location where ambient temperature is as indicated below and temperature rise final not to exceed the limit prescribed below:

1.	**Maximum Ambient Temperature**	**50 Deg C**
2.	**Maximum oil temperature rise by thermometer**	**40 Deg C**
3.	**Maximum winding temperature rise by winding resistance measurement**	**50 Deg C**

5.9 **FLUX DENSITY :**

5.9.1 The maximum flux density in any part of the core and yoke, at normal ratio and at normal voltage and frequency, of each transformer shall be stated. The normal flux density for cold rolled grain oriented steel laminations **shall not exceed 1.6 tesla, at normal tap position. Over fluxing should be limited to 12.5%.**

5.9.2 However, incase of transformers with variable flux the voltage variation which would affect flux density at every tap shall be kept in view while designing transformers.

5.10 **VIBRATION AND NOISE :**

5.10.1 Every care shall be taken to ensure that the design and manufacture of all transformers and auxiliary plant shall be such as to reduce noise and vibration to the level of that obtained in good modern practice. The maximum noise level should be as per NEMA standard.

5.10.2 The manufacturer will ensure that the noise level shall not be more than the NEMA standard publication TR-1.

5.11 SUPRESSION OF HARMONICS :

The transformers shall be designed with particular attention to the suppression of harmonic voltages, especially the third and fifth, so as to eliminate wave form distortion and from any possibility of high frequency disturbances, inductive

effect loop circulating currents between the neutral points at different transforming stations reaching such a magnitude as to cause interference with communication circuits. For achieving this suppression of harmonics delta connected stabilizing winding should be avoided.

5.12 **CORE :**

The core shall be constructed from high grade cold rolled non-ageing grain oriented silicon steel laminations, M4 or Superior Grade.

Only prime quality CRGO sheets should be used in the transformers and no Second/Defective/Scrap CRGO finds way into transformers. Therefore regarding quality control following documents are to be furnished before giving the inspection offer.

1. Invoices of supplier
2. Mill's test certificate
3. Packing list.
4. Bill of landing
5. Bill of entry certificate by custom
6. Description of material, electrical analysis, Physical inspection, certificate for surface defects, thickness and width of the material.
7. Subjecting to at least 10% of the transformers to routine tests and no load and load loss measurement.

   It is to note that, using seconds/defective CRGO sheets or load losses found to be more than stipulated limit, heavy penalty will be imposed or the suppliers will be black listed.

5.13 MAGNETIC CIRCUIT :

5.13.1 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself of to the earthed clamping structure and the production of flux components at right angles to the planes of the laminations which may cause local heating.

5.13.2 Every care shall be exercised in the selection, treatment and handling of core steel to ensure that as practicable the laminations are flat and the finally assembled core is free from distortion.

5.13.3 Each lamination shall be insulated with a material that will not deteriorate due to pressure and the action of hot oil.

5.13.4 Oil ducts shall be provided where necessary to ensure adequate cooling. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts, where the magnetic circuit is divided into pockets by cooling ducts parallel to the plane of the laminations or by insulation material above 0.25mm thick tinned copper strip brazing pieces shall be inserted to maintain electrical continuity between pockets.

5.13.5 The frame work and clamping arrangements shall be earthed.

5.13.6 The class and type of insulation used on the core bolts and under the nuts and side plates shall be stated in the guaranteed technical particulars. Adequate core clamping arrangements shall be made to prevent distortion or wavy form of laminations and withstand short circuit forces. Core clamping bolts shall be effectively insulated with Kraft paper and fibre glass tubes. All the tie rods fixing the core shall be phosphated.

5.14 MECHANICAL CONSTRUCTION OF CORE

5.14.1 All parts of the cores shall be of robust design capable of withstanding any shocks to which they may be subjected during lifting, transport, installation and service.

5.14.2 All structural members of the assembled cores shall be of steel. All castings shall be fitted and structural steel adequately cleaned and painted before being built into the structure. Any non-magnetic or high resistance alloy used shall be of established quality.

5.14.2 Adequate filaments shall be provided to enable the core and windings to be lifted.

5.14.4 Suitable provision shall be made for the storage of any removable portions of the lifting tackle on the transformer tank.

5.14.5 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.

5.14.6 The supporting frame work of the cores shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve or cause trapping or air during filling.

5.15 WINDINGS:

5.15.1 A) All windings shall be made of electrolytic high conductivity copper, shall be fully insulated as defined in IS:2026. All neutral points shall be insulated for the voltage specified in IS 2026. The windings shall be so designed that all coil assemblies of identical voltage, rating shall be inter changeable. **The maximum allowable current density is 2.5 A/mm^2**

B) INSULATION DETAILS : The MPC shall be 0.6 mm (min.) maintained for HV winding and 0.5 mm (min.) for LV winding. The negative tolerance shall not be allowed in paper covering.

(i) HV coil to yoke : 50 mm (min.)

(ii) LV coil to yoke : 50 mm (min.)

(iii) Inter-coil spacers between HV sections : 3 mm (min.)

(iv) Channel separator : 3 mm (min.)

(v) Bottom foot channel insulation : 3mm (min.)

(vi) Inter-phase barrier : 2 x 1.5 mm (min.)

(vii) Cylinder between core to LV : 2 x 1.5 mm (min.)

(viii) Oil duct between LV to cylinder : 6 mm (min.)

(ix) Oil duct between cylinder to HV : 6 mm (min.)

(x) Type of block between HV sections : Press Boards

(xi) Number of blocks per circle (number) : 12 Nos. (min.)

(xii) Internal clearance between the inner wall of the tank and the outside surface of the HV coil :

(a) On length side : 100 mm (min.)

(b) On breadth side : 150 mm (min.)

(xiii) Radial clearance between LV and HV : 20 mm (min.)

(xiv) Phase-to-phase clearance between HV limbs : 20 mm (min.)

(xv) Clearance between top of yoke and inside of tank cover : 150 mm (min.)

5.15.2 Power Transformer shall be designed to withstand the impulse test voltage as per IS 2026.

5.15.3 The transformer shall withstand the power frequency voltage test as per IS:2026.

5.15.4 The windings shall be designed to reduce to a minimum the out-of-balance forces in the transformer at all voltage ratios.

5.15.5 The insulation of transformer windings and connection shall be free from insulating composition liable to soften, ooze out, shrink or collapse during service.

5.15.6 The stacks of windings shall receive adequate shrinkage treatment before final assembly.

5.15.7 The coil clamping arrangement and the finished dimensions of any oil duct shall be such as will not impede the free circulation of oil through the ducts.

5.15.8 No strip conductor wound on edge shall have a width exceeding six times its thickness.

5.15.9 The conductors shall be transposed at sufficient intervals in order to minimise eddy currents and equalize the distribution of currents and temperature along the windings.

5.15.10 The HV winding shall be arranged so as able to be removed without hindrance to and causing any damage to the LV winding.

5.16 **BRACING OF WINDING :**

5.16.1 The windings and connections of all transformers shall be braced to withstand shocks which may occur during transport or due to switching and other transport condition during service.

5.16.2 Coil clamping rings, if provided shall be of steel.

5.16.3 Any metal pieces in contact with laminated rings shall be so designed and secured that they do not weaken the electrical or the mechanical properties of the rings.

5.16.4 If the transformer winding is built up of section of disc coils, separated by spacers, the clamping arrangements shall be such that equal pressure are applied to all columns of spacers. All such spacers shall be securely located, shall be of suitable material and shall receive adequate shrinkage treatment before assembly.

5.17 **INTERNAL EARTHING ARRANGEMENTS**

5.17.1 **INTERNAL EARTHING 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.

5.17.2 **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 structure

b) By direct metal-to-metal contact with the tank base, maintained by the weight of the core windings.

c) By a connection to the top structure on the same side of core as the main earth connection to the tank.

5.18 **EARTHING OF MAGNETIC CIRCUIT :**

5.18.1 The magnetic circuit shall be earthed to the clamping structure at one point only through a link placed in an accessible position beneath an inspection opening in the tank cover. The connection to the link shall be on the same side of the core as the main earth connection.

5.18.2 Magnetic circuits having an insulated sectional construction shall be provided with a separate link for each individual section where oil ducts or insulating barriers parallel to the plane of the laminations divide the magnetic circuit into two or more electrically separate parts the ducts or barriers shall be bridged in accordance with Clause 5.13.4 and the magnetic circuit shall not be regarded as being of sectional construction.

5.19 **EARTHING OF COIL CLAMPING RINGS :**

Where coil clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of transformer as the main earth connections.

5.20 **SIZE OF EARTHING CONNECTIONS :**

All earthing connections with exception of those from the individual coil clamping rings shall have cross sectional areas of not less than 0.8 Sq cms. Connections inserted between laminations may have the cross sectional area reduced to 0.2 Sq cm.

5.21 **TANK :**

5.21.1 **Tank Construction: The tank should be rectangular in shape.** The tanks of all transformers shall be complete with all accessories and shall be designed so as to allow the complete transformer in the tank and filled with oil to be lifted by crane or jacks, transported by road, rail or water without over straining any joint and without causing subsequent leakage of oil.

5.21.2 The main tank body excluding tap changing compartments, shall be capable of withstanding a full vacuum of 760 mm of mercury, when empty of oil.

5.21.3 The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using rollers, plates or rails.

5.21.4 Normally a detachable under base will be used, but in case transport facilities permit, a fixed under base can be used.

5.21.5 Where the base is of a channel with iron construction, it shall be designed to prevent retention of water.

5.21.6 The base channels for the transformers covered by this specification shall be 200x75/76 mm Transformers **and bottom channels should not be curved**.

5.21.7 Tank stiffeners shall be continuously welded to the tank and designed to prevent retention of water.

5.21.8 Wherever possible the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes

shall have minimum inside diameter of 15mm except for short branch pipes which may be 6mm minimum inside diameter.

5.21.9 All joints other than these which may have to be broken shall be welded **and number of tank welding joints should not be more than 4**.

5.22 LIFTING AND HAULAGE FACILITIES :

Each tank shall be provided with:

(a) **Lifting lugs should be 4 nos. and** suitable for lifting the transformer complete with oil.

(b) A minimum of four jacking lugs, in accessible positions to enable the transformers complete with oil to be raised or lowered using hydraulic or screw jacks. The maximum height of the lugs above the base shall be:

(i) Transformers upto and including 10 tonnes weight, 800 mm excluding the under base dimensions.

(ii) Transformers above 10 tonnes weight, 500 mm excluding the under base dimensions. If detachable

(c) Suitable haulage holes shall be provided.

5.23 TANK COVER :

5.23.1 Each tank cover shall be of adequate strength, and shall not distort when lifted. Inspection openings shall be provided as necessary to give easy access to bushings, for changing ratio or winding connections, or testing the earth connections at the link board. Each inspection opening shall be of suitable size for the purpose for which it is provided and atleast two openings one at each end of the tank shall be provided.

5.23.2 **The tank cover should have 2 nos. lifting lugs and inspection covers should have 1 no. lifting hook to be provided for lifting arrangements**. Unless otherwise approved inspection covers shall not weigh more than 25 kg each.

5.23.3 The tank cover shall be fitted with pockets for a thermometer and for the bulbs of the oil winding temperature indicators, protection shall be provided wherever necessary for each capillary tube.

5.23.4 The thermometer pocket shall be fitted with a captive screwed cap to prevent the ingress of water.

5.23.5 The pockets shall be located in the position of maximum oil temperature at CMR and it be possible to remove the instrument bulbs without lowering the oil in the tank (C.M.R Continuous Maximum Rating)

5.24 CONSERVATOR VESSELS, OIL GAUGES AND BREATHERS:

5.24.1 A conservator complete with sump and drain valve shall be provided in such a position as not to obstruct the electrical connections to the transformer having the capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and the cooling equipment from the minimum ambient temperature to 90 Deg C the minimum indicated oil level shall be with the lead pipe from the main tank covered with not

less than 15mm depth of oil and the indicated range of oil levels shall be from minimum to maximum.

5.24.2 If the sump is formed by extending the foot pipe inside the conservator vessel, this extension shall be for atleast 25mm. The conservator shall be designed so that it can be completely drained by means of the drain valve provided, when mounted as in service.

5.24.3 One end of the conservator shall be bolted into position so that it can be removed for cleaning purpose.

Normally one oil gauge magnetic / prismatic / plain type shall be provided.

The oil level is 10 Deg°C, 30 Deg°C and 90 Deg°C (Maximum) shall be marked on the gauge.

Taps or Valves shall not be fitted to oil gauge.

The oil connection from the transformer tank to the conservator vessel shall be arranged at a rising angle of 3 to 9 Degrees to the horizontal upto the Buchholtz relay and shall consists of

a. For transformers from 1001 KVA – 50mm inside diameter pipes as per IS: 3639.

b. A valve shall be provided at the conservator to cut off oil supply to the transformer after providing a straight run of pipe for atleast a length of five times the internal diameter of the pipe on the tank side of the gas and oil actuated relay and atleast three times the internal diameter of the pipe on the conservator side of the gas and oil actuated relay.

5.24.4 Each conservator vessel shall be fitted with a breather in which a silica gel is the dehydrating agent and designed so that: It is atleast 3 times the internal diameter of the pipe on the conservator side of the gas and oil actuated relay

a. The passage of air is through the silica gel.

b. The external atmosphere is not continually in contact with the silicagel through provision of an oil seal.

c. The moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from distance.

d. All breathers shall be mounted at approximately 1400 mm above ground level with suitable clamping device for the breather pipe.

e. The breather shall be metallic type silica gel breather with see-through container for silicagel and with metallic frames with suitable threading to fix the breather to the pipe of the transformer. Plastic frames are not acceptable. The samples of Breather are to be got approved by the AP AP_PDCL before supply.

5.25 **FILTER DRAIN VALVES, SAMPLING DEVICES AND AIR RELEASE PLUG :**

Each transformer shall be fitted with the following:

a) One drain valve of minimum 50mm shall be provided

b) One 50 mm valve at the top and one 50 mm valve at the bottom of the tank mounted diagonally opposite to each other for filtration purpose.

c) A drain valve as specified below shall be fitted to each conservator.

d) For diameter upto 650 mm, size of the valve 15mm, for diameter above 650mm size of valve 25mm.with suitable clamping device for the breather pipe

e) A robust oil sampling device shall be provided at the top and bottom of the main tank. The sampling device shall not be fitted on the filter valve.

f) One 15 mm air release plug.

g) All other valves opening to atmosphere shall be fitted with blank flanges.

5.26 **COOLER AND RADIATOR CONNECTIONS :**

Valves and valve mountings shall be provided as specified under cooling plant section 5.32.

5.27 **VALVES**

5.27.1 All valves shall be of gun metal or cast steel or may have cast iron bodies with gun metal fittings. They shall be of way type with internal screw and shall be opened by turning counter clock wise when facing the hand-wheel. The valves shall be of robust construction and it should be possible to operate the valves without application of much force.

5.27.2 Means shall be provided for pad locking the bottom valves in the open and close positions. This is required for the valves where opening device like hand-wheel, keys etc are the integral part.

5.27.3 Every valve shall be provided with an indicator to show clearly the position of the valves. All valves shall be provided with flanges having machined faces. The drilling of valve flanges shall comply with the requirements of IS: 3639.

5.28 **PRESSURE RELIEF DEVICE :**

5.28.1 The pressure relief device shall be provided of sufficient size for rapid release of pressure that may be generated within the tank, and which might result in damage to the equipment. The device shall operate at static pressure of less than the hydraulic test pressure for transformers tanks. Means shall be provided to prevent the ingress of rain.

5.28.2 Unless otherwise approved the relief device shall be mounted on the main tank, if on the cover, shall be fitted with skirt projecting 25mm inside the tank and of such a design to prevent gas accumulation.

5.28.3 Two diaphrams of suitable design and material shall be used one at the base and the other at the mouth of the vent pipe.

5.28.4 An oil gauge is required on the stand pipe for indicating fracture of diaphragm.

5.28.5 One of the following methods shall be used for relieving or equalising the pressures in the pressure relief devices.

a) An equaliser pipe connecting the pressure relief device to the conservator.

b) The fitting of silicagel breather to the pressure relief device breather being mounted in a suitable position for access at ground level.

5.29 **EARTHING TERMINAL :**

Two earthing terminals capable of carrying for a second, full lower voltage short circuit current of the transformer shall be provided. Provisions shall be made at

positions close to each of the bottom two corners of the tank for bolting the earthing terminals to the tank structure to suit local conditions.

5.30 **RATING AND DIAGRAM AND PROPERTY PLATES :**

The following plates shall be fixed to the transformer tank at an average height of about 1750 mm above ground level.

a) A rating plate bearing the data specified in the appropriate clauses of IS : 2026.

b) A diagram plate showing the internal connections and also the voltage vector relationship of the several windings in accordance with IS : 2026 and in addition a plain view of the transformer giving the correct physical relationship of the terminals. When links are provided in accordance with clause –5.2 (voltage ratio) for changing the transformer ratio, than approved means shall be provided for clearly indicating ratio for which the transformer is connected, no load voltage shall be indicated for each tap.

c) A plate showing the location and function of all valves and air release corks or plugs. This plate shall also warn operators to refer to the maintenance instructions before applying the vacuum treatment for drying.

The above plates shall be of material capable of withstanding continuous outdoor service.

5.31 **JOINTS AND GASKETS :**

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with neoprene rubber unless otherwise specified.

5.32 **COOLING PLANT :**

General

a) **Radiators and Coolers** shall be so designed as to avoid pockets in which moisture may collect and shall withstand the pressure tests.

b) Unless the pipe work is shielded by adequate earth metal the clearance between all pipe work and live parts shall be more than the clearance for live parts to earth.

5.33 **RADIATORS MOUNTED DIRECTLY TO THE TANK/BANKED :**

5.33.1 Radiators connected directly to the tank shall be detachable and shall be provided with machined or ground flanged inlet and outlet branches. 19mm drain plug shall be provided at the bottom and 19mm air release plug shall be provided at the top of each radiator for draining and filling. These two plugs shall have neoprene rubber gaskets only.

5.33.2 The radiator fins shall be manufactured from a steel sheet with a thickness of not less than 1.25 mm.

5.33.3 Valves shall be provided on the tank at each point of connection to the tank. These valves shall have neoprene rubber gaskets 6mm thick on either side.

5.33.4 The oil circuits of oil coolers shall be provided with the following:

a) A valve at each point of connection to the transformers tank.

b) Removable blanking plates to permit the blanking off the main oil connection of each cooler.

c) A drain plug of 19 mm at the lowest point of each bank of cooler.

d) Air release plug 15 mm

All radiator groups shall be provided with belting /by 50x50x6mm MS angle.

5.34 **OIL PIPING AND FLANGES :**

Drain valves / plugs shall be provided in order that each section of pipe work can be drained independently.

5.35 **VOLTAGE CONTROL (On load type) :**

The OLTC shall confirm to IS : 8468 – 1977.

5.0 MVA transformers voltage control equipment shall be of on load changing type on the HV side for HV variation of +5% to –15% in 16 equal steps of 1.25% for varying its effective transformation ratio while the transformers are on-load and without producing phase displacement.

It shall not be possible to operate the electric work drive when the manual operating gear is in use.

5.36 **VOLTAGE CONTROL OFF LOAD**:

5.36.1 The equipment for local electrical and local manual operation shall be provided and shall comply with the following conditions.

a) It shall not be possible for any two electric controls to be in operation at the same time.

b) Operation from local/ remote control switch shall cause one tap movement only.

c) It shall not be possible to operate electric drive when the manual operating gear is in use

d) All electrical control switches and the local operating gear shall be clearly labeled in a suitable manner to indicate the direction of the tap changing.

e) The local control switches shall be mounted in the marshalling box or driving gear housing.

f) The equipment shall be so arranged as to ensure that when a tap change has been commenced it shall be completed independently of the operation of the control relays or switches. If a failure of the auxiliary supply during tap changing or any other contingency would result in that movement not being completed adequate means shall be provided to safeguard the transformer and its auxiliary equipment.

5.36.2 Suitable apparatus shall be provided for each transformer to give indications as follows:

A mechanical indication of the number of tapping position shall be provided to the OLTC gear of the transformer.

5.36.3 All relays and operated devices shall operate correctly at a voltage between the limits specified in the relevant Indian standards.

5.36.4 The tap changing switches and mechanism shall be mounted in oil tanks or compartments mounted at an accessible position on the transformer tank.

5.36.5 Any enclosed compartment not oil filled shall be adequately ventilated. Metal clad heaters shall be provided in the driving mechanism chamber and in the marshalling box, all contractor relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.

5.36.6 The location of OLTC tank as viewed from the 33 KV side shall be on left side of the transformer.

5.36.7 The oil in those compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of pipe connection from the highest point of the chamber to the conservator. This connection shall be controlled by suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate Bucholtz relay / oil surge relay shall be provided for the on load tap changer chamber.

5.36.8 It shall not be possible for the oil in those compartments of the tap change equipment which contain contacts used for making or breaking current to mix with the oil in the compartments containing contracts not used for making or breaking current.

5.36.9 Any DROP DOWN tanks with tap changing apparatus shall be fitted with guide rods to control the movement during lifting or lowering operations. The guide rods shall be so designed as to take support of the associated tank when in the fully lowered position. Lifting gear fitted to DROP DOWN tanks shall include suitable device to prevent run away during lifting and lowering operations.

5.36.10 Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil guage.

5.36.11 The alternating supply for electrical operation of the control and indicating gear shall be standard 415 volts, three phase, 4 wire, 50 Hz.

5.36.12 Limit switches shall be provided to prevent over running of the mechanism and except where modified in clause shall be directly connected in the circuit of the operating motor. In addition a mechanical stop or other approved device shall be provided to prevent over running of the mechanism under any conditions. Limit switches may be connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated.

5.36.13 Thermal devices or other means shall be provided to protect the motor and control circuits. All relays, switches, fuses etc., shall be mounted in the marshalling box or driving gear housing and shall be clearly marked for purposes of identification.

5.36.14 The control circuits shall operate at 110 V single phase to be supplied from a transformer having a ratio of 240/55-0-55V with the centre point earthed through a removable link mounted in the marshalling box or tap changer drive.

5.36.15 The whole of the apparatus shall be of robust design and capable of giving satisfactory service without undue maintenance under the conditions to be met in service, including frequent operation.

5.36.16 A five digit counter shall be fitted to the tap changing mechanism to indicate the number of operations completed by the equipment.

5.36.17 A permanently legible lubrication chart shall be fitted within the driving mechanism chamber.

5.36.18 All cabling and wiring shall comply with clause 5.4.

5.37 ON LOAD TAP CHANGER

5.37.1 The following type and routine tests shall be carried out on on-load tap changer and motor drive mechanism in accordance with IS 8468-1977 or its latest version.

OLTC shall be provided external type but not built in type and with separate conservator. It should bilinear type but not coarse & fine system

i) **Type Test**:- Type tests shall be performed on the samples of the relevant tap changers or components after their final development. The following shall constitute the type tests.

- Mechanical test
- Auxiliary circuits insulation tests
- Test for temperature rise of contracts
- Switching tests
- Short circuit current tests
- Transition impedance tests
- Mechanical life test
- Dielectric test

ii) **Routine Tests**:- The following shall constitute the routine tests

- Mechanical test
- Auxiliary circuits insulation tests
- Dielectric tests.

5.37.2 MOTOR DRIVE MECHANISM

i) **Type Tests**: The following shall constitute the type tests:

- Mechanical Tests
- Auxiliary circuits insulation test
- Mechanical load test
- Over run test
- Protection of motor drive cubicles

ii) **Routine Tests**: The following shall constitute the routine tests.

- Mechanical test
- Auxiliary circuit insulation test

5.37.3 PARALLEL OPERATION OF TRANSFORMERS WITH REMOTE ON LOAD TAP CHANGER PROVISION:

In the wiring diagram of local control switch provision shall be made for connecting a remote control panel suitable for remote operation, if necessary in future for OLTC operation.

5.38 BUSHINGS, INSULATORS AND TERMINALS :

5.38.1 Transformers shall be fitted with bushing insulators.

5.38.2 The electrical characteristics of bushings and bushing rods shall be in accordance with IS 3347 and IS 2099.

5.38.3 Bushing insulators for 33 KV shall be provided with arcing horns except for neutral bushings.

5.38.4 Clamps with double nuts and spring washers shall be provided for the “Bushing Rods”.

5.38.5 The rod gap shall be adjustable type to enable a coordination of insulation level with surge diverters.

5.38.6 Any stress shield shall be considered as integral part of the bushing assembly.

5.38.7 Special precautions shall be taken to exclude moisture from paper insulation during manufacture, assembly, transport and erection. The surface of all paper insulations shall be finished with non-hydro scopic varnish which cannot be damaged easily.

5.38.8 Each porcelain bushing or insulator, and paper bushing shall have marked upon it the manufactures identification mark, and such other mark as may be required to assist in the representative allocation of batches for the purposes of the samples tests.

5.38.9 Clamps and fittings made of steel or malleable iron shall be galvanised. All bolts threads shall be greased before erection.

5.38.10 The bushing flanges shall not be of re-entrant shape which may trap air.

5.38.11 The bushing turrets shall be provided with vent pipes which shall be connected to route any gas collection through the Bucholtz relay.

5.38.12 The clearances in air between live conductive parts and live conductive part to earthed structures shall be as follows:

Nominal system voltage kV rms.	**Test Voltage impulse kV P**	**Clearances**	
		Phase to phase mm	**Phase to earth mm**
11 kV	**75 kV P**	**280 mm**	**205 mm**
33 kV	**170 kV P**	**350 mm**	**320 mm**

5.38.13 Necessary features on transformer tank for mounting LAS on both HV and LV sides shall be provided. They should be detachable type and not to be welded. A suitable earth strip shall also be provided for each LA and it should be brought out separately to the ground insulation from the tank.

5.39 **TEMPERATURE INDICATING DEVICES AND ALARM :**

5.39.1 Transformer shall be provided with Temperature indications for measuring Transformer oil temperature and Transformer winding temperature. These samples of temperature indicator shall be got approved before supply.

5.39.2 Except where outdoor types of indicators are supplied, the temperature indicators shall be housed in the marshalling box. Winding temperature indicators are to be provided for 3.15 MVA and above transformers.

5.39.3 The tripping contacts of winding temperature indicators shall be adjustable to close between 60 Deg. C and 120 Deg. C and alarm contacts to close between 50 Deg. C and 100 Deg. C and both shall reopen when the temperature has fallen by about 100 Deg. C.

5.39.4 .All contacts shall be adjustable on a scale and shall be accessible on removal of the cover.

5.39.5 .The temperature indicators shall be so designed that it shall be possible to check the operation of the contacts and associated equipment.

5.39.6 Connections shall be brought from the device to terminals placed inside the marshalling box.

5.40 GAS AND OIL ACTUATED RELAYS

5.40.1 Each transformer shall be fitted with gas and oil actuated relay [Buchholtz Relay] equipment having contacts which close following oil surge or low oil level conditions.

5.40.2 Each gas and oil actuated relay shall be provided with a test cock and a flexible pipe connection for checking the operation of the relay.

5.40.3 Where specified to allow gas to be collected at ground level a pipe approximately 5 mm inside diameter shall be connected to the gas release cock of the gas and oil actuated relay and brought down to a point approximately 1.25 mts above ground level, where it shall be terminated by a cock.

5.40.4 A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the pipe and the cross level of the relay.

5.40.5 The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that mal operation of the relays shall not take place under normal service conditions.

5.40.6 The pipe work shall be so arranged that oil and gas arising from the transformer shall pass into oil actuated relays. The oil circuit through the relay shall not form delivery path in parallel with any circulation oil pipe, nor shall it be tied into or connected through a pressure relief vent, sharp bends in the pipe work shall be avoided.

5.40.7 When a transformer is provided with two conservators the gas and oil actuated relays shall be arranged as follows.

5.40.8 If the two conservators are connected to the transformer by common oil pipe one relay shall be installed in the common pipe.

5.40.9 If the two conservators are piped separately to the transformer two relays shall be installed, one in each pipe connection.

5.40.10 Adequate clearances between all pipe work and live metal shall be provided.

5.41 MARSHALLING BOX :

5.41.1 The sheet steel vermin proof, with ventilated and weather proof marshaling box (as per IP55) of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have sloping roof and the interior and exterior painting shall be in accordance with relevant clause of cleaning and painting.

5.41.2 The marshalling box, wherever provided, shall accommodate the following equipments. Alternative weather proof instruments can be mounted out door.

a) Temperature indicators

b) Control and protection equipment for the local electrical control of tap changer, if the same cannot be accommodated in the motor driving gear housing and

c) Terminal board and gland plates for incoming and out going cables.

5.41.3 All the above equipments except (c) shall be mounted on panels and back of panel wiring shall be used for inter connection.

5.41.4 The temperature indicators shall be so mounted that the dials are not more than 1600 mm ground level and the door(s) to adequate size.

5.41.5 To prevent internal condensation an approved type of metal clad heater shall be provided controlled by suitable switch. Ventilation levels shall be provided.

5.41.6 All incoming cables shall enter the kiosk form the bottom and gland plate shall be not less than 450mm from the base of box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture form the cable trench.

5.41.7 Undrilled gland plate shall be provided for accommodating glands for incoming and outgoing cables.

5.42 CONTROL CONNECTIONS AND INSTRUMENT WIRING, TERMINAL BOARDS & FUSES :

5.42.1 All wiring connections, terminal boards, fuses and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bared ends of stranded wire shall be sweated together to prevent creepage of oil along the wire. Nut and bolt type terminal blocks (TB) shall be provided in MB

5.42.2 There shall be no possibility of oil entering, connection boxes used for cables or wiring.

5.42.3 Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non rusting metal cleats of the limits compression type. All wiring to a panel shall be taken from suitable terminal boards.

5.42.4 Where conduits are used, the runs shall be laid with suitable falls, and lowest parts of the run shall be external to the boxes. All conduits runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

5.42.5 When 415 volts connections are taken through junction boxes or marshalling boxes they shall be adequately screened and 415 ‘VOLTS DANGER’ notices must be affixed to the outside of the junction boxes or marshaling boxes.

5.42.6 All box wiring shall be in accordance with relevant IS. All wiring shall be of a stranded copper of 660 V grade and size not less than 4.00 sq mm for CT leads and not less than 2.5 sq mm for other connections.

5.42.7 All wires of panels and all multi core cables shall have ferrules, which bear the same number at both ends.

5.42.8 At these ends of inter connection between the wiring carried out by separate contractors; where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

5.42.9 The same ferrule number shall not be used on wires in different circuits on the same panels.

5.42.10 Ferrules shall be of white insulating material shall be provided with glassy finish to prevent the addition of dirt. They shall be clearly and durably marked in block and shall not be affected by damp or oil.

5.42.11 Stranded wires shall be terminated with crimped tubular lugs. Separate washers shall be used for each wire. The size of the washers shall be suited to the size of

the wire terminated. Wiring shall in general be accommodated in the sides of the box and the wires for each circuit shall be separately grouped. Back of the panel wiring shall be arranged so that access to the connecting stems of relays and other apparatus is not impeded.

5.42.12 Wires shall not be jointed or tied between terminal points

5.42.13 Wherever practicable circuits in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.

5.42.14 Where apparatus is mounted on panels all metal cases shall be separately earthed by means of copper wire or strip having a cross section of not less than 2 sq. mm. Where strip is used, the joints shall be sweated.

5.42.15 All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminals boards arranged as in service. All diagrams shall show which view is employed.

5.42.16 Multi core cable tails shall be so bound that each wire may be traced without difficulty to its cables.

5.42.17 The screens of screen pairs of multi core cables shall be earthed at one end of the cable only. The position of earthing connections shall be shown clearly on the diagrams.

5.42.18 All terminal boards shall be mounted towards the rear doors to give easy access to terminate obliquely and to enable ferrule numbers to be read without difficulty.

5.42.19 Terminal boards rows should be spaced adequately not less than 100 mm apart to permit convenient access to wires and terminations.

5.42.20 Terminal boards shall be so placed with respect to the cable gland (at the minimum distance of 200 mm) as to permit satisfactory arrangements of multi core cable tails.

5.42.21 Terminal board shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections, the height of the barriers and the spacing between terminals such as to give adequate protection, while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers.

5.42.22 No live metal shall be exposed at the back of the terminal boards.

5.42.23 All fuses shall be of the cartridge type and shall conform to relevant IS

5.42.24 Fuses and links shall be labeled.

6.0 **TESTS**

6.1 **TYPE TESTS :**

6.1.1 The type, acceptance and routine tests and tests during manufacture, shall be carried out on the transformer as per the provisions of IS 2026.

6.1.2 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the supplier in the proforma for “Guaranteed Technical Particulars” furnished in this specification or acceptance value specified in this specification, whichever is more stringent for that particular test.

6.1.3 Test certificate of not more than five years old, from a recognized national laboratory with NABL accreditation shall be furnished. The bidder shall furnish two

sets of type test reports as per relevant standards along with the bid. BIDS WITHOUT THE FOLLOWING TYPE TEST REPORTS WILL BE LIABLE FOR REJECTION.

6.1.4 Type test as listed below shall be performed on the transformer as specified in IS:2026.

1. Impulse voltage withstand test.
2. Dielectric type tests.
3. Temperature rise test. (This test shall be carried out on the tap having maximum losses)
4. Short circuit.

Note: 1). Temperature data corrected to 75 Deg.C including ambient temperature in the test reports.
2). It is obligatory on the part of the manufacturer to carry out S.C. test unless this has been made on a transformer of identical design and is acceptable to the purchaser.
3). If records of type tests including short circuit test on a transformer of each capacity, with essential details is representative of the one being purchased, are available, they may be furnished as evidence of type tests instead of actual tests.

6.1.5 For any change in the design/type already tested and design/type offered against this specification, the AP AP_PDCL reserves the right to demand repetition of the tests without any extra cost.

6.1.6 The type test reports including short circuit withstand test report and impulse test report must accompany the offer. The short circuit withstand test report must accompany the active part, general arrangement drawings, duly inspected and certified by testing agency. The expenses to be incurred towards the tests shall be to their account. The S.C. tested unit will not be accepted for supply to the AP AP_PDCL.

6.2 **ACCEPTANCE AND ROUTINE TESTS :**

- Measurement of winding resistance
- Measurement of ratio, polarity and phase relationship
- Measurement of impedance voltage
- Measurement of load loss.
- Measurement of no load loss and no load current.
- Measurement of insulation resistance. The insulation resistance of each winding in turn to all the other windings, core, frame and tank connected together and to earth shall be measured by standard megger and the values shall not be less than the values indicated below.

	At 30^{o}C	**At 40 Deg C**	**At 50 Deg C**	**At 60 Deg C**
33 kV to earth	500 M.Ohms	250 M.Ohms	125 M.Ohms	65 M.Ohms
11 kV to earth	400 M Ohms	200 M Ohms	100 M Ohms	50 M Ohms

- Induced over voltage withstand test.

- ♦ The separate source voltage withstand test.

6.2.1 All acceptance and routine tests stipulated in the relevant standards shall be carried out by the supplier in presence of purchaser's representative. The purchaser reserves the right to insist for witnessing the acceptance/routine testing of the bought out items to pass tests.

6.2.2 **Tests during manufacture :** The Bidder shall furnish details of tests carried out during the process of manufacture and end inspection by the bidder to ensure the desired quality of the equipment to be supplied.

6.3 **ADDITIONAL TESTS :**

6.3.1 **SPECIAL TEST :** Special tests as specified in IEC 60 076 – 1993 in clause 10.1.3 shall also be undertaken with an agreement between the manufacturer and the purchaser.

6.3.2 The purchaser reserves the right of having at his own expenses any other tests(s) of reasonable nature carried out at Bidders premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests, to satisfy himself that the material comply with the specifications.

6.3.3 In case of failure in any type test, the supplier is required to modify the design of the material and the material shall be type tested again for the modified design, without any extra cost to the purchaser. No delivery extension shall be given for this additional testing.

6.3.4 The entire cost of testing for the acceptance and routine tests and tests during manufacture shall be treated as included in the quoted unit price.

6.3.5 CHALLENGE TESTING: "The other manufacture can also request challenge testing for any test based on specification and losses. The challenger would request for testing with testing fee. The challenge test fees are proposed at least three times the cost of testing. This is likely to deter unnecessary challenges. The challenger would have the opportunity to select the sample from the store and any such challenge should be made within the guarantee period. The party challenged, and the utility could witness the challenged testing.

The challenged testing would cover the

1. Measurement of magnetizing current
2. No Load losses test.
3. Load Losses test (At 50% loading or as per acceptance test)
4. Temperature rise test.

The challenge test could be conducted at NABL accredited laboratory, like ERDA and CPRI. If the values are within limit the product gets confirmed else not confirmed. No positive tolerance in losses is permitted. If the product is not confirmed the manufacture would pay the challenge fee and challenger would get the fee refunded. However as redressal system the challenger would allowed to ask for fresh testing of two more samples from the store and the same be tested in NABL laboratory in presence of party challenged, challenger and the utility. If any one or both sample does not confirm the test then the product said to have failed the test. In such cases the manufacture will be declared as unsuccessful manufacturer for the said product with wide publicity and would not be allowed to compete in tenders of the Boards for the period of three years and heavy penalty would be imposed".

6.4 **TEST REPORTS / TEST CERTIFICATES:**

6.4.1 Record of routine test reports shall be maintained by the Bidder at his works for periodic inspection by the purchaser's representative.

6.4.2 Test certificates of tests conducted during manufacture shall be maintained by the Bidder. These shall be produced for verification as and when desired by the purchaser.

6.5 **TEST FACILITIES :**

6.5.1 The tests shall be carried out as per relevant Standards and test certificates shall be furnished for approval. The Bidder shall indicate the details of the equipment available with him for carrying out the various tests as per relevant Standards. The bidder shall indicate the sources of all materials. He shall indicate the name of the supplier and make of meters, relays, conductor, insulating oil, electrical steel laminations constructional steel etc.

6.5.2 **NOTE :** The Meters used for conducting tests shall be calibrated periodically at reputed Government Accredited Test Laboratories and test certificates shall be available at works for verification by purchasers representative.

6.5.3 Tests as per applicable standards should be carried out in respect of porcelain bushings, galvanization, relays and meters.

6.5.4 Manufacture shall submit the calculations to confirm the thermal ability as per clause No. 9.1 of IS-2026 part –I of 1977

6.6 **TESTS REPORTS ON THE ANALYSIS OF RAW MATERIALS :**

The tender shall indicate the source of raw material and enclose test certificates and report on the analysis of electrolytic copper used for the winding and the steel used for the core, insulation materials as also bought out items from sub-suppliers.

6.7 **TANKS**

a) **Routine tests:** Oil leakage test : All 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 as per IS. 335 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 of not less than 12 hours for oil and 1 hour for air, during which time no leakage shall occur.

b) **Type Tests:**

i) **Vacuum Test:** One transformer tank of each size shall be subjected to the specified vacuum shall be tested at an internal pressure of 3.33 KN/m2 (25 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified below without affecting the performance of the transformer.

Horizontal length of flat plate (in mm)	**Permanent deflection (in mm)**
Upto and including 750	5
751 to 1250	6.5

1251 to 1750	8
1751 to 2000	9.5
2001 to 2250	11
1151 to 2500	12.5
2501 to 3000	16
Above 3000	19

ii) **Pressure Test:** One transformer tank of each size together with its radiators, conservator vessel and other fitting shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m2 (5 lb/sq.in) whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above.

6.8 Training of DISCOM PERSONNEL: AP AP_PDCL reserves the right to depute AP AP_PDCL's personnel for training at your works relating to design, manufacture, assembly, testing and operation & maintenance in batches. You shall provide necessary facilities during training period specified by AP_PDCL

6.9 Manufacturer authorized representative shall be present at the time of commissioning of Power Transformer.

7.0 **INSPECTION :** All tests and inspection as per relevant IS shall be carried out at the place of manufacture by the IIIrd party authorized by the AP_PDCL **along with AP_PDCL representative** for each lot of PTRs offered for inspection by the manufacturer. 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. **All such inspection charges conducted by IIIrd party are to be borne by the Supplier.**

The purchaser has all the rights to conduct tests including type tests, at his own cost by an independent agency whenever there is dispute regarding the quality of supply, or interpretation of test results. In the event of failure of Transformer in such tests the expenses incurred in testing shall be to supplier's account. The failed unit will not be accepted for supply to the AP_PDCL after repairs.

STAGE INSPECTION: The stage wise inspection of the transformers during the manufacturing/assembling stage shall be carried out by the purchaser's representative. The purchaser has absolute right to reject the raw materials/component/sub assemblies or complete equipment not conforming to the requirements of the specifications or of poor quality/workmanship. The purchaser at his opinion may collect the samples of various raw materials/components for his independent testing.

7.1 The purchaser's representative shall, at all times, be entitled to have access to the works and at all places of manufacture where equipment offered shall be manufactured and the representative shall have full facilities for unrestricted inspection of the bidder's works, raw materials and process of manufacture and conducting necessary tests as detailed herein.

7.2 The Bidder shall keep the purchaser informed in advance of the time of starting and

of the progress of manufacture of the offered equipment in its various stages so that arrangements can be made for inspection.

7.3 The supplier shall give 15 days advance intimation to enable the purchaser to depute his representative for witnessing acceptance and routine tests.

7.4 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off, by the purchaser in writing.

7.5 The acceptance of any quantity of material shall in no way relieve the Bidder of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

7.6 **AP_PDCL may its option get the materials inspected stage wise by the 3rd party on each unit/units offered for inspection along with a AP_PDCL's representative, if it feels necessary. If a 2nd time inspection becomes necessary the inspection charges shall be born by you.**

7.7 The bidder shall indicate the name(s) of reputed inspection agencies and the inspection charges clearly for each lot. The inspection charges will be borne by the purchaser. However the purchaser reserves the right to appoint at its cost any inspection agency to carry out the inspection.

7.8 The AP_PDCL reserves the right to insist for witnessing the acceptance routine testing of the boughtout items.

8.0 SPECIAL GURANTEE FOR POWER TRANSFORMER

8.1 The Power Transformer shall be guaranteed for satisfactory operation for a period of 5 years from the date of receipt at stores. All similar materials are removable parts of similar equipment shall be interchangeable with each other.

9.0 QUALITY ASSURANCE PLAN:

9.1 The bidder shall invariably furnish the following information along with his bid, failing which his bid shall be liable for rejection. Information shall be separately given for individual type of material offered.

i) The structure of organization.
ii) The duties and responsibilities assigned to staff ensuring quality of work.
iii) The system of purchasing, taking delivery and verification of materials.
iv) The system for ensuring quality of workmanship.
v) The quality assurance arrangements shall conform to be relevant requirements of ISO 9001 or ISO 9002 as appropriate.

vi) Statement giving list of important raw materials names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested. List of test normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.

vii) Information and copies of test certificates as in (vi) above in respect of bought out accessories.

viii) List of manufacturing facilities available.

ix) Level of automation achieved and list of areas where manual procession exists.

x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

xi) Lists of testing equipment available with the bidder for final testing of equipment specified and test plant limitation. If any, vis-a-vis the type, special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

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

i. List of raw materials as well as bought out accessories and the names of sub suppliers selected from those furnished along with offers.

ii. Type test certificates of the raw materials and bought out accessories if required by the purchaser.

iii. Quality assurance plan (QAP) with hold points for purchaser's inspection. The quality assurance plan and purchasers hold points shall be discussed between the purchaser and Contractor before the QAP is finalized.
The Contractor shall submit the routine test certificates of bought out accessories and central excise asses for raw material at the time of routine testing if required by the purchaser and ensure that the quality assurance requirements of specification are followed by the sub-contractor.

9.3 The quality assurance programme shall give a description of the quality system and quality plans with the following details.

A) Quality System :

- The structure of the organisation.
- The duties and responsibilities assigned to staff ensuring quality of work.
- The system for purchasing, taking delivery and verification of materials.
- The system for ensuring quality workmanship.
- The system for control of documentation.
- The system for the retention of records.
- The arrangement for the contractor's internal auditing.
- A list of administration and work procedures required to achieve and verify contract's quality requirements. These procedures shall be made readily available to the purchaser for inspection on request.

B) Quality Plans :

- An outline of the proposed work and programme sequence.
- The structure of the contractors organisation for the contract.
- The duties and responsibilities assigned to staff ensuring quality of work.

- Hold and Notification points.
- Submission of Engineering documents required by the Specification.
- The inspection of materials and components on receipt.
- Reference to the contractors work procedures appropriate to each activity.
- Inspection during fabrication/Construction.
- Final inspection and test.

10.0 DOCUMENTATION :

10.1 All drawings shall conform to International Standards Organisation (ISO) `A' series of drawings sheet/India Standards Specifications IS:656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I.Units.

10.2 LIST OF DRAWINGS AND DOCUMENTS :

10.2.1 Four sets of complete dimensioned drawings showing the general arrangements, fitting details clearance, winding details shall be furnished along with the tender as under.

a) Outline dimensional drawings of transformer and accessories including LA mounting arrangement the tank with necessary clearances between the tank and HV/LV side LA's as per IS 2026.

b) Assembly drawings and weights of main component parts

c) Tap changing and rare plate diagrams.

d) Schematic control and wiring diagram for all auxiliary equipment.

e) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding, longitudinal and cross sectional views showing the duct sizes, cooling pipe etc. for transformer/ heat exchanger drawn to scale shall be furnished.

f) Large scale drawing of high and low tension winding of the transformer showing the nature and arrangement of insulation and terminal connections.

g) Six copies of instruction books erection manual and operation and maintenance manuals and spare part bulletins for each consignee.

h) Test Reports.

i) Descriptive literature and data on transformer construction, winding bushing, heat exchanger, tap changing gear etc.,

10.2.2 Descriptive literature and data on transformer construction, winding bushing, heat exchanger, tap changing gear etc., The successful Bidder shall, within 2 weeks of placement of order, submit three sets of final versions of all the above said drawings for purchaser's approval. The purchaser shall communicate his comments/approval on the drawings to the supplier within four weeks. The supplier shall, if necessary, modify the drawings and resubmit three copies of the modified drawings for their approval. The supplier shall within two weeks, submit 23 prints and two good quality report copies of the approved drawings for purchaser's use.

10.2.3 Six sets of the type test reports, duly approved by the purchaser, shall be submitted by the supplier for distribution before commencement of supply. Adequate copies of acceptance and routine test certificates, duly approved by the purchaser, shall accompany the dispatch consignment.

10.2.4 The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier's risk.

10.2.5 Two set of nicely printed bound volumes of operation, maintenance and erection manuals and approved drawings in English language shall be supplied along with each circuit breaker, in addition to the five sets to be sent directly to the purchaser.

10.2.6 Approval of drawings/work by purchaser shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirements of the latest revision of application standards, rules and codes of practices. The equipment shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering and purchaser shall have to power to reject any work or materials which, in his judgment is not in full accordance therewith.

11.0 **PACKING & FORWARDING :**

11.1 The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be, and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied immediately by supplier without any extra cost.

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

a) Name of the consignee.
b) Details of consignment.
c) Destination.
d) Total weight of consignment
e) Handling and packing instructions.
f) Bill of Material indicating contents of each package.

11.3 The supplier shall ensure that the packing list and bill of material are approved by the purchaser before dispatch. The packing shall be done as per the manufacturer's standard practice. However, he should ensure the packing is such that, the material should not get damaged during transit by Rail/Road.

11.4 The marking on each package shall be as per the relevant standards and shall also contain "AP_PDCL".

11.5 CENTRE OF GRAVITY:

The centre of gravity of the assembled transformers shall be low and as near to the vertical central line as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric relating to the track either with or without oil, its location shall be shown on the outline drawing.

12.0 QUANTITY AND DELIVERY REQUIREMENTS :

The quantity and delivery requirement are indicated in the schedule of requirement

13.0 SUPERVISION SERVICES :

The Purchaser will arrange for unloading of the consignments.

14.0 MANDATORY SPARES & TOOLS :

14.1 NECESSORY ACCESSORIES AND FITTINGS :

1. Oil conservator with filling hole and gap and drain in cock.
2. Oil level guage with 10° C, 30° C, 60° C and 90° C marking. .
3. Silica gel breather.
4. Air release plug
5. Two numbers of earthing terminals with lugs
6. On load tap changing gear with Buchholtz relay / oil surge relay.
7. Drain valve, filter valve
8. Buchholtz relay (double float)
9. Radiators with valves (size LxBxH) Qty (Nos.)
10. Lifting lugs with fastening holes
11. Four Nos. Jacking pads with thickness not less than 20 mm
12. Inspection covers (2 Nos.)
13. Thermometer pockets (2 Nos.)
14. Winding temperature indicator with two contacts(Micro Switch contact type)
15. Pressure relief device.
16. Rating and diagram plate and flow chart
17. Oil temperature indicator (dial type with one contact for alarm(Micro Switch contact type)
18. Marshaling box
19. HT & LT bushings. These bushings shall be provided with bimetallic clamps suitable for panther ACSR Conductor. The bushing rods for all capacities should be of ¾" dia. for HV and 1" dia. for LV or M20 copper size for all capacities
20. Necessary oil for first filling.
21. Bottom mounting channel (min. size of channel shall be 200x75/76mm for 5.0 MVA.

22. Necessary features on transformer tank for mounting LAs on both HV & LV shall be provided and they shall be detachable type and not to be welded.
23. Explosion vent with diaphragm
24. Valve in equalising pipe
25. Pulling eyes – 8 Nos.
26. Sampling devices (bottom and top)

Note: Any other fittings that are necessary for the satisfactory operation of the transformers shall be provided without any extra cost.

14.2 **OPTIONAL SPARES**:- The tender shall quote separately for the following spares.

i) Set of coils for one limb of the winding.
ii) HT bushing.
iii) LT bushing.
iv) Neutral bushing.
v) One set of gaskets
vi) One set of thermometers
vii) One oil gauge.

14.3 The tender shall also quote for any item of spares recommended for 5 years normal operation. The purchaser will decide on the actual spares to be ordered on the basis of the list and item prices of spares. Detailed prices of tools and spare parts shall be indicated as per Annexure – I-A

14.4 NAME PLATE : Equipment should be provided with name plate giving full details of manufacturers, capacities and other details as specified in the relevant ISS. The purchase order No. date and words "AP_PDCL" must be etched on the name plate. AP_PDCL logo shall be Embossed on the Transformer Tank of size 12"x18" on the opposite side of the name plate as enclosed

15.0 WARRANTY:

The period of warranty will be 5 years (five years)the date of acceptance of the material in stores i.e. Form-13 date of last consignment, last piece of transformer received against this specification. AP_PDCL reserves the right to claim the financial loss incurred / suffered due to the failure of Power Transformers during the guarantee period.

ANNEXURE – I
GUARANTEED TECHNICAL PARTICULARS FOR OILS

Sl. No.	**Characteristics**	**Particulars as per ISS:335/93**
1.	Appearance	
2.	Density at 29.5 deg. C (Max.)	
3.	Kinematics viscosity at 27 deg. C (Max.)	
4.	Interfacial tension at 27 deg. C (Max.)	
5.	Flash point. Pensky-Marten (Closed) (Min.)	
6.	Pour Point (Max.)	
7.	Neutralization value : a) Total acidity (Max.) b) Inorganic acidity / alkalinity	
8.	Corrosive sulphur	
9.	Electric strength (breakdown voltage) (Min.) a) New un-filtered oil b) After filtration	
10.	Dielectric dissipation factor (Tan Delta at 90 deg. C) (max.)	
11.	Specific resistance (Resistivity) a) At 90 deg. C (Min.) b) At 27 deg. C (Min.)	
12.	Oxidation stability a) Neutralisation value after oxidation (Max.) b) Total sludge, after oxidation (Max.)	
13.	Agening characteristics after accelerating ageing (Open Breaker Method with copper catalyst) for 96 Hrs. as per ASTM D-1934-1978 a) Specific resistance(Resistivity) i)At 27 deg. C (Min.) ii)At 90 deg. C (Min.) b) Dielectric dissipation factor Tan Delta at 90 deg. C (Max.) c) Total acidity (Max.) d) Total sludge value (Max.)	
14.	Presence of oxidation inhibitor	
15.	Water content (Max.)	

ANNEXURE – II
GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE MANUFACTURER

I. STANDARD FORM OF TECHNICAL PARTICULARS:

1.	Name of the Manufacturer	
2.	Service	
	Type	
3.	Ratings : - Rated KVA Rated Voltage of HV/LV KV No-Load Voltage Ratio KV Temperature rise in oil deg. C Temperature rise by resistance/ winding of deg. C Rated frequency : c/s	
4.	Number of Phases	
5.	Connections- High Voltage - Low Voltage - Vector group of reference	
6.	Tappings- High Voltage % Low Voltage %	
7.	No load loss at rated voltage kW	
8.	Load loss at rated current at 75 deg.C(kW)	
9.	%Impedance at rated current and freq. At 75 deg.C	
10.	Reactance at rated current and frequency %	
11.	Efficiencies at 75 deg.C at unity power Factor At full load % At ¾ full load % At ½ full load %	
12.	Regulation at full load at 75 deg.C At unity power factor % At 0.8 Power factor lagging %	
13.	No load current at rated voltage and frequency	
14.	Approximate weights : KG I) Core KG II) Windings KG III) Core with frame KG IV) Tank and fittings KG V) Oil(Excluding OLTCG Oil) KG VI) Total weight KG	
15.	Approximate quantity of oil Ltrs. (including OLTC – OIL)	
16.	Approximate overall dimensions- Length mm Breadth mm Height mm	
17.	Terminal arrangements - High Voltage Low Voltage	
18.	Reference standard	

19.	Remarks	

II ADDITIONAL TECHNICAL PARTICULARS:

1.	Approximate Max. flux density at rated Vol. & Frequency CGS Lines/cm2	
2.	Efficiencies at 75 deg.C at 0.8 Power Factor lagging At full load % At ¾ full load % At ½ full load %	
3.	Load at which maximum efficiency occur (full load) %	
4.	Maximum efficiency	
5.	Impulse levels with 1/50 ms wave High voltage kV Low voltage kV	
6.	No load loss at 110% rated voltage and rated frequency kW	
7.	No load current at 110% rated voltage and rated frequency A	
8.	Type of windings High voltage Low voltage	
9.	Insulation materials Turn insulation high voltage Turn insulation low voltage Insulation core to low voltage Insulation high voltage to low voltage	
10.	Clearances Minimum clearance between phases	
a)	In oil mm	
b)	Out of oil mm Minimum clearance high voltage to(mm) Earth in oil Minimum clearance high voltage to tank(mm) in oil	

III Details of tank

1	Length x Breadth x Height mm	
2	Approximate thickness of sides mm	
3	Approximate thickness of top mm	
4	Approximate thickness of bottom mm	
5	Approximate thickness of tube mm Radiators	
6	Minimum clearance height for lifting core and windings from tank (mm)	
7	Shipping details - Parts detached for transport Approximate weight of heaviest package (Kg) Approximate dimensions of largest package Length (mm) Breadth (mm) Height (mm)	

IV DETAILS OF AUXILIARY WINDINGS:

1.	Rating Rated KVA Rated voltage kV	
2.	Connections	
3.	Tappings	
4.	Impedance at 75 deg/C/rated current at With respect to high voltage % With respect to low voltage %	

V DETAILS OF BUSHINGS:

1.	Type	
2.	Momentary Power Freq. dry withstand voltage kV	
3.	Visible power freq. Discharge voltage kV	
4.	One minute dry withstand power freq. voltage kV	
5.	One minute wet withstand power freq. voltage kV	
6.	Full wave withstand impulse voltage kV	
7.	Under oil flashover or puncture withstand voltage kV	
8.	Creepage distance in air (mm)	
9.	Recommended gap setting (mm)	
10.	Weight of assembled bushing (Kg)	

VI DETAILS OF ON LOAD TAP CHANGING GEAR:

1.	Make	
2.	Type	
3.	Rating MVA Rated voltage kV Rated current A Step voltage V No. steps	
4.	Control	
5.	Auxiliary supply details	
6.	Voltage control	
7.	Line drop compensation	
8.	Parallel operation	
9.	Protective devices	
10.	Approx. overall weight Kg	
11.	Approx. overall dimensions (mm)	
12.	Approx. overall quantity of oil (Ltrs)	

VII DETAILS OF TYPE TESTS:

1. Type Test :
   (a) Is the offered design type-tested? (Yes/No).
   (b) If yes, fill up the following table.

Sl. No.	Name of test	Description of Power Transformer with losses	Date of test	Tested Laboratory & Location	Number of sheets
1 (a)	Short-circuit dynamic and thermal withstand test				
(b)	Impulse withstand test with chopped wave as per clause no.13 of IS-2026, part-III				
2.	Whether the transformer conform to IS-2026 (Yes/No)				
3.	OLTC Particulars (i) Make : CTR/OLG or equivalent (ii) Type : ON LOAD, Linear type Continuous (but not coarse and fine type). (iiii) Rating : (iv) Control : Manual & Electrical and compatible for RTCC and Parallel operation. (v) Auxiliary supply : 3-Phase, 440V, 50 Hz (vi) Approx. overall weight : (vii) Approx. overall dimensions : (viii) Approx. overall quantity of oil				

	(Ltrs.)				
4.	Any technical deviations offered (Yes/No) If yes, mention the clause no. and reason for deviation				
5.	Type of supports for HV delta, line and tap leads				
6.	Material and size of HV delta and tap leads				
7.	Size of core frame channel				
8.	Size and no. of core studs				
9.	Size and no. of tie rods				
10.	Limit of unbalance of LV neutral (max)				

VIII FURTHER ADDITIONAL DETAILS

Sl.No. Description 5.00 MVA

1. Core Grade
2. Core diameter (mm)
3. Gross core area (sq. cm)
4. Net core area (sq. cm)
5. Flux density Tesla
6. Weight of the core (Kg)
7. Loss per Kg of core at

The Specified Flux Density

8. Core Window Height mm
9. Centre to centre distance mm
10. No. of L.V. Turns
11. No. of H.V. Turns
12. Size of L.V. conductor bare/covered (mm)
13. Size of H.V. conductor bare/covered (mm)
14. No. of parallels
15. Current density of L.V. Winding Amps/mm2
16. Current density of H.V. Winding Amps/mm2
17. Wt. Of the H.V. winding copper for transformer Kg
18. Wt. Of the L.V. winding copper for transformer Kg
19. No. of L.V. COILS/PHASE
20. No. of H.V. COILS/PHASE
21. Height of L.V. Winding mm :
22. Height of H.V. Winding mm :
23. ID/OD of L.V. Winding mm :
24. ID/OD of H.V. Winding mm :
25. Size of the duct in L.V. Winding mm :
26. Size of the duct in H.V. Winding mm :
27. Size of the duct between H.V. & L.V. mm :
28. HV winding to LV clearance (mm) :
29. HV winding to tank clearance (mm) :
30. Calculated impedance %

31. HV to earth creepage distance (mm)
32. LV to earth creepage distance (mm)

ANNEXURE –III

(SCHEDULE OF DEVIATION)

Sl. No.	Requirements/ Equipment	Specification Clause No.	Deviations	Remarks

i) It is hereby conformed that except for deviations mentioned above, the offer conforms to all the other features specified in Technical Specification Section III of this Bid Document.

ii) The additional features that are provided in the meters which have not been covered in the specification are cited at Appendix _____ of the bid.

iii) Technical details/information enclosed with the bid as required in Technical Specification Section-III of the bid document is listed at Appendix _____.

Place: Signature of the Bidder

Date: Name

Business address:

ACRONYMS

Reference Abbreviations	Name and Address
IEC	International Electro Technical Commission Bureau Central de la Commission Electro Technique International, Rue de verembe ***Geneva, Switzerland***
ISO	*International Organisation for* Standardisation, Danish Board of Standardisation Aurehoegyej-12, DK-2900, heel prup, DENMARK.
ISS	Indian Standard Bureau of Indian Standards, Nank Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110 002, INDIA.

<u>SCHEDULE -I</u>

SCHEDULE -IA

DEPARTURE FROM SPECIFICATION

Sl. No.	Reference to clause No. of this specification	Departures

SCHEDULE -IB

MANUFACTURER'S AND PLACES OF MANUFACTURE TESTING & INSPECTION

Sl. No.	**Description**	**Manufacturer**	Place of manufacture	Place of testing and inspection

SCHEDULE -IC

LIST OF SUPPLIES MADE SO FAR WITH FULL DETAILS OF GOODS SUPPLIED AND TO WHOM SUPPLIED

Sl. No.	DETAILS OF GOODS SUPPLIED	TO WHOM SUPPLIED

SCHEDULE -ID

WEIGHT AND DIMENSIONS OF PACKAGES OF DESPATCH

Sl. No.	**Equipment**	Contents of individual packages	Weight Kg	**Dimensions**

SCHEDULE -IE

DESCRIPTIVE LITERATURE AND FULL PARTICULARS OF THE EQUIPMENT OFFERED

Sl. No.	Item No.	Description

SCHEDULE -IF

PERFORMANCE STATEMENT

Sl. No	Name and Address of authority who placed the order	Order No and Date	Name and description of material	Qty(in Nos.)	Value (in Rs.)	Name and Address of Consignee	Actual date of delivery	Despatching Particulars

SCHEDULE – II

SOURCE OF MATERIALS/PLACES OF MANUFACTURE, TESTING AND INSPECTION

Sl. No.	ITEM	Source of material	Place of manufacture	Place of testing and inspection
1.	Laminations			
2.	Copper			
3.	Core plates			
4.	Steel castings			
5.	Tank			
6.	Radiators			
7.	Insulating cylinders			
8.	Insulating paper			
9.	Bushing HV/LV			
10.	Insulated winding wire a) Tap Changer b) Thermometer			

	c) Bucholtz Relay d) Magnetic oil level guage e) Silicagel Breather			
11.	Oil			
12.	Oil Temperature Indicator			
13.	Winding Temperature Indicator			
14.	Silicagel Breather			
15.	Pressure relief valve			

SCHEDULE – III

SHORT CIRCUIT WITHSTAND AND IMPULSE TESTS SO FAR CONDUCTED

Sl. No.	Voltage & Rating	Tap Range & Tap Size of the T/F tested	Place and institution where tested and date of test		Month/date for short circuit test if proposed in near future
			Impulse	Short Circuit	
1.	33/11 kV, 5000 KVA(Cu)				

Note : 1. In case the impulse voltage and short circuit test has not been conducted so far, indicate the proposed date for such testing in near future.

2. In case tests have already been carried out, furnish the detailed reports of such test along with the tender including inspection of active parts after the test.

SCHEDULE – IV

QUALITY ASSURANCE PROGRAM.

Sl. No.	Name of the component.	Characteristics is exercised and is so indicate type quantum of check	Whether	Check	Ref. to	Remarks
1	2	3	4	5	6	7
RAW MATERIALS						
1.	Aluminium / Copper conductor.	(i) Dimension. (ii) Electrical conductivity.				
2.	Insulating paper Dielectric strength of paper.					
3.	Core laminations.	Dimension.				
4.	MS Plate and sections.	Dimension.				
5.	Press Board Perma Wood	i) Dimension. ii) Physical				

		properties. (Density, tensile strength, compressibility, oil absorption, shrinkages)				
6.	a) Insulation Surface finish.					
	b) Copper contacts.	i) Surface finish. ii) Dimension. iii) Contact surface.				
7.	Transformer Oil.	i) Dielectric Strength. ii) Moisture content.				
8.	Radiator.	i) Strength & leak. ii) Rimention.				
9.	Axles, roller.	i) Dimension & finish wheels.				
B) INPROCESS CHECKS :						
1.	Tank conservator & steel fabricated.	i) Cracking of major welds. ii) Dimension items. iii) Vaccum test of leak.				
2.	Core.					
3	Winding.	i) Checking of dimension. ii) Tightness of HV & LV windings. iii) Checking of paper slit dimension. iv) Checking of spacer and their spacing. v) Checking for pre-shrickages and prestressing.				

4.	Drying.	i) Drying process. ii) Oil (only dielectric strength & moisture content to be measured.)				
5.	Other components.	Check insulation for channel.				
C) AFTER ASSEMBLY CHECKS :						
1.	Assembly					
D) FACTORY TEST FOR ROUTING TEST :			Resistivity	Acidity		
1.	Oil Dielectric strength & moisture in to transformer, after hearten test.		Before filling.	After filling.		
2.	i) Ratio at each tap.					
	ii) Vector group.					
	iii) Winding resistance at principal tap & extreme taps.					
	iv) Insulation resistance before & after hear run test.					
	v) Separate source withstand test.					
	vi) Magnetising current at full voltage 90% and 110% excitation & iron loss.					
	vii) Over fluxing normal tap(-) 10% tap.					
	viii) Load loss measurement.					
	ix) Induced voltage withstand test.					
	x) Impedance at principal tap and at extreme taps.					
	xi) Spill current in neutral.					
3.	Type Test :					
	i) Temperature rise test.					
	ii) Pressure test.					

Note: one soft copy of GTP (in Excel) as per specification should be uploaded