

STANDARD TECHNICAL SPECIFICATION COVER SHEET**Specification No. : ENG-HV-2038****Specification Name : Technical Specification 7-11 kV 1.0 MVA Line Voltage Regulator Transformer**

Prepared by	Reviewed by	Reviewed by	Reviewed by	Approved by	Released by
SWARUP NAYAK	Vijender Goyal	SHANTAPRIYA JENA	JYOTIPRAKASH MOHANTY	KHAJAN BHARDWAJ	POURUSH GARG
TPCODL	TPSODL	TPNODL	TPWODL	TPCODL	TPCODL
10-03-2023	11-03-2023	11-03-2023	17-03-2023	18-03-2023	18-03-2023

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1. SCOPE:

I.This Specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forward, supply and unloading at site/store and performance of Oil immersed, non-sealed, naturally cooled, three Phase 11KV Line Voltage Regulator Transformer 500KVA & 1000 KVA to control voltage variation ranging from 7 to11KV.

II.The transformer shall be complete with all components and accessories, which are necessary or usual for their efficient performance and trouble free operation under the various operating and atmospheric conditions specified in clause no. 3

III.Such of the parts that may have not been specifically included, but otherwise form part of the transformer as per standard trade and/or professional practice and/or are necessary for proper operation of transformer, will be deemed to be also included in this specification. The successful bidder shall not be eligible for any extra charges for such accessories etc. notwithstanding the fact that at the time of an initial offer bidder had segregated such items and quoted for them separately.

2. APPLICABLE STANDARDS:

The equipment (and the materials used) covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian standards & other relevant standards for components & CEA guidelines with latest amendment from time to time, thereof, some of which are listed below:

Indian Standards	Title
IS 1180	Outdoor Type Oil Immersed Distribution Transformers Upto and Including 2500 KVA, 33 kV-Specification
IS 2026 (all parts)	Specification for Power Transformers
IS 104	Specification for ready mixed paint, brushing, zinc chrome, priming
IS 335	Specification for new insulating oil.
IS 649	Testing for steel sheets and strips and magnetic circuits.
IS 5	Specification for Colors for ready mixed paints and enamels
IS 1576	Solid Pressboard for Electrical Purposes -Specification
IS 2099	Specification for bushings for alternating voltages above 1000 volts

IS 2362	Determination of water content in oil by Karl in oil Fischer Method – Test Method.
IS 3024	Grain oriented electrical steel sheets and strips
IS3347 (Part I & Part-3)	Dimensions for Porcelain Transformer Bushings for Use in Normal and Lightly Polluted Atmospheres - Part 1 : Up to and including 1 kV
IS 4253: Part II:	Specification for cork composition sheets- Part II : Cork and Rubber
IS 4257(Part I):	Dimensions for Clamping Arrangements for Porcelain transformer Bushings - Part I: For 12 kV to 36 kV Bushings
IS 5082	Wrought Aluminum and Aluminum Alloy bars, Rods , Tubes, Sections, Plates and Sheets for Electrical Applications
IS 5561	Specification for Electric Power Connectors
IS 6103	Specification for Testing of specific resistance of electrical insulating liquids
IS 2026 part 7	Guide for loading of Oil-immersed transformer
IS 6792	Method for Determination of Electric Strength of Insulating Oil
IS 7404 (Part-1):	Paper Covered conductors: Round Conductors
IS 7421	Specification for porcelain bushings for alternating voltages up to and including 1000kv
IS 8603 (Part-1) :	Dimensions for Porcelain Transformer Bushings for Use in Heavily Polluted Atmospheres - Part I:12 kV and 17.5 kV Bushings
IS 9335	Specification for Cellulosic Papers for Electrical Purposes
IS 10028	Code of Practice for Selection, Installation and Maintenance of Transformers
IS 11149	Specification for rubber gaskets
IS 12444	Specification for Continuously Cast and Rolled Electrolytic Copper Wire Rods for Electrical Conductors.
IS/IEC 60947 (PART 1& PART 2)	Specification for LV Switchgear & Control gear
IS 6160	Rectangular electrical conductors for electrical machines
IS 13964	Methods of measurement of transformer and reactor sound levels

IS 3401	Specification of silica Gel
IS 1897	Copper strip for electrical purposes
IS 60529	Degree of protection provided by enclosure
IS 816	Welding of Mild Steel
CEA	Guidelines for specifications of energy efficient outdoor type single and three phase distribution transformers
IS 6262	Method of test for power factor and dielectric constant of electrical insulating liquids
IS 16659	Fluids For Electro technical Applications - Unused Natural Esters For Transformers And Similar Electrical Equipment
IS 16081	Insulating liquids — Specifications for. Unused synthetic organic esters for Electrical purposes
IEC 60156	Method of determination of electric strength of insulating oils.
IEC 60296	Specification for unused mineral insulating oils for transformers and switchgear.
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IS 1852	Rolling and cutting tolerances for hot rolled steel products

3. CLIMATIC CONDITIONS:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	1500 mm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr

9	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

TPCODL/TPNODL/TPWODLTPSODL service area has heavy saline conditions along the coast and High cyclonic Intensity winds with speed upto 300 Kmph. The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months.

4. GENERAL TECHNICAL REQUIREMENTS:

SL	Parameters	Unit	500 KVA	1000 KVA
1.	Description		11KV Line Voltage Regulator Transformer	
2.	Service		Outdoor	
3.	Reference Standard & Tolerances		IS:2026	
4.	KVA Ratings of Transformers	kVA	500	1000
5.	Voltage Variation	KV	7KV-11KV on Source Side to maintain a constant 11KV on Load side.	
6.	Full Load Current	Amp	41.24A at 7KV, 26.24A at 11KV	82.48 at 7KV, 52.48A at 11KV
7.	Voltage Control		By provision of an AVR With OLTC	
8.	Rated Frequency	Hz	50	
9.	No. of Phases	Nos	3	
10.	Max Flux density at normal voltage (11KV) and frequency (50Hz)	Tesla	1.6 T	
11.	Max Flux density at 12.5% increase of Combined Nominal V & f .	Tesla	1.9 T	
12.	Max Current density	A/Sq. mm	2.5	

13.	Vector Group		Ynya0	
14.	Type of Cooling		ONAN	
15.	Temperature Rise- Top Oil/ Winding,	°C	40/45	
16.	No-Load Loss at rated voltage (11kV) & Frequency	kW	1 kW ($\pm 10\%$ Tolerance)	2 kW ($\pm 10\%$ Tolerance)
17.	Load Loss at rated current and at 75 Deg at Highest Tap	kW	2 kW ($\pm 10\%$ Tolerance)	3.5 KW ($\pm 10\%$ Tolerance)
18.	Impedance Voltage at rated current at 75 Deg	%	0.55 ($\pm 10\%$ Tolerance)	0.6 ($\pm 10\%$ Tolerance)
19.	Type of Tap Changer		In-Tank OLTC (On Load Tap Changer)	
	Make		EASUN MR/CTR	
	Tapping Range		16 Step,17-Position	
20.	Insulation Class		Class-A	
21.	Separate Source Power Frequency Voltage Withstand	KVR MS	28	
22.	Induced Over Voltage Withstand	KVR MS	22	
23.	Full Wave Lightening Impulse Withstand Voltage of winding	kVp	95	
24.	Terminal Arrangement -			
	Load Side Bushing		Outdoor type 17.5KV Bushing on Top	
	Source Side Bushing		Outdoor type 17.5KV Bushing on Top	
25.	Weight (With $\pm 10\%$ Tolerance)		As per Manufacturer's Design	
26.	Weight of Core	Kg	As per Manufacturer's Design	
27.	Weight of Winding(Copper)	Kg	As per Manufacturer's Design	

28.	Core &Winding	Kg	As per Manufacturer's Design
29.	Tank &Fitting	Kg	As per Manufacturer's Design
30.	Transformer Oil	Ltrs/ Kg	As per Manufacturer's Design
31.	Total Weight of Transformer	Kg	As per Manufacturer's Design
32.	Auxiliary Transformer 3Ph 1KVA for Tap Changer and Control. (Separate/In Built)	Qty	1
33.	Core Material & Grade		CRGO M3 0.23 mm
34.	Winding Resistance at 20 Deg.c Per phase(Tap.No.1)	Ohm	As per Manufacturer's Design
35.	Magnetizing Current at 90%,100% &112.5%	%	2%,3% & 5.0% of Rated Current
36.	Winding Material Insulation		QPC
37.	Type of Mounting		Floor Mounted/ Plinth Mounted

5. GENERAL CONSTRUCTION:

- I. The transformer shall be stacked core, copper coil, oil immersed, naturally cooled (ONAN), non-sealed type with plain rectangular tank.
- II. The transformer shall be suitable for service with fluctuations in supply voltage as per GTP
- III. The transformer shall be designed suitable for service life of 25 years.
- IV. The transformer and accessories shall be designed to facilitate trouble free operation, inspection, maintenance and repairs under the various operating and atmospheric conditions specified in clause no. 3.
- V. The design shall incorporate every precaution and provision for the safety of the equipment as well as staff engaged in operation and maintenance of the equipment.
- VI. All outdoor apparatus of the transformer, including bushing insulators with their

mountings, shall be designed so as to avoid any accumulation of water.

5.1 CORE:

- I. Transformer core shall be stack type, 2D, constructed from high grade cold rolled, non-ageing, grain oriented, silicon steel lamination which shall be properly annealed (under inert atmosphere, if required) to relieve stresses.
- II. The core shall have low loss and good grain properties.
- III. Core should be coated with hot oil proof, with insulation coating, an inorganic coating equivalent to C-5 type as ASTM A976 or IS 3024, like Carlite -3.
- IV. All core should be clamped together with frames to prevent vibration and noise. The core clamping shall be preferably without through bolts and if any bolt used same shall be effectively insulated.
- V. The core thickness should be 0.23mm or better. 23HP85 as per IS 3024 or better with Minimum Polarization in Tesla at a Field Strength of 800 A/m
- VI. Only single grade and same thickness of core stampings shall be accepted and mixing of different grades shall not be allowed.
- VII. The complete design of the core must ensure maximum permanency of the core losses without continuous working of the transformers .
- VIII. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated. The vendor shall submit the calculations in support of the same.
- IX. The handling of core lamination and stacking should be smooth and uniform.
- X. The transformer shall be suitable for continuous service without damage under 'over fluxing' where the ratio of voltage over frequency exceeds the corresponding ratio at rated voltage and rated frequency up to 12.5% and the core shall not get saturated. The BH graph to be submitted by bidder for core material.
- XI. Increase of 12.5% of rated voltage shall not increase the no-load current by 5% maximum of full load current .
- XII. The bidder shall be required to submit the following documents in regard to procurement of core material during stage inspection:
 - a. Invoice of supplier
 - b. Mill's test certificate
 - c. Packing list
 - d. Bill of landing
 - e. Bill of entry certificate by custom (if required)

- f. Description of material, electrical analysis, physical inspection certificate for surface defects, thickness and width of material.
- XIII. The bidder shall offer the core for inspection and approval of TPCODL/TPNODL/TPWODLTPSODL during manufacturing stage. Heavy penalty or black listing shall be imposed on the bidders using defective CRGO sheets i.e in case of nonconformance w.r.t TPCODL/TPNODL/TPWODLTPSODL Specifications.
- XIV. Transformer core assembly shall have enclosed type lifting lugs for lifting arrangement.
- XV. **Bidder shall provide the below details in below table:**

Sl. No.	Description	Unit	To be furnished by bidder
1	Magnetizing (No Load) Current		
	90% Voltage	%	
	100% Voltage	%	
	112.5% Voltage	%	
2.	Core grade		
3.	Thickness of core Lamination	Mm	
4.	Core Dimension: Length X height X diameter	mm x mm x mm	
5.	Gross core area	Sq.cm	
6.	Net core area	Sq.cm	
7.	Flux density (calculated)	Tesla	
8.	Over fluxing without saturation to be submitted)	Tesla	
9.	Mass of core	Kg	
10.	Loss per Kg of core at the above specified flux density	Watt	
11.	Core window height	Mm	
12.	Center to center distance of the	Mm	

13	Mass of Core Lamination (min.	Kg	
14	Make of Core offered		

5.2 WINDING CONNECTIONS

- I. Load and Source Side windings shall be constructed from high- conductivity (copper conductors), QPC copper conductor with min. 25% overlap per layer of paper.
- II. The conductor should be drawn uniformly without any deformation and any burr.
- III. No metallic or non-metallic dust should be present in-between QPC conductor.
- IV. The current density for Load and Source Side winding should not be more than 2.5 Ampere per sq.mm.
- V. The insulation between core and bolts, core and clamps shall withstand **2.5 kV for one minute.**
- VI. Proper bonding of inter layer insulation with the conductor shall be ensured.
- VII. All turns of windings shall be adequately supported (by which material) to prevent movement. The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- VIII. The joints in the winding shall be avoided but if it is necessary then, they shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. Crimping is not allowed at any joints.**
- IX. Bidder shall provide the below details in below table:**

SL	Parameters	Unit	Technical Data
1	Description		
2	Service		
3	Reference Standard & Tolerances		
4	KVA Ratings of Transformers	kVA	
5	Voltage Variation	KV	
6	Full Load Current	Amp	
7	Voltage Control		
8	Rated Frequency	Hz	
9	No. of Phases	Nos	
11	Max Flux density at normal voltage (11KV) and frequency (50Hz)	Tesla	
11	Max Flux density at 12.5% increase of Combined Nominal V & f .	Tesla	
12	Current density	A/Sq.mm	
13	(Intentionally Kept Blank)		
14	Vector Group		
15	Type of Cooling		
16	Temperature Rise-Top Oil/ Winding,	°C	
17	No-Load Loss at rated voltage (11kV) & Frequency	kW	
18	Load Loss at rated current and at 75 Deg	kW	

19	Impedance Voltage at rated current	%	
20	Type of Tap Changer		
	Make		
	Tapping Range		
21	Insulation Class		
22	Separate Source Power Frequency Voltage Withstand	KVRMS	
23	Induced Over Voltage Withstand	KVRMS	
24	Full Wave Lightning Impulse Withstand Voltage of winding	kVp	
25	Terminal Arrangement -		
	Load Side Bushing		
	Source Side Bushing		
26	Efficiency at 75°C at unit P.F & at 0.8 PF Lagging		
	a. 125% Load	%	
	b.100% Load	%	
	c. 75% Load	%	
	d.50% Load	%	
	e.25% Load _	%	
27	Regulation		
	a. At unit P.F	%	
	b. At 0.8 P.F Lagging at 75°C	%	
	c. Maximum Efficiency occurs at	%	
	d. Maximum Efficiency	%	
28,	Weight (With ±10% Tolerance)		
	Weight of Core	Kg	
	Weight of Winding(Copper)	Kg	
	Core &Winding	Kg	
	Tank &Fitting	Kg	
	Transformer Oil	Ltrs/Kg	
	Total Weight of Transformer	Kg	
29	Auxiliary Transformer 3Ph 1KVA for Tap Changer and Control. (Separate/In Built)	Qty	
30	Core Material & Grade		
31	Winding Resistance at 20 Deg.c Per phase(Tap.No.1)	Ohm	
32	Magnetizing Current at 90%,100% &112.5%	%	
33	Winding Material Insulation		

5.3 INSULATING PAPER AND INSULATING PRESSBOARD

- I. Inter layer insulation both for Load and Source Side windings shall be Epoxy diamond dotted Kraft paper and compressed pressboard of make (refer Clause no.5.32) subject to approval of TPCODL/TPNODL/TPWODLTPSODL
- II. Load and Source Side windings shall be constructed from high- conductivity (copper conductors), QPC copper conductor with min. 25% overlap per layer of paper.
- III. Kraft paper and Pressboard should be made of pure Cellulose from soft wood pulp manufactured from sulphate process. No additive, adhesive or coloring matter shall be present.
- IV. Kraft paper and Pressboard should be of class A (105°C) insulation material.
- V. All spacers, axial wedges / runners used in windings shall be made of pre-compressed solid pressboard.
- VI. All axial wedges/runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely.
- VII. Insulation shearing, milling and punching operations shall be carried out in such a way, that there should not be any burr, sharp edges and dimensional variations.
- VIII. Kraft paper self-adhesive tape to be used for bonding of insulating paper layer, spanner and paperboards that are immersed in the oil filled transformer.
- IX. Insulation shall be uniform throughout the winding. Graded Insulation is not allowed.
- X. **Below required values could be verified if required at any stage of the inspection and it should fulfill the requirement as per below table:**

Characteristics	Kraft Paper	Pressboard (all Sizes)
1. Dimension	As specified by bidder with $\pm 5\%$ tolerance.	As specified by bidder with tolerance as per IS1576.
2. Apparent Density	$>0.80 \text{ g/cm}^3$	as per IS 1576 w.r.t Thickness
3. pH of Aqueous extract	6-8%	6-8%
4. Electrical strength i) in air ii) In Oil	7KV/mm -----	12KV/mm 35KV/mm
5. Ash content	Maximum 1%	Maximum 0.7
6. Moisture content	Maximum 8%	Maximum 8%
7. Oil absorption	-----	Minimum 9%
8. Heat stability	As per IS 9335-part 3	As per IS 1576
9. Tear index	As per IS 9335-part 3	As per IS 1576

Bidder has to submit the test certificates as per IS-9335, IS-1576 for all type of insulating materials covering above stated parameters along with **below parameters during stage inspection** :

- a. Substance (Grammage) (g/m³)
- b. Compressibility
- c. Tensile strength
- d. Conductivity of water extract
- e. Shrinkage in air
- f. Flexibility

- g. Cohesion between plies.
- h. Elongation
- i. Air permeability
- j. Bidder shall provide the below details in below table

Sl. No.	Description	Unit	As furnished by bidder
1.	QPC Paper for Load and Source Side conductors :		
	Type of QPC Paper		
	Make of QPC Paper		
	Thickness QPC Paper	mm	
	Percentage Overlapping (not less than 25%)	%	
2.	Type of Paper for Interlayer Insulation		
	Make of Paper for Interlayer Insulation		
	Thickness of Paper for Interlayer Insulation	mm	
3.	Type of Paper for Insulation Between Load and Source Side winding		
	Make of Paper for Insulation Between Load and Source Side winding		
	Thickness of Paper for Insulation Between Load and Source Side winding (for all sizes)	mm	
4.	Type of Pressboards used for Insulation Between Load and Source Side winding		
	Make of Pressboards used for Insulation Between Load and Source Side winding		
	Thickness of Pressboards for Insulation Between Load and Source	mm	

	Side winding (all size)		
5.	Type of Paper used for insulation between core and Winding		
6.	Type of Pressboard used for insulation between core and Winding		
	Make of Pressboard used for insulation between core and Winding		
	Thickness of Pressboard used for insulation between core and Winding (All sizes)		
7.	Material used for top and bottom yoke insulation		
	Make of material used for top and bottom yoke insulation		
	Thickness of material used for top and bottom yoke insulation	mm	
8.	Type of material used for Spanner, wedge and Axial for insulation		
	Make of material used for Spanner, wedge and Axial for insulation		
	Thickness of material used for Spanner, wedge and Axial for insulation (all sizes)	mm	

5.4 LOSSES

- I. The bidder shall individually guarantee No load loss (Iron loss at rated voltage and frequency) and full load Copper Loss (at 75°C) without any positive tolerance.
- II. **The bidder shall also guarantee the total loss at 50% and 100% load condition (at rated voltage and frequency and these should be within the limits of maximum total losses declared by TPCODL/TPNODL/TPWODLTPSODL for both 50% and 100% loading values (as per table below) :**

Description	
Maximum Losses at 50% loading at 75°C (Watts)	



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Maximum Losses at 100% loading at 75°C (Watts)	
Description	
Maximum Losses at 50% loading at 75°C (Watts)	
Maximum Losses at 100% loading at 75°C (Watts)	

No positive tolerance shall be allowed on the losses as mentioned above. However, bidder can offer losses less than specified but no consideration in cost will be given for the same.

*** : Ratings are for optional/ future use**

- III. The successful bidder shall guarantee the quoted losses for at least five years. If at any point of time during operation if it is found that the total losses at 50% and 100% load are more than the values given in specifications, then bidder shall be liable to pay a fine of Rs 250 per watt to the amount by which losses at 50% loading and 100% loading increase with respect to the values given in specifications.
- IV. During testing at Bidder's works if it is found that the actual measured losses are more than the values quoted by the Bidder, TPCODL/TPNODL/TPWODLTPSODL shall have the right to reject the complete lot.
- V. During testing at Bidder's works, if the temperature rise exceeds the specified values, the entire lot shall be rejected by TPCODL/TPNODL/TPWODLTPSODL.
- VI. During testing at Bidder's works, if the impedance values differ from the guaranteed values including tolerance, the entire lot shall be rejected by TPCODL/TPNODL/TPWODLTPSODL.
- VII. Transformer losses shall be checked on any one of DT from supplied lot at TPCODL/TPNODL/TPWODLTPSODL workshop. If it is found that the actual measured losses are more than the values quoted by the Bidder, TPCODL/TPNODL/TPWODLTPSODL shall have the right to reject the complete lot.

VIII. **Bidder shall provide the below details in below table:**

Sl. No.	Description	Unit	To be furnished by bidder
1	No Load losses	Watt	
2	Load losses at 50%loading at 75° C	Watt	
3	Load losses at 100% loading at 75° C	Watt	
4	Total losses at 50%load at 75° C	Watt	
5	Total losses at 100% load at 75° C	Watt	
6	Efficiency at 75 deg. C		
7	Efficiency at Unity P.F.		

7.1	100% load	%	
7.2	80% load	%	
7.3	60% load	%	
7.4	40% load	%	
7.5	20% load	%	
8	Efficiency at 0.8 P.F.		
8.1	100% load	%	
8.2	80% load	%	
8.3	60% load	%	
8.4	40% load	%	
8.5	20% load	%	
9	Regulation at :		
9.1	Unity P.F. at 75 deg. C	%	
9.2	0.8 P.F. at 75 deg. C	%	
9.3	% Impedance at 75 deg. C	%	

5.5 TRANSFORMER TANK AND TANK CONSTRUCTION

- I. The transformer tank shall be of robust construction, rectangular in shape and shall be built up of electrically tested welded mild steel plates.
- II. The tank shall be fabricated by welding at corners. No horizontal or vertical joints in tank side walls and its bottom or top cover shall be allowed.
- III. All welding operations should be carried by qualified welders (performance qualification certificates to the customer) as per the relevant ASME standards and a copy of the welding procedure has to be submitted to TPCODL/TPNODL/TPWODLTPSODL at the time of drawing approval.
- IV. The thickness of tank should be as below:
For top and bottom : 6 mm (min.)
For Sides : 5 mm (min.)
Tolerance shall be applicable as per IS 1852 as per above thickness band.
- V. In addition the cover of the main tank shall be provided with an **air release plug**.
- VI. The tank plates shall be of such strength that the complete transformer when filled with oil may be lifted bodily by means of the lifting lugs provided. The top cover shall have no cut at point of lifting lug.
- VII. The transformer tank cover shall be bolted with tank rim so as to make a leak proof joint.
- VIII. The tank plate and lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.



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- IX. The tank cover shall have slight slope (10 mm ± 2mm) towards Source Side side to drain rain water.
- X. There must be sufficient space from the core to the top cover to take care of oil expansion. The oil volume inside the tank shall be such that even under the extreme operating conditions, the **pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative** and the tank shall be of adequate mechanical strength to withstand it.
- XI. The transformer should be capable of **withstanding 0.8kg/sq.cm air pressure and a vacuum of 0.7kg/sq.cm**. The permanent deflection of the flat plate, when the tank without oil is subjected to a vacuum of 525 mm of mercury shall not be more than the values specified:

Length of Plate	Deflection
Up to 750 mm	5.0 mm
751 mm to 1250 mm	6.5 mm
1251 mm to 1750 mm	8.0 mm
Above 1750 mm	9.0 mm

- XII. The tank design shall be such that the core and the windings can be lifted freely without dismantling the bushings.
- XIII. All joints of tank and fittings shall be oil tight and no bulging shall occur during service.
- XIV. Anti –theft arrangement via drill hole in one of the thread shall be provided at top cover.
- XV. The tightening torque chart to be provided for all bolts used. This shall be submitted along with each rating drawings.
- XVI. The transformer shall be provided with four pulling lugs of MS plate of 8mm thick to pull the transformer horizontally.

Lifting lugs:

- I. The transformer shall be provided with a minimum of four welded heavy duty enclosed lifting lugs of Structural steel E250 or better grade quality A (Minimum quality A) as per IS 2062 plate of minimum 16mm thickness for lower rating and gradually increased for higher rating as per weight suitably reinforced by vertical supporting flat stiffener smooth welded properly on the side walls up to reinforcing angle. They shall be so extended that cutting bend plate is not required. The transformer lifting lug shall be painted with yellow colour.
- II. The location of lifting lugs shall be such that the clearance between lifting chain and nearest part of bushing shall be at least 100 mm.
- III. There shall be facilities for lifting the core coil assembly separately.
- IV. The lifting lugs shall be designed in such a way that any two diagonal lugs are capable of lifting two times of the total weight of the transformer. The design of should be such that it should be suitable for 120degree lifting rope angle as per ASME B30.9 and at any point of time the maximum stress allowed on the Lug martial shall be lesser than 82MPa as per ANSI C.57.12.10
- V. Calculation sheet for Lifting lug design to be submitted by Bidder. The calculation shall include the Stress on lifting lug material and stress on welding both. The Stress on the welding should be less than 840kg/cm² as per ANSI C.57.12.10. All calculation to be done for considering lifting on any diagonal opposite two lugs conditions.
- VI. The lifting lugs shall be located on the side walls only and conservator on LT box side. Separate drawing to be submitted stating welding thickness, welding length and location on tank along with stiffener support for all rating and all lugs.

Bidder shall provide the transformer size and clearances in below table:

Sl. No.	Description	Unit	To be furnished by bidder
1	Transformer overall Length x Height x width	mm x mm x mm	
2	Only Tank overall Length x Height x width	mm x mm x mm	
3	Source Side Cable box overall LxWxH (If applicable)	mm x mm x mm	
4	Load Side Cable box overall LxWxH (If applicable)	mm x mm x mm	
5	Clearances		
5.1	Core and Winding	mm	
5.3	Winding Phase to phase	mm	
5.5	Between yoke and inside of tank to cover	mm	
5.6	Between yoke and bottom	mm	
5.7	Any point of winding to tank	mm	
6	Calculated Impedance	%	
7.1	Winding to Earth Creepage distance in oil (minimum 15mm)	mm	
8.	Conservator dimension (dia x Length)	mmxmm	
9.	Size of Pipe used for conservator to Tank	mm	
10.	Size of Pipe used for Valves	Mm	
11.	Base Channel size	mmxmmxmm	
12.	No. of Radiators	Nos	
13.	No. of fins per Radiator	Nos	

14	Dimension of radiator fins (L x W)	mmxmm	
15	Make of Tank material		

5.6 RADIATORS

- I. Radiators of pressed steel type conforming to the design requirement suitable for mineral oil and Ester oil (all type) type transformer.
- II. The Pressed Steel type should be used in vertical formation without any bending and should be individually tested for leakage and pressure test etc. before welding with the main tank.
- III. **Thickness** of sheet for radiators shall be **1.20 mm (min)**.
- IV. The **mounting** of the radiators shall be **detachable**
- V. The number / cross section / length / fixing arrangement of radiators shall be indicated in the general assembly drawing.
- VI. Radiator thickness must be uniform without any dent or damage and also no bulging or concave should occur even after performing pressure/ vacuum test and temperature rise test.
- VII. Corrugated designs are not accepted.

5.7 GASKET

- I. **Cork rubber gaskets** conforming to Type C , grade RC70 as per IS 4253 (Part-2) shall be provided for all oil bearing & water ingress resistant requirements for components like bushings bottom gasket, terminal box, Top Cover, Conservator, Valves etc.
- II. **Nitrile/Neoprene rubber gaskets** conforming to Type IV – 4C (heat and oil resistant) as per IS 11149 shall be provided for bushing O ring (oil gaskets).
- III. **Only Joint free Gasket to be used. Only in case of top cover gasket and terminal box gasket up to two dove-tail joints with adhesive shall be allowed. The terminal box gasket joint shall come at bottom part.**
- IV. Cork sheet, Nitrile/Neoprene rubber gaskets shall be free from cracks, pinholes and shall be capable of being cut or punched without crack or tearing.

5.8 On Load Tap Changer

On Load Tap changer (OLTC) on Source Side	
a) Type	On Load (In Tank)
b) Range	7kV -11kV 0 to -36%
c) Number of Steps	16 Step (17 Position)
e) Manual / Automatic	Yes (Both)
f) Remote / Local	Yes (Both)
g) IS	8468-2006
h) All contacts should be SCADA compatible and suitable for connection to TMU	Yes
i) Protection for OLTC	Yes
j) Potential free contacts for SCADA shall be Provided	Yes



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k) Flow of Power	Bidirectional
l) AVR and SCADA compatibility	Yes

5.9 BUSHINGS AND TERMINAL CONNECTORS

A. HT Bushings (17.5 kV/250 A) on Load and Source Side Side:

- I. The bushings shall be outdoor type, external part shall be made of porcelain material. Rods, nuts and flat washer (Tightening Nut along with Check Nut) shall be made of tinned brass material.
- II. IS to be followed: IS 8603(Part- I) for porcelain, IS 3347 part3 section 2 for metal part and Complete bushing shall comply IS 2099.
Outdoor Bushing on Top with Bird Guard
- III. The bushings shall have Hot Dipped Galvanized or Alum-zinc coated or SS material arcing horns with 8mm diameter. The thickness of coating shall be **86 microns** (minimum at any point).
- IV. The bushing shall be fitted with bird guard on the bushing connector.
- V. Complete Tinned Brass joint less connectors shall be provided on bushing rods suitable for bare dog conductor connections. The connector should have large contact area. Hardware shall be Hot Dipped Galvanized or Aluzinc coated or SS material

LA of suitable voltage rating shall be mounted at both ends of the transformer

5.10 TERMINAL CONNECTORS

HT TERMINAL CONNECTOR:

- I. Tinned Brass connectors shall be provided connected with bushing rods for bare top plate bushings .
- II. UV resistant polymeric insulating shrouds shall be provided on the bare bushing terminals.

5.11 INTENTIONALLY KEPT BLANK

5.12 EQUILISING/ EQUIPOTENTIAL STRIP

- I. The Transformer top cover shall be connected with main tank using **tinned copper strip (30mm wide, 0.7mm thick)** at two places (diagonally opposite with each other).
- II. The strip should touch bare surface of tank in order to ensure proper electrical connection of tank body with top cover with the strip.
- III. All the covers like inspection cover, Conservator cover must be electrically connected using **tinned copper strip (30mm wide, 0.7mm thick)**.
- IV. Separate arrangement to be made and cover tightening bolt not to be used for equipotential strips.

5.13 EARTHING CONNECTIONS

NEUTRAL EARTHING:

- I. 12KV Grade of neutral bushing shall be provided

BODY EARTHING:

- I. Two body earthing terminals pads boss arrangement (up to 500sq.mm) shall be provided on Transformer tank with M12 SS Bolt with 70 sq. mm lug. with SS plain washer and spring washer.
- II. It shall be located on the lower side of the transformer, diagonally opposite to each other.
- III. Each Earthing terminal pad on DT shall be provided with two SS M12 bolts on each pad on each side with two 70 sq.mm AL Lugs and washers.

5.14 OIL

Note: Default Oil shall be Mineral oil only if not specified / asked for other oil.

Mineral Oil: In case of Mineral Oil below are the requirements to be fulfilled:

1. All transformers shall be filled with new, unused, clean, standard mineral oil in compliance with IS 335-2018 / IEC 296 type-II and shall be free from all traces of polychlorinated biphenyl (PCB) compounds.
2. The use of recycled oil is not acceptable.
3. Oil shall be filled under vacuum before filling it shall be filtered and tested (as per IS 6103).
4. The test parameters should be as per the table below:

Test parameters	Values
Break Down Voltage (min)	70 kV
Water content ppm, (max.)	30 ppm
Specific resistance (min.) (at 27°C)	2.5 × 10 ¹² ohm-cm

Bidder has to provide the oil data in below table:

Sl. No.	Description	Unit	To be furnished by bidder
1	Type of oil		
2	Oil Qty. for first filling	Ltr.	
3	Grade of Oil		
4	Maker's name		
5	BDV at the time of first filling	kV	

5.15 CONSERVATOR

- I. The conservator shall be supported / fixed on the main body of the transformer tank.
- II. The capacity of the conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of

conservator shall be such as to contain **10% quantity of the oil used in transformer**. Normally, at least **30% volume of conservator** shall be filled with Oil.

- III. The connecting pipe of the conservator shall be so fitted to transformer tank that the pipe can be detached from the tank.
- IV. Joint less pipe shall be used which shall be connected with round flanges.
- V. The inside diameter of the pipe connecting the conservator to the main tank shall be within 25 to 50 mm and it should be projected into the conservator so that its end is approximately 20mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level corresponding to -5°C should be above the sump level.
- VI. The conservator oil filling cap/hole shall be of 32mm diameter & female type cap to be provided.
- VII. The conservator to be fitted with MOG such that it shall operate/open contact when the oil level in conservator goes below -5 degree C /Minimum mark. The float switch shall be with normally closed type. This contact shall be wired up in auxiliary terminal box.
- VIII. Buchholz relay: The pipe should not contain any right angle elbows. Its diameter should correspond to the diameter of the hole for the passage of oil of the relay. The pipe must be arranged to slope upwards towards the conservator at an angle of about 2 to 4 degrees to the horizontal (max 5 degrees). The part of the pipe preceding the relay should be straight for a length equal to at least five pipe diameters; the part of the pipe leading to the conservator immediately adjacent to the relay should be straight for a length equal to at least three pipe diameters.
- IX. The Oil conservator shall be provided with:
 - a. **Oil level indicator** (as per clause no. 5.18).
 - b. **Dehydrating breather** (as per clause no. 5.22).
 - c. **Drain plug**
 - d. **Oil filling hole** (1.25 inch/32mm with thread size of BSP 1.25inch, 11TPI) with cover.
 - e. **Detachable end plate** on one side (the side on which the gauge glass is fitted), to enable the maintenance staff to periodically clean the inside of the conservator tank

Center of Gravity

The transformer should be designed in such a way that the centre of gravity of complete transformer with oil and with all accessories shall fall at the vertical centre at lower height such that the transformer should be stable on flat surface ground and while lifting at lifting hooks.

5.16 OIL LEVEL INDICATOR

- I. Oil level indicator with **prismatic glass and red colour background** shall be provided.
- II. The oil gauge glass shall be removable and so embodied in the end plate so as to prevent oil leakage.
- III. The Oil level indicator should indicate oil level at minimum, normal and maximum as -5°C, 30°C and 90°C respectively.

5.17 PRESSURE RELEASE VALVE

- I. All transformers shall be provided with PRV with auxiliary contacts. The contact to be wired up in the auxiliary terminal box.
- II. PRV shall be provided to operate before reaching the test pressure as specified in the above class.
- III. PRV shall not have air release arrangement.
- IV. The PRV shall seal-off after the excess pressure has been released and it shall have mechanical flag arrangement.
- V. The PRV shall have NO, NC contacts wired up in auxiliary terminal box.

5.18 AIR RELEASE PLUG

The cover of the main tank shall be provided with an **air release plug on all ratings.**

5.19 DRAIN VALVE AND FILTER VALVE

- I. The drain valve and filter valve shall be of Brass with gate valve.
- II. The drain valve and filter valve shall have double round flanges. One side shall be fixed with tank and other side should be left open for oil filling/filtration purpose.
- III. The drain valve and filter valve shall be provided with embossed name plate stating drain valve and filter valve.
- IV. The drain valve shall be located on the bottom and filter valve shall be provided at side top of tank.
- V. Locking arrangement shall be provided to stop movement of hand wheel.
- VI. The valves shall be covered with a MS box of 2mm thickness by welding on tank. The paint thickness shall be min. 120 micron on the box.

5.20 DEHYDRATING BREATHER

- I. The breather pipe shall enter the conservator from the upper side of the conservator.
- II. The breather shall contain 1 kg of silica gel.
- III. The silica gel shall be blue colored as per IS: 3401 – 1992. Quantity shall be decided by manufacturer.
- IV. The body of the breather shall be unbreakable, transparent, UV stabilized seamless polycarbonate tube of minimum thickness 3mm
- V. The top cover shall be of pressure die cast aluminum and powder coated.
- VI. The oil cup shall be of UV protected polycarbonate.
- VII. Oil cup shall have marking of oil filling level
- VIII. The breather shall be supplied as per approved make and as per specifications.
- IX. The gasket should be of Class 3B, Type III as per IS 11149 Nitrile rubber (Oil resistant gaskets)
- X. All tie rods and all hardware should be of stainless steel material (SS 304)
- XI. While fixing of breather on transformer Teflon tape should be used to make it air tight & water tight. This shall be checked during inspection and after receipt at our stores on each transformer.
- XII. The breather should have passed air pressured test as per our specification i.e. Breather shall be tested at an air pressure of 0.35kg/cm² (5 PSI) for period of 30 minutes. NABL lab test report to be submitted from OEM.

5.21 OIL TEMPERATURE INDICATOR

- I. Dial Type Oil temperature indicator shall be provided inside the marshalling Box
- II. Range: 0- 120 °C, Accuracy: ± 4 °C.
- III. The OTI shall have auxiliary contacts for alarm and trip contacts at preset temperatures, both the contacts should be wired up in the auxiliary terminal box.
- IV. The IP65 gland should be used for dial for taking out auxiliary wires.
- V. The OTI shall be IP55 tested.

5.22 FASTENERS

- I. All the bolts or studs shall be **at least 6 mm in diameter** except when used for small wiring terminals. **All bolts shall be of grade 8.8.**
- II. All nuts/bolts/washers exposed to atmosphere shall be as follows:

Size 12mm (or below)	Stainless Steel
Above 12mm	Steel with antirust coating (aluzinc coated), Hot dip galvanized

- III. All ferrous bolts, nuts and washers placed in outdoor positions shall be hot dip galvanized to prevent corrosion (except high tensile steel bolts and spring washers which shall have electrolytic action between dissimilar metals).
- IV. In case the galvanization is removed due to welding or manufacturing, the parts should be properly cleaned and painted to avoid exposure to atmosphere.
- V. The cup type washers to be used as spring washers, cut spring washers are not accepted.
- VI. Taper washers shall be provided where necessary. Protective washers of suitable material shall be provided on front and back of the securing screws.
- VII. Each bolt shall project at least one thread but more than three threads through the nut. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided. The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- VIII. Core bolts shall be black colored high tensile grade-8.8

5.23 SURFACE PREPARATION AND PAINTING

- I. The paint shall be applied by airless spray. Thickness shall be 120 Microns.
- II. Steel surfaces shall be prepared by **shot blast cleaning** (IS-9954) to grade Sq.2.5 of ISO 8501-1 or **chemical cleaning** including phosphating of the appropriate quality (IS 3618).
- III. **Heat resistant (Hot oil proof) paint** shall be used for the **inside surface** and whereas for **external surface one coat of thermosetting powder paint or one coat of epoxy primer (zinc chromate/Zinc Phosphate) followed by two coats of polyurethane (P.U.) base paint.** as per table given below

S.No.	Paint type (should be UV restraint, non-fading)	Area to be painted	No of coats	Total dry film thickness (min); micron
1.	Thermosetting powder paint	Inside	01	30
		Outside	01	60
2.	Liquid Paint			
a.	Epoxy (primer)	Outside	01	30
b.	P.U. Paint (finish paint)	Outside	02	25 (each)
c.	Hot oil resistant paint	Inside	01	35

The two coats shall be of oil and weather-resistant nature with final coat as flossy and non-fading paint of shade 631 as per IS 5.

- IV. The dry film thickness shall not exceed the specified minimum dry film thickens by more than 25%.
- V. Any damaged part shall be cleaned to bare metal with an area extending 25 mm around its boundary. A priming coat shall be immediately applied followed by full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage. The repainted surface shall present a smooth surface which shall be obtained by carefully chamfering the paint edges before and after priming.
- VI. Painting shall not affect by weather changes & performance against pilling out or fading etc. to be guaranteed for 5 Years.

5.24 RADIO INTEREFENCE

When operated at voltages up to **12.5%** in excess of the normal system rating, transformers shall be substantially free from partial discharges (i.e. corona discharges in either internal or external insulation) which are likely to cause interference with radio or telephone communication.

5.25 OVERLOAD CAPACITY

The transformer shall be suitable for loading as per IS 2026 part 7

5.26 FITTINGS

The following standard fittings shall be provided:

- I. Two earthing terminal pads/ boss with earthing symbol \perp for body earthing on opposite sides with 70sq.mm AL lug and M12 SS bolt and washers.
- II. Air Release Device.
- III. Thermometer Pocket with cap.
- IV. Drain cum Sampling Valve & filter valve
- V. Pressure Release Valve
- VI. Radiators
- VII. Cable **Box** /Bare Bushing (as per site requirement) for all transformer. For Source side, cable box or Bare bushings can be provided. **User group shall decide this during tender.**
- VIII. For bare bushing transformer- bird guard on bushings terminals connectors
- IX. Load and Source Side two part Gland plates (Non-Magnetic and with Single compression Brass glands).
- X. Conservator with Dehydrating Breather on Load Side.
- XI. Prismatic Oil level Gauge and MOG in conservator.
- XII. Lifting lugs (enclosed type) for the top cover, complete transformer and core and winding assembly.
- XIII. Pulling Lugs.
- XIV. Jacking Pads
- XV. Stiffener Angle.
- XVI. 2 Base channels all Transformer
- XVII. Marking Plates as asked in clause 6.1
- XVIII. Oil Temperature indicator with alarm & trip contact
- XIX. Two GI earth strip of Size 50x6 mm for neutral earthing from both side with minimum GI coating thickness of 86 microns. With SS nut bolts and washer.
- XX. Magnetic Oil level Gauge , Winding Temperature Indicator , Magnetic Reed type Buchholz relay in line with IS 1180.
- XXI. Marshalling Box with stud type terminals .

5.27 WINDING TEMPERATURE INDICATOR (WTI)

- I. WTI shall be provided (Qty:1)
- II. WTI shall be **indicating type**, responsive to the combination of top oil temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding.
- III. WTI shall operate a remote alarm and trip in the event of attaining the predefined temperature.

5.28 BUCHHOLZ RELAY

- I. Magnetic Reed type Buchholz relay shall be provided with alarm and tripping contacts to detect accumulation of gas.
- II. The installation shall be fixed and weather proof to avoid any water seepage inside the relay.
- III. Round flange of nominal pipe bore of **50mm diameter** shall be used.
- IV. In addition, pocket with heater coil along with Resistance Temperature Indicator (RTD) shall be provided for WTI and OTI. CT for RTD for winding hot spots shall be provided.

5.29 Two Separate Marshalling Box shall be provided

- 1. For Transformer OTI, WTI, etc and AVR
 - I. Marshalling Box of suitable size, made up of **Mild Steel** and with **theft proof locking arrangement** shall be provided.
 - II. Marshalling box shall have IP 55 protection.
 - III. Marshalling Box shall have provision for wiring the **WTI, OTI, MOG, PRV, Buchholz relay and WTI CT terminals**. The terminals shall be provided as per table below:

Element	Alarm	Trip
Oil Temperature Indicator	NO,NC,COM	NO,NC,COM
Winding Temperature Indicator	NO,NC,COM	NO,NC,COM
Buchholz	NO,NC,COM	NO,NC,COM
Magnetic Oil Level Gauge	NO,NC,COM	
PRV	NO,NC,COM	
Spare TB	4 No.	
Tap Position		

- IV. WTI meter shall be wired/ installed in the marshalling box.
- V. Plastic ferrules engraved with black letters shall be used to mark the wires in the marshalling box.
- VI. Wiring in Marshalling box shall be done by 2.5 sq.mm Cu FRLS PVC stranded panel wires.
- VII. All the cables and conduits between the transformer and control cabinet shall be included in the scope of supply by the bidder.

2 . For AVR Controls

- I. Marshalling Box of suitable size, made up of Mild Steel and with theft proof locking arrangement shall be provided.
- II. All necessary arrangement for local operation /Remote operation to be provided.
- III. All the cables and conduits between the transformer and control cabinet shall be included in the scope of supply by the bidder.
- IV. Marshalling box shall have IP 55 protection.
- V. All necessary protection for OLTC/AVR to be provided.
- VI. AVR should have SCADA compatibility using Modbus or IEC60870-103 Protocol for remote monitoring and control.

5.30 MAKE OF MAJOR COMPONENTS & RAW MATERIALS

The BA shall procure the following constituent items from the designated vendors as follows:

S.no	RAW MATERIAL/EQUIPMENT	MAKE
a)	Copper	M/S Sterlite, M/S Hindustan Copper, M/S Hindalco.
b)	Core	M/S AK Steels, POSCO, Kawasaki/JFE, Nippon Steel.
c)	Insulation paper and Pressboards	ITC paper, ABB, Raman Boards-Mysore, Senapathy Whiteley – Bangalore
d)	Transformer Oil (Mineral oil)	Savita, Apar, Gandhar
e)	Gaskets & Corks	Nu Cork, Anchor Corks
f)	Steel For Tank	M/s, TATA Steel, M/s SAIL, M/s. JSW Steel, M/s. IISCO, M/s. RINL/Vizag Steel, M/s. Jindal Steel,
g)	Dehydrating Breather	Yogya, Anushree, Electrical engineers
h)	Bushings	Genesys Electricals,Hindustan Chemicals, Rashtriya Electricals,LAMCO
i)	Buchholz, PRD, SPR, OTI , WTI, and other devices	Reputed make to be approved by TPCODL/TPNODL/TPWODLTPSO DL during detailed engineering.

Also, Bidder has to provide all test certificates from original manufacturers & relevant sourcing documents. BA shall also have shot blasting facility.

6. MARKING:

6.1 MARKING PLATES

I. Name Plate (Rating) Plate : SS material

A rating plate shall be fitted to each transformer in a visible position and shall carry all the information as **specified in clause no. 6.2**

II. Terminal Marking Plate : on same name plate also accepted

- The terminal marking plate shall be provided which shall be strictly in accordance with **figure 4 of IS 1180-Part 1: 2014**. This plate may be combined with the rating plate or can be provided separately.
- Value of short circuit impedance on extreme tapping and on principal tapping and indication of winding to which impedance is related has to be displayed additionally.

III. Details Plate : MS sheet of 2.5mm with punched details and welded on tank.

A separate plate of **size 125 mm x 125 mm** shall be provided having following details:

- Name of the firm.
- Serial No.
- Rating of transformer.
- Order no. and date.
- Date of dispatch.

IV. Guarantee Plate :

A separate warranty plate made of **Stainless Steel** with following clause written on it.

“THE EQUIPMENT GUARANTEED UPTO A PERIOD OF 48 MONTHS FROM THE DATE OF COMMISSIONING OR 60 MONTHS FROM THE DATE OF LAST SUPPLY”

All the plates described above (clause 1 to 4) should be as followings:

Material	Stainless Steel
Thickness	1 mm
Engraving	The letters on the rating plate shall be engraved black on the white/silver back ground.
Fixing	Fixing screws shall be of stainless steel.

V. Danger Plate: On all cable boxes (If applicable)

Danger notice shall have red lettering on a white background on a plate as specified in **IS: 2551 – 1982**.

VI. BIS Certification Mark: On main name plate

The Bidder is required to get approval from BIS and display BIS mark on the name plate.

- a. Oil filled, naturally cooled type
- b. Make

- c. Capacity in KVA
- d. Voltage up to 11 KV
- e. Total losses at 50% loading in watts
- f. Total losses at 100% loading in watts
- g. Model and year of manufacturing.

VII. Control Circuit drawing Plates:

- Engraved drawing for control circuit unit shall be available on Marshalling box.

6.2 NAME PLATE DETAILS

The name plate shall be strictly as per **IS 1180: 2014 (figure 1)**. Additionally, following points shall be displayed :

- I. **Actual no load losses of transformer.**
- II. **Actual total losses of transformer at 50% load and 100% load.**
- III. Standard mark (BIS certification).
- IV. **“PROPERTY OF TPCODL/TPNODL/TPWODLTPSODL”** shall be written in bold letters.
- V. PO number with date has to be mentioned.
- VI. Overall dimensions of the transformer

6.3 MARKING

- I. All transformers shall have Source Side windings marked as 2U, 2V, 2W. The neutral point terminal shall be indicated by the letter 2N. Clear Marking as “Source Side” to be done.
- II. The Load Side winding for the same phase shall be marked by 1U, 1V, 1W. Clear Marking as “Load Side” to be done.
- III. The markings shall be done by steel strips in which marks had been engraved in black colour.
- IV. Colour marking of the bushings shall be done.
- V. On the top cover of tank and the core channel, Manufacturer’s name and Manufacturer’s serial no. shall be engraved.
- VI. On the body of tank, Manufacturer’s name, rating, serial no. and year of manufacturing shall be written with black paint on yellow base. It should be written in suitable place in approved format that it is readable from ground after installation on pole.
- VII. Durable QR code Sticker with name plate details and warranty details to be fixed on two accessible places i.e one on side wall of Load Side terminal box and other one is on conservator.

7. TESTS:

- I. All routine, acceptance & type tests shall be carried out in accordance with the IS 2026 and IS 1180: Part-1 (2014).
- II. All routine & acceptance tests shall be witnessed by the TPCODL/TPNODL/TPWODLTPSODL/his authorized representative.
- III. All the components shall also be type tested as per the relevant standards.

Following tests shall be necessarily conducted on the Distribution Transformers in addition to others specified in IS/IEC standards.

7.1 TYPE TESTS

- I. Lightning Impulse Test [As per IS 2026 (Part 3) Clause no. 12].
- II. Temperature Rise Test [As per IS 2026 (Part 2) Clause no.4].
NOTE: Maximum measured total loss (No load at Rated excitation load loss at maximum current tap converted to 75°C reference temperature) at 100 percent loading shall be supplied during temperature rise test.
- III. Short Circuit Withstand test [As per IS 2026 (Part 5)].
NOTE: Routine tests before and after short circuit test shall be conducted as per IS 2026(Part 1).
- IV. Pressure Test [As per IS 1180: Part 1 (2014)].
- V. Determination of sound levels [IS 2026 (part 10)].
- VI. No load current at 112.5% voltage
- VII. BDV and moisture content of oil in transformer (IS 335).
- VIII. Magnetic balance test.
- IX. Measurement of Zero-phase sequence impedance.
- X. Measurement of Harmonics of no-load current.
- XI. Test to verify IP 55 for Marshalling Box.

Note: - Out of the above mention type test, the tests under sl. No. 1, 2, 3 and 4 shall be conducted at CPRI/ERDA labs and the balance tests to be conducted at TPCODL/TPNODL/TPWODLTPSODL recommended NABL lab. **In-house test labs are accepted if in-house lab is NABL accredited for these tests.**

7.2 ROUTINE TESTS

Sr. No.	Test to be done	Reference BIS	Clause no.
1	Measurement of Winding Resistance on each tap.	IS 2026 (Part 1)	16.2.1 & 16.2.3
2	Measurement of voltage ratio, check of voltage displacement, polarity, phase sequence and vector group	IS 2026 (Part 1)	16.3
3	Measurement of short circuit impedance (principal tapping, when applicable) and load loss at 50% and 100% load	IS 2026 (Part 1)	16.4
4	Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 112.5% of rated voltage	IS 2026 (Part 1)	16.5
5	Measurement of insulation resistance	IS 2026 (Part 1)	16.6
6	Induced over voltage withstand test	IS 2026 (Part 3)	11
7	Separate Source voltage withstand test	IS 2026 (Part 3)	10
8	Oil leakage test	IS 1180 (Part 1)	21.5.1.3
9	Neutral current measurement	IS 1180	7.9.2
10	BDV and moisture content of oil in transformer (Type-2 oil)	For mineral oil : IS 335 (2018) For Ester oil : IEC 60247 & IEC61099	For mineral oil : IS 335 Table 2

7.3 ACCEPTANCE TESTS

- I. Temperature Rise test on one unit of first lot against every release order / PO for each rating. For further lots, TPCODL/TPNODL/TPWODLTPSODL reserves the right to perform Temperature rise if required. [As per IS 2026 (Part 2) Clause no.4]



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- II. Oil leakage test for acceptance shall be conducted at pressure of 0.35kg/sq.cm for one hour. (IS 1180 (Part 1) clause 21.5.1.3)
- III. The painted surface shall pass the Cross Adhesion Test (IS1180 part 1 clause no. 21.4.d).
- IV. Calibration of WTI and OTI.
- V. Magnetic Balance Test.
- VI. OEM test reports for breather for air pressure test.
- VII. At stage inspection -Checking of weight, dimensions, fitting and accessories, tank sheet thickness, oil quantity, material finish and workmanship, physical verification of core coil assembly and measurement of flux density on one unit of each rating of the offered lot with reference to the GTP and contract drawings. Oil BDV of all offered lot.
- VIII. At least 10% transformer of the offered lot (minimum of one) shall be subjected to all the tests mentioned under the section 'ROUTINE Test" in presence of TPCODL/TPNODL/TPWODLTPSODL's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS: 1180 and IS: 2026.
- IX. Device trails & test (Buchholz trip, Buchholz alarm, PRV trip, WTI alarm, WTI trip and OTI alarm.
- X. At Stage and Final inspection, the incoming raw material and its movement/consumption record in the related jobs of TPCODL/TPNODL/TPWODLTPSODL will be verified by inspecting officer. In case of any deviation or non-availability of such records, the offered lot may get rejected.

8. TYPE TEST CERTIFICATES:

- I. The Bidder shall furnish the type test certificates of the offered rating and design of transformer for the tests as mentioned above as per the corresponding standards.
- II. All the tests shall be conducted at CPRI / ERDA or as defined in 7.1 as per the relevant standards.
- III. In the event of any discrepancy in the test reports, i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to TPCODL/TPNODL/TPWODLTPSODL.
- IV. Type tests should have been conducted as per TS during the period not exceeding timeline as per latest CEA guideline.

9. PRE-DISPATCH INSPECTION:

- I. Bidder to raise the inspection calls for stage inspection and only after getting clearance from TPCODL/TPNODL/TPWODLTPSODL shall proceed for further manufacturing. The bidder shall raise the inspection call for Final Inspection or prototype Inspection in TPCODL/TPNODL/TPWODLTPSODL format.
- II. If the prototype inspections asked for during drawing approval then bidder to make one unit of transformer and raise for inspection call for stage and final for prototype inspection.
- III. Equipment shall be subject to inspection by a duly authorized representative of the TPCODL/TPNODL/TPWODLTPSODL.
- IV. Inspection may be made at any stage of manufacture at the option of the purchaser and the equipment if found unsatisfactory as to workmanship or material, the same is liable to rejection.
- V. Bidder shall grant free access to the places of manufacture to TPCODL/TPNODL/TPWODLTPSODL's representatives at all times when the work is in progress.
- VI. Inspection by the TPCODL/TPNODL/TPWODLTPSODL or its authorized representatives shall not relieve the supplier of his obligation of furnishing equipment

- in accordance with the specifications.
- VII. The BA shall ensure that 100% of the lot must be ready for inspection and atleast 10% must be ready with all mounting and accessories during inspection.
- VIII. Material shall be dispatched only after getting MDCC (Material Dispatch Clearance Certificate) from TPCODL/TPNODL/TPWODLTPSODL.
- IX. Following documents shall be sent along with material:
- a) Test reports
 - b) MDCC issued by TPCODL/TPNODL/TPWODLTPSODL
 - c) Invoice in duplicate
 - d) Packing list
 - e) Drawings & catalogue
 - f) Guarantee / Warrantee card
 - g) Delivery Challan.
 - h) Other Documents (as applicable)
- X. To ascertain the quality of the transformer oil, the original manufacturer's tests report shall be submitted at the time of inspection.
- XI. Arrangements shall also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of TPCODL/TPNODL/TPWODLTPSODL's representative.
- XII. In respect of raw material such as core stampings, winding conductors, insulating paper and oil, bidder shall use materials manufactured/supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the TPCODL/TPNODL/TPWODLTPSODL.
- XIII. The bidder shall furnish following documents along with their offer in respect of the raw materials:
- a) Invoice of supplier.
 - b) Mill's certificate
 - c) Packing List.
 - d) Bill of Landing
 - e) Bill of entry certificate by custom.
- XIV. To ensure about the quality of transformers, the inspection shall be carried out by the TPCODL/TPNODL/TPWODLTPSODL's representative at following two stages:
- a) Online anytime during receipt of raw material and during manufacturing/assembly Stage.
 - b) At finished stage i.e. transformers are fully assembled and ready for dispatch.
- XV. Advance intimation of 7Days (Within Odisha)/12 Day (Outside Odisha) is required for both Stage and final inspections.
- XVI. All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and TPCODL/TPNODL/TPWODLTPSODL at the time of purchase.
- XVII. The manufacturer shall offer the inspector representing the TPCODL/TPNODL/TPWODLTPSODL all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as Active Inspection during Acceptance Tests.
- XVIII. During the stage inspection a few assembled core coil and assembled Tanked transformer shall be dismantled (only in case of CRGO material) to ensure that the CRGO laminations, Windings and workmanship are of good quality. TPCODL/TPNODL/TPWODLTPSODL also reserves the right to review any document or certificates related to material, manufacturing process, quality checks at any point of stage inspection.

- XIX. TPCODL/TPNODL/TPWODLTPSODL also reserves the right to inspect the tank of transformer before surface preparation and painting. The same shall be informed to TPCODL/TPNODL/TPWODLTPSODL accordingly.
- XX. Final inspection Call for carrying out acceptance tests as per relevant IS/IECs shall be sent by the Bidder along with routine test certificates.
- XXI. The bidder shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical / electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.
- XXII. The TPCODL/TPNODL/TPWODLTPSODL has the right to have the test carried out at his own by an independent agency wherever there is a dispute regarding the quality supplied. **Also TPCODL/TPNODL/TPWODLTPSODL has right to test 1% of the supply selected either from the stores or field** to check the quality of the product. In case of any deviation TPCODL/TPNODL/TPWODLTPSODL have every right to reject the entire lot or penalize the bidder, which may lead to blacklisting, among other things.
- XXIII. At the time of inspection the material should be ready as specified, In case of material non-readiness or material failure in acceptance, Cost of re-inspection shall be borne by bidder.

10. INSPECTION AFTER RECEIPT AT STORE:

- I. The material received at the TPCODL/TPNODL/TPWODLTPSODL store shall be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection.
- II. In case the transformers proposed for supply against the order are not exactly as per the tested design, the Bidder shall be required to carry out the short circuit test and impulse voltage withstand test at its own cost in the presence of the representative of TPCODL/TPNODL/TPWODLTPSODL.
- III. The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.
- IV. Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations
- V. TPCODL/TPNODL/TPWODLTPSODL reserves the right to conduct all tests on Transformer after arrival at site / stores and the manufacturer shall guarantee test certificate figures under actual service conditions.
- VI. TPCODL/TPNODL/TPWODLTPSODL reserves the right to conduct short circuit test and impulse voltage withstand test in accordance to IS, afresh on each ordered rating at purchaser cost, even if the transformer of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by TPCODL/TPNODL/TPWODLTPSODL either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to TPCODL/TPNODL/TPWODLTPSODL stores. The findings and conclusions of these tests shall be binding on the bidder.

11. GUARANTEE:

- I. Bidder shall stand guarantee towards design, materials, workmanship & quality of process/ manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any



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defect is found by the Purchaser up to a period of 48 months from the date of commissioning or 60 months from the date of last supplies made under the contract, whichever is earlier.

- II. Bidder shall be liable to undertake to replace/rectify such defects at his own costs within mutually agreed timeframe and to the entire satisfaction of the TPCODL/TPNODL/TPWODLTPSODL, failing which the TPCODL/TPNODL/TPWODLTPSODL will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the TPCODL/TPNODL/TPWODLTPSODL's own charges (@ 20% of expenses incurred), from the Bidder or from the "Security cum Performance Deposit" as the case may be.
- III. In case of Distribution transformer fails within the guarantee period TPCODL/TPNODL/TPWODLTPSODL will immediately inform the Bidder who shall take back the failed Distribution Transformer within 15 days from the date of intimation at his own cost and replace / repair the transformer within forty five days of date of intimation with a roll over guarantee. The outage period i.e. period from the date of failure till unit is repaired / replaced shall not be counted for arriving at the guarantee period.
- IV. Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

12. PACKING AND TRANSPORT:

- I. Bidder shall ensure that all the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit.
- II. Transformers shall be delivered filled with oil and supplied with all accessories mounted. Screws and bolts shall be thoroughly tightened to ensure no leakage of oil.

Note: One use plastic not to be used for packing of the material.

13. TENDER SAMPLE:

All offered transformer detailed documents to be submitted as per clause no.18. The sample shall be not applicable

14. QUALITY CONTROL:

The bidder shall submit with the offer Quality assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. TPCODL/TPNODL/TPWODLTPSODL's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections.

The following information shall necessarily be submitted with the bid:

- I. List of important raw materials, names of sub-suppliers for raw materials, standards to which raw material is tested and the copies of test reports of the tests carried out on raw materials in presence of Bidder's representatives.
- II. List of manufacturing facilities available, level of automation achieved and the areas where manual process exists.
- III. List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of these tests and inspections

- IV. List of testing equipment for final testing with valid calibration reports. Manufacturer shall possess 0.1 class instruments for measurement of losses.
- V. QAP withhold points for TPCODL/TPNODL/TPWODLTPSODL inspection.

15. TESTING FACILITIES:

Bidder shall have adequate in house testing facilities for carrying out all routine tests, acceptance tests and pre-dispatch inspection as per relevant International / Indian standards.

16. MANUFACTURING FACILITIES:

The successful bidder will have to submit (after placement of RC) technical compliance document and drawing of each part along with CCA, breather, bushings, terminal box etc. as per RC line items to be submitted for getting approval before mass manufacturing.

The first time supplier will have to make one prototype sample of each line tem of RC as per CAT-B approved drawing within 30 days of drawing approval. Inspection call to be raised by bidder before 7 days of date of proposed inspection. TPCODL/TPNODL/TPWODLTPSODL shall arrange inspectors and intimate or confirm the date. Any observation during inspection shall have to be addressed within 7 days and revised improved drawing & technical details to be shared to TPCODL/TPNODL/TPWODLTPSODL for final approval.

Manufacturing mass quantity to start only after getting CAT-A approved drawings or as per intimation from TPCODL/TPNODL/TPWODLTPSODL

17. SPARES, ACCESSORIES AND TOOLS

Bidder shall give an assurance that the reparability of transformer is ensured by using standard spare parts and accessories available in market in India.

18. DRAWINGS AND DOCUMENTS:

Following drawings and documents shall be prepared based on TPCODL/TPNODL/TPWODLTPSODL specifications and statutory requirements and shall be submitted with the bid:

- a. Completely filled in compliance to each clause of Technical Specification and any Additional Details and Fittings.
- b. Description of the transformer and all components drawings.
- c. General arrangement for Transformer.
- d. Bill of material.
- e. Design calculation details of transformer losses, cooling, efficiency and current density, weight of coils and components
- f. Experience Certificate and list
- g. Type test certificates.
- h. List of makes of major components as listed above.

Drawings / documents to be submitted for approval after the award of the order within 7 days before mass manufacturing are as under:

List of Drawings/Parameters to be submitted:

- a. Technical Parameters as asked in Specification (General Technical Particulars, General Technical Requirements, Additional Details, Fittings, Type test Reports and Routine test certificates of bought out accessories).
- b. General Arrangement Drawing of the Transformer (Front view, Top view and both sides view. Complete list of fittings to be displayed and quantities to be mentioned with the drawing).
- c. Internal Core arrangement drawing.
- d. Internal Core-coil assembly drawing.
- e. Foundation Plan drawing.
- f. Marking plates and Markings (as mentioned in clause 6)
- g. Load and Source Side bushings drawing (with internal view and metal parts)
- h. Conservator drawing.
- i. Marshalling Box with wiring details
- j. Prismatic oil level gauge drawing.
- k. Silica Gel Breather drawing.
- l. BH curve & Loss/Kg graph of core material offered.
- m. The tightening torque chart to be provided for all bolts used in specific rating.
- n. Type Test Certificates.
- o. Installation/ Mounting Instructions/Drawing.
- p. Efficiency vs Load curve of the offered design.
- q. Quality Assurance plan.

List of Calculations to be submitted:

- a. All the calculations shall be step by step showing the use of formulas and other practical considerations. **Concise calculations in table or excel sheet shall not be accepted.** Also, the reference (only standard sources as IS, IEC or any such standard is acceptable) of the formulas shall be mentioned.
- b. Resistance Calculation (75 deg. C)
- c. Load Losses Calculation (at 75 deg. C)
- d. No load Losses.
- e. Stray Losses.
- f. Weight of Copper (Bare and with Insulation also).
- g. Weight of Core.
- h. Flux Density calculations.
- i. Current Density Calculations.
- j. Short Circuit withstand.
- k. Temperature Rise Calculations.
- l. Conservator Volume calculations
- m. Cooling Calculations showing cooling with tank and radiators separately with no. of radiators and fins mentioned specifically (For both Mineral oil and Ester oil)
- n. Calculation sheet for Lifting lug design and mounting lug design to be submitted by Bidder.

Additional Documents to be submitted :

- a. List of raw materials as well as bought out accessories and name of sub-suppliers selected from those furnished along with offer.
- b. Type test certificates of the raw materials and bought out accessories.
- c. The successful Bidder shall submit the **routine test certificates of bought out accessories** and central excise passes for raw material at the time of routine testing.

All the documents & drawings shall be in English language. After the receipt of the order, the successful bidder will be required to furnish all relevant drawings/parameters/calculation to TPCODL/TPNODL/TPWODLTPSODL for approval.



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Instruction Manuals:

Bidder shall furnish softcopies of nicely bound manuals (In English language) covering erection and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices.

19. SCHEDULE- "A" GUARANTEED TECHNICAL PARTICULARS:

All clauses and points in the Specification to be complied for along with GTR and offered design details.

20. SCHEDULE "B" DEVIATIONS:

(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

SL. No	Clause No.	Details of deviation with justifications
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TPCODL
TPWODL

TPNODL
TPSODL

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1000KVA

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We confirm that there are no deviations apart from those detailed above.

Seal of the Company:

Signature

Designation

STANDARD TECHNICAL SPECIFICATION COVER SHEET**Specification No. : ENG-EHV-1033****Specification Name : Technical Specification for 33kV, 2.5MVA, 5MVA and 10MVA Line Voltage Regulator Transformer**

Prepared by	Reviewed by	Reviewed by	Reviewed by	Approved by	Released by
SWARUP NAYAK	MILAN MAITY	Jyoti Ranjan Sahu	SANTOSH KUMAR PATRA	KHAJAN BHARDWAJ	POURUSH GARG
TPCODL	TPNODL	TPSODL	TPWODL	TPCODL	TPCODL
01-03-2023	02-03-2023	02-03-2023	02-03-2023	18-03-2023	18-03-2023

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1. SCOPE:

This Specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forward, supply and unloading at site/store and performance of Oil immersed, non-sealed, naturally cooled, three Phase 33KV Line Voltage Regulator Transformer to control voltage variation ranging from 25KV to 33KV.

2. APPLICABLE STANDARDS:

The equipment and the materials used covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian standards & other relevant standards for components & CEA guidelines with latest amendment from time to time, thereof, some of which are listed below:

Indian Standards	Title
IS 1180	Outdoor Type Oil Immersed Distribution Transformers Upto and Including 2500 KVA, 33 kV-Specification
IS 2026 (all parts)	Specification for Power Transformers
IS 104	Specification for ready mixed paint, brushing, zinc chrome, priming
IS 335	Specification for new insulating oil.
IS 649	Testing for steel sheets and strips and magnetic circuits.
IS 5	Specification for Colors for ready mixed paints and enamels
IS 1576	Solid Pressboard for Electrical Purposes -Specification
IS 2099	Specification for bushings for alternating voltages above 1000 volts
IS 2362	Determination of water content in oil by Karl in oil Fischer Method – Test Method.
IS 3024	Grain oriented electrical steel sheets and strips
IS3347 (Part I & Part-3)	Dimensions for Porcelain Transformer Bushings for Use in Normal and Lightly Polluted Atmospheres - Part 1 : Up to and including 1 kV
IS 4253: Part II:	Specification for cork composition sheets- Part II : Cork and Rubber
IS 4257(Part I):	Dimensions for Clamping Arrangements for Porcelain transformer Bushings - Part I: For 12 kV to 36 kV Bushings
IS 5082	Wrought Aluminum and Aluminum Alloy bars, Rods , Tubes, Sections, Plates and Sheets for Electrical Applications

IS 5561	Specification for Electric Power Connectors
IS 6103	Specification for Testing of specific resistance of electrical insulating liquids
IS 2026 part 7	Guide for loading of Oil-immersed transformer
IS 6792	Method for Determination of Electric Strength of Insulating Oil
IS 7404 (Part-1):	Paper Covered conductors: Round Conductors
IS 7421	Specification for porcelain bushings for alternating voltages up to and including 1000kv
IS 8603 (Part-1) :	Dimensions for Porcelain Transformer Bushings for Use in Heavily Polluted Atmospheres - Part I:12 kV and 17.5 kV Bushings
IS 9335	Specification for Cellulosic Papers for Electrical Purposes
IS 10028	Code of Practice for Selection, Installation and Maintenance of Transformers
IS 11149	Specification for rubber gaskets
IS 12444	Specification for Continuously Cast and Rolled Electrolytic Copper Wire Rods for Electrical Conductors.
IS/IEC 60947 (PART 1& PART 2)	Specification for Secondary Side Switchgear & Control gear
IS 6160	Rectangular electrical conductors for electrical machines
IS 13964	Methods of measurement of transformer and reactor sound levels
IS 3401	Specification of silica Gel
IS 1897	Copper strip for electrical purposes
IS 60529	Degree of protection provided by enclosure
IS 816	Welding of Mild Steel
CEA	Guidelines for specifications of energy efficient outdoor type single and three phase distribution transformers
IS 6262	Method of test for power factor and dielectric constant of electrical insulating liquids

IS 16659	Fluids For Electro technical Applications - Unused Natural Esters For Transformers And Similar Electrical Equipment
IS 16081	Insulating liquids — Specifications for. Unused synthetic organic esters for Electrical purposes
IEC 60156	Method of determination of electric strength of insulating oils.
IEC 60296	Specification for unused mineral insulating oils for transformers and switchgear.
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IS 1852	Rolling and cutting tolerances for hot rolled steel products

3. CLIMATIC CONDITIONS:

1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	1500 mm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr
9	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

TPCODL/TPNODL/TPSODL/TPWODL service area has heavy saline conditions along the coast and High cyclonic Intensity winds with speed upto 300 Kmph. The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months.

4. GENERAL TECHNICAL REQUIREMENTS:

SL	Parameters	Unit	Technical Data		
1.	Description		33KV Line Voltage Regulator Transformer		
2.	Service		Outdoor use		
3.	Reference Standard & Tolerances		IS:2026		
4.	KVA Ratings of Transformers	kVA	2500	5000	10000
5.	Operating Voltage Range	KV	25KV-33KV on Source Side to maintain a constant 33KV on Load side.	25KV-33KV on Source Side to maintain a constant 33KV on Load side.	25KV-33KV on Source Side to maintain a constant 33KV on Load side.
6.	Full Load Current	Amp	43.73 A at 33KV, 57.73A at 25KV	87.47 A at 33KV, 115.46A at 25KV	174.95 A at 33KV, 230.92A at 25KV
7.	Voltage Control method		By provision of In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering) with AVR for automatic operation	By provision of In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering) with AVR for automatic operation	By provision of In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering) with AVR for automatic operation
8.	Rated Frequency	Hz	50	50	50
9.	No. of Phases	Nos	3	3	3
10.	Flux density at 33KV and frequency 50Hz	Tesla	1.6 T	1.6 T	1.6 T
11.	Max Flux density at 12.5% increase of Combined Nominal V & f	Tesla	1.9 T	1.9 T	1.9 T
12.	Current density at min tap	A/Sq.mm	2.4	2.4	2.4
13.	Vector Group		Ynya0	Ynya0	Ynya0
14.	Type of Cooling		ONAN	ONAN	ONAN

15.	Temperature Rise- Top Oil/ Winding	°C	40/45	40/45	40/45
16.	Total Loss at rated current and at 75 Deg at Highest Tap	kW	10KW (±10%)	20KW (±10%)	30KW (±10%)
17.	Impedance Voltage at rated current at 75 Deg	%	0.6% (±10%)	1% (±10%)	3% (±10%)
			Design Calculation to be furnished	Design Calculation to be furnished	Design Calculation to be furnished
18.	Type of Tap Changer		In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering)	In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering)	In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering)
	Make		EASUN MR/CTR	EASUN MR/CTR	EASUN MR/CTR
	Tapping Range		16 Step,17- Position (to be able to increase voltage from 25KV to 33KV)	6 Step,17- Position in step (to be able to increase voltage from 25KV to 33KV)	6 Step,17- Position in step (to be able to increase voltage from 25KV to 33KV)
19.	Insulation Class		Class-A	Class-A	Class-A
20.	Separate Source Power Frequency Voltage Withstand	KVRMS	70	70	70
21.	Induced Over Voltage Withstand	KVRMS	66	66	66
22.	Full Wave Lightning Impulse Withstand Voltage of winding	kVp	170	170	170
23.	Terminal Arrangement -				

	Load Side Bushing		Outdoor type 36KV Bushing on Top
	Source Side Bushing		Outdoor type 36KV Bushing on Top
	Neutral Bushing		Outdoor type 36KV Bushing on Top
24.	Weight (With $\pm 10\%$ Tolerance)		
25.	Weight of Core	Kg	To be furnished by Bidder
26.	Weight of Winding(Copper)	Kg	
27.	Core &Winding	Kg	
28.	Tank &Fitting	Kg	
39.	Transformer Oil	Ltrs	
30.	Total Weight of Transformer	Kg	To be furnished by Bidder
31.	Auxiliary Transformer 3Ph 1KVA for Tap Changer and Control. (Separate/In Built)	Qty	1
32.	Core Material & Grade		CRGO M3 or better 0.23 MM
33.	Winding Resistance at 20 Deg.c Per phase(Tap.No.1)	Ohm	To be furnished by Bidder
34.	No Load Current at Rated Voltage and Frequency	%	0.5%
35.	Winding Material Insulation		TPC

5. GENERAL CONSTRUCTION:

- I. The transformer shall be stacked core, copper coil, oil immersed, naturally cooled (ONAN), non-sealed type with plain rectangular tank.
- II. The transformer shall be suitable for service with fluctuations in supply voltage as per GTP
- III. The transformer shall be designed suitable for service life of 25 years.
- IV. The transformer and accessories shall be designed to facilitate trouble free operation, inspection, maintenance and repairs under the various operating and atmospheric conditions

specified in clause no. 3.

- V. The design shall incorporate every precaution and provision for the safety of the equipment as well as staff engaged in operation and maintenance of the equipment.
- VI. All outdoor apparatus of the transformer, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

5.1 CORE:

- I. Transformer core shall be stack type, 2D, constructed from high grade cold rolled, non-ageing, grain oriented, silicon steel lamination which shall be properly annealed (under inert atmosphere, if required) to relieve stresses.
- II. The core shall have low loss and good grain properties.
- III. Core should be coated with hot oil proof, with insulation coating, an inorganic coating equivalent to C-5 type as ASTM A976 or IS 3024, like Carlite -3.
- IV. All core should be clamped together with frames to prevent vibration and noise. The core clamping shall be preferably without through bolts and if any bolt used same shall be effectively insulated.
- V. The core thickness should be 0.23mm or better
- VI. Only single grade and same thickness of core stampings shall be accepted and mixing of different grades shall not be allowed.
- VII. The complete design of the core must ensure maximum permanency of the core losses without continuous working of the transformers.
- VIII. The value of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated. The vendor shall submit the calculations in support of the same.
- IX. The handling of core lamination and stacking should be smooth and uniform.
- X. The transformer shall be suitable for continuous service without damage under 'over fluxing where the ratio of voltage over frequency exceeds the corresponding ratio at rated voltage and rated frequency up to 12.5% and the core shall not get saturated. The BH graph to be submitted by bidder for core material.
- XI. The bidder shall be required to submit the following documents in regard to procurement of core material during stage inspection:
 - a. Invoice of supplier
 - b. Mill's test certificate
 - c. Packing list

- d. Bill of landing
 - e. Bill of entry certificate by custom (if required)
 - f. Description of material, electrical analysis, physical inspection certificate for surface defects, thickness and width of material.
- XII. The bidder shall offer the core for inspection and approval of TPCODL/TPNODL/TPSODL/TPWODL during manufacturing stage. Heavy penalty or black listing shall be imposed on the bidders using defective CRGO sheets i.e in case of nonconformance w.r.t TPCODL/TPNODL/TPSODL/TPWODL Specifications.
- XIII. Transformer core assembly shall have enclosed type lifting lugs for lifting arrangement.
- XIV. **Bidder shall provide the below details in below table:**

Sl. No.	Description	Unit	To be furnished by bid
1	Magnetizing (No Load) Current		
	90% Voltage	%	
	100% Voltage	%	
	112.5% Voltage	%	
2.	Core grade		
3.	Thickness of core Lamination	Mm	
4.	Core Dimension: Length X height X diameter	mm x mm x m	
5.	Gross core area	Sq.cm	
6.	Net core area	Sq.cm	
7.	Flux density (calculated)	Tesla	
8.	Over fluxing without saturation (BH curve to be submitted)	Tesla	
9.	Mass of core	Kg	
10.	Loss per Kg of core at the above specified flux	Watt	
11.	Core window height	Mm	

12.	Center to center distance of the core	Mm	
13	Mass of Core Lamination (min.)	Kg	
14	Make of Core offered		

5.2 WINDING CONNECTIONS

- I. Windings shall be constructed from high- conductivity (copper conductors), Tripple Paper Covered (TPC) copper conductor with min 25% overlap per layer of paper.
- II. The conductor should be drawn uniformly without any deformation and any burr.
- III. No metallic or non-metallic dust should be present in-between TPC conductor.
- IV. The current density for winding should not be more than 2.4 Ampere per sq.mm.
- V. The insulation between core and bolts, core and clamps shall withstand **2.5 kV for one minute**.
- VI. Proper bonding of inter layer insulation with the conductor shall be ensured.
- VII. All turns of windings shall be adequately supported (by which material) to prevent movement. The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- VIII. The joints in the winding shall be avoided but if it is necessary then, they shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. Crimping is not allowed at any joints.
- IX. Winding shall be such that neutral formation is at the top.
- X. Bidder shall provide the below details in below table:

SL	Parameters	Unit	Technical Data
1	Description		
2	Service		
3	Reference Standard & Tolerances		
4	KVA Ratings of Transformers	kVA	
5	Voltage Variation	KV	
6	Full Load Current	Amp	
7	Voltage Control		
8	Rated Frequency	Hz	
9	No. of Phases	Nos	
11	Max Flux density at normal voltage (33 KV) and frequency (50Hz)	Tesla	
11	Max Flux density at 12.5% increase of Combined Nominal V & f .	Tesla	
12	Current density	A/Sq.mm	
14	Vector Group		
15	Type of Cooling		
16	Temperature Rise-Top Oil/ Winding,	°C	

17	No-Load Loss at rated voltage (33 kV) & Frequency	kW	
18	Load Loss at rated current and at 75 Deg	kW	
19	Impedance Voltage at rated current	%	
20	Type of Tap Changer		
	Make		
	Tapping Range		
21	Insulation Class		
22	Separate Source Power Frequency Voltage Withstand	KVRMS	
23	Induced Over Voltage Withstand	KVRMS	
24	Full Wave Lightning Impulse Withstand Voltage of winding	kVp	
25	Terminal Arrangement -		
	Load Side Bushing		
	Source Side Bushing		
26	Efficiency at 75°C at unit P.F & at 0.8 PF Lagging		
	a. 125% Load	%	
	b.100% Load	%	
	c. 75% Load	%	
	d.50% Load	%	
	e.25% Load _	%	
27	Regulation		
	a. At unit P.F	%	
	b. At 0.8 P.F Lagging at 75°C	%	
	c. Maximum Efficiency occurs at	%	
	d. Maximum Efficiency	%	
28,	Weight (With ±10% Tolerance)		
	Weight of Core	Kg	
	Weight of Winding(Copper)	Kg	
	Core &Winding	Kg	
	Tank &Fitting	Kg	
	Transformer Oil	Ltrs/Kg	
	Total Weight of Transformer	Kg	
29	Auxiliary Transformer 3Ph 1KVA for Tap Changer and Control. (Separate/In Built)	Qty	
30	Core Material & Grade		

31	Winding Resistance at 20 Deg.c Per phase(Tap.No.1)	Ohm	
32	Magnetizing Current at 90%,100% &112.5%	%	
33	Winding Material Insulation		

5.3 INSULATING PAPER AND INSULATING PRESSBOARD


- I. Inter layer insulation both for Primary Side and Secondary Sidewindings shall be Epoxy Kraft paper and compressed pressboard of make (refer Clause no.5.32) subject to approval of TPCODL/TPNODL/TPSODL/TPWODL
- II. Primary and secondary windings shall be constructed from high- conductivity (copper conductors), Triple Paper Covered (TPC) copper conductor with min. 25% overlap per layer of paper.
- III. Kraft paper and Pressboard should be made of pure Cellulose from soft wood pulp manufactured from sulphate process. No additive, adhesive or coloring matter shall be present.
- IV. Kraft paper and Pressboard should be of class A (105°C) insulation material.
- V. All spacers, axial wedges / runners used in windings shall be made of pre-compressed solid pressboard.
- VI. All axial wedges/runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely.
- VII. Insulation shearing, milling and punching operations shall be carried out in such a way, that there should not be any burr, sharp edges and dimensional variations.
- VIII. Kraft paper self-adhesive tape to be used for bonding of insulating paper layer, spanner and paperboards that are immersed in the oil filled transformer.
- IX. Insulation shall be uniform throughout the winding. Graded Insulation is not allowed.
- X. **Below required values could be verified if required at any stage of the inspection and it should fulfill the requirement as per below table:**

Characteristics	Kraft Paper	Pressboard (all Sizes)
1. Dimension	As specified by bidder with $\pm 5\%$ tolerance.	As specified by bidder with tolerance as per IS1576.
2. Apparent Density	$>0.80 \text{ g/cm}^3$	as per IS 1576 w.r.t Thickness
3. pH of Aqueous extract	6-8%	6-8%
4. Electrical strength i) in air ii) In Oil	7KV/mm -----	12KV/mm 35KV/mm
5. Ash content	Maximum 1%	Maximum 0.7
6. Moisture content	Maximum 8%	Maximum 8%
7. Oil absorption	-----	Minimum 9%
8. Heat stability	As per IS 9335-part 3	As per IS 1576
9. Tear index	As per IS 9335-part 3	As per IS 1576

Bidder has to submit the test certificates as per IS-9335, IS-1576 for all type of insulating materials covering above stated parameters along with **below parameters during stage inspection** :

- a. Substance (Grammage) (g/m³)
- b. Compressibility
- c. Tensile strength
- d. Conductivity of water extract
- e. Shrinkage in air
- f. Flexibility
- g. Cohesion between plies.
- h. Elongation
- i. Air permeability
- j. Bidder shall provide the below details in below table

Sl. No.	Description	Unit	As furnished by bidder
1.	TPC Paper for Conductors :		
	Type of TPC Paper		
	Make of TPC Paper		
	Thickness TPC Paper	mm	
	Percentage Overlapping (not less than 25%)	%	
2.	Type of Paper for Interlayer Insulation		
	Make of Paper for Interlayer Insulation		
	Thickness of Paper for Interlayer Insulation	mm	
3.	Material used for top and bottom yoke insulation		
	Make of material used for top and bottom yoke insulation		
	Thickness of material used for top and bottom yoke insulation	mm	
4.	Type of material used for Spanner, wedge and Axial for insulation		
	Make of material used for Spanner, wedge and Axial for insulation		

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	Thickness of material used for Spanner, wedge and Axial for insulation (all sizes)	mm	
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5.4 LOSSES

- I. The bidder shall individually guarantee No load loss (Iron loss at rated voltage and frequency) and full load Copper Loss (at 75°C) without any positive tolerance.
- II. The bidder shall also guarantee the total loss at 100% load condition (at rated voltage and frequency and these should be within the limits of maximum total losses declared by TPCODL/TPNODL/TPSODL/TPWODL for 100% loading values (as per table below)

Description	
Maximum Losses at 100% loading at 75°C (Watts)	
Description	
Maximum Losses at 100% loading at 75°C (Watts)	

No positive tolerance shall be allowed on the losses as mentioned above. However, bidder can offer losses less than specified but no consideration in cost will be given for the same.

- III. During testing at Bidder's works if it is found that the actual measured losses are more than the values quoted by the Bidder, TPCODL/TPNODL/TPSODL/TPWODL shall have the right to reject the complete lot.
- IV. During testing at Bidder's works, if the temperature rise exceeds the specified values, the entire lot shall be rejected by TPCODL/TPNODL/TPSODL/TPWODL
- V. During testing at Bidder's works, if the impedance values differ from the guaranteed values including tolerance, the entire lot shall be rejected by TPCODL/TPNODL/TPSODL/TPWODL
- VI. Transformer losses shall be checked on any one of Transformer from supplied lot at TPCODL/TPNODL/TPSODL/TPWODL workshop. If it is found that the actual measured losses are more than the values quoted by the Bidder, TPCODL/TPNODL/TPSODL/TPWODL shall have the right to reject the complete lot.
- VII. Bidder shall provide the below details in below table:

Sl. No.	Description	Unit	To be furnished by bidder
1	No Load losses	Watt	
2	Load losses at 75° C	Watt	
3	Efficiency at 75 deg. C		
4	% Impedance at 75 deg. C	%	

5.5 TRANSFORMER TANK AND TANK CONSTRUCTION

- I. The transformer tank shall be of robust construction, rectangular in shape and shall be built up of electrically tested welded mild steel plates.
- II. The tank shall be fabricated by welding at corners. No horizontal or vertical joints in tank side walls and its bottom or top cover shall be allowed.
- III. All welding operations should be carried by qualified welders (performance qualification certificates to the customer) as per the relevant ASME standards and a copy of the welding procedure has to be submitted to TPCODL/TPNODL/TPSODL/TPWODL at the time of drawing approval.
- IV. The thickness of tank should be as below:
For 2.5MVA and 5MVA :
 For top and bottom : 10 mm (min.)
 For Sides : 8 mm (min.)
For 10 MVA :
 For top and bottom : 12 mm (min.)
 For Sides : 10 mm (min.)
 Tolerance shall be applicable as per IS 1852 as per above thickness band.
- V. In addition the cover of the main tank shall be provided with an air release plug.
- VI. The tank plates shall be of such strength that the complete transformer when filled with oil may be lifted bodily by means of the lifting lugs provided. The top cover shall have no cut at point of lifting lug.
- VII. The transformer tank cover shall be bolted with tank rim so as to make a leak proof joint.
- VIII. The tank plate and lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.
- IX. The tank cover shall have slight slope (10 mm ± 2mm) towards Primary Side side to drain rain water.
- X. There must be sufficient space from the core to the top cover to take care of oil expansion. The oil volume inside the tank shall be such that even under the extreme operating conditions, the pressure generated inside the tank does not exceed 0.4 kg/sq. cm positive or negative and the tank shall be of adequate mechanical strength to withstand it.
- XI. The transformer should be capable of withstanding 0.8kg/sq.cm air pressure and a vacuum of 0.7kg/sq.cm. The permanent deflection of the flat plate, when the tank without oil is subjected to a vacuum of 525 mm of mercury shall not be more than the values specified:

Length of Plate	Deflection
Up to 750 mm	5.0 mm



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Specification Name: Technical Specification for 33kV, 2.5MVA, 5MVA and 10MVA Line Voltage Regulator Transformer

751 mm to 1250 mm	6.5 mm
1251 mm to 1750 mm	8.0 mm
Above 1750 mm	9.0 mm

- XII. The tank design shall be such that the core and the windings can be lifted freely without dismantling the bushings.
- XIII. All joints of tank and fittings shall be oil tight and no bulging shall occur during service.
- XIV. The tightening torque chart to be provided for all bolts used. This shall be submitted along with each rating drawings.
- XV. The transformer shall be provided with four pulling lugs of MS plate of 8mm thick to pull the transformer horizontally.

Lifting lugs:

- I. The transformer shall be provided with a minimum of four welded heavy duty enclosed lifting lugs of Structural steel E250 or better grade quality A (Minimum quality A) as per IS 2062 plate of minimum 16mm thickness for lower rating and gradually increased for higher rating as per weight suitably reinforced by vertical supporting flat stiffener smooth welded properly on the side walls up to reinforcing angle. They shall be so extended that cutting bend plate is not required. The transformer lifting lug shall be painted with yellow colour.
- II. The location of lifting lugs shall be such that the clearance between lifting chain and nearest part of bushing shall be at least 100 mm.
- III. There shall be facilities for lifting the core coil assembly separately.
- IV. The lifting lugs shall be designed in such a way that any two diagonal lugs are capable of lifting two times of the total weight of the transformer. The design of should be such that it should be suitable for 120degree lifting rope angle as per ASME B30.9 and at any point of time the maximum stress allowed on the Lug martial shall be lesser than 82MPa as per ANSI C.57.12.10
- V. Calculation sheet for Lifting lug design to be submitted by Bidder. The calculation shall include the Stress on lifting lug material and stress on welding both. The Stress on the welding should be less than 840kg/cm² as per ANSI C.57.12.10. All calculation to be done for considering lifting on any diagonal opposite two lugs conditions.

Bidder shall provide the transformer size and clearances in below table:

Sl. No.	Description	Unit	To be furnished by bidder
1	Transformer overall Length x Height x width	mm x mm x mm	
2	Only Tank overall Length x Height x width	mm x mm x mm	
3	Clearances		
	(a)Core-Winding		

	(b)Winding Ph-Ph		
	©Winding -Yoke		
	Creepage (Winding to Earth in Oil)		
4	Between yoke and inside of tank to cover	mm	
5	Between yoke and bottom	mm	
6	Any point of winding to tank	mm	
7	Calculated Impedance	%	
8.	Conservator dimension (dia x Length)	mmxmm	
9.	Size of Pipe used for conservator to Tank	mm	
10.	Size of Pipe used for Valves	Mm	
11.	Base Channel size	mmxmmxmm	
12.	No. of Radiators	Nos	
13.	No. of fins per Radiator	Nos	
14	Dimension of radiator fins (L x W)	mmxmm	
15	Make of Tank material		

5.6 RADIATORS

- I. Radiators of pressed steel type conforming to the design requirement suitable for mineral oil and Ester oil (all type) type transformer.
- II. The Pressed Steel type should be used in vertical formation without any bending and should be individually tested for leakage and pressure test etc. before welding with the main tank.
- III. The number / cross section / length / fixing arrangement of radiators shall be indicated in the general assembly drawing.
- IV. Radiator thickness must be uniform without any dent or damage and also no bulging or concave should occur even after performing pressure/ vacuum test and temperature rise test.
- V. Corrugated designs are not accepted.

5.7 GASKET

- I. Cork rubber gaskets conforming to Type C , grade RC70 as per IS 4253 (Part-2) shall be provided for all oil bearing & water ingress resistant requirements for components like Primary Side & Secondary Side bushings bottom gasket, Top Cover, Conservator, Valves etc.
- II. Nitrile/Neoprene rubber gaskets conforming to Type IV – 4C (heat and oil resistant) as per IS 11149 shall be provided for bushing O ring (oil gaskets).
- III. Only Joint free Gasket to be used. Only in case of top cover gasket up to two dove-tail joints with adhesive shall be allowed.
- IV. Cork sheet, Nitrile/Neoprene rubber gaskets shall be free from cracks, pinholes and shall be capable of being cut or punched without crack or tearing.

5.8 On Load Tap Changer

On Load Tap changer (OLTC) on Primary Side Side	
a) Type	In-Tank OLTC (On Load Tap Changer)/ Side Mounted OLTC (TBD in Detailed Engineering)
b) Range	25kV -33kV
c) Number of Steps	16 Step (17 Position)
e) Manual / Automatic	Yes (Both)
f) Remote / Local	Yes (Both)
g) IS	8468-2006
h) All contacts should be SCADA compatible and suitable for connection to TMU	Yes
i) Protection for OLTC	Yes
j) Potential free contacts for SCADA shall be Provided	Yes
k) Flow of Power	Bidirectional
l) AVR and SCADA compatibility	Yes

5.9 BUSHINGS AND TERMINAL CONNECTORS

A. Primary Side & Secondary Side Bushings (36 kV/250 A)

- I. The bushings shall be outdoor type, external part shall be made of porcelain material. Rods, nuts and flat washer (Tightening Nut along with Check Nut) shall be made of tinned brass material.
- II. IS to be followed: IS 8603(Part- I) for porcelain, IS 3347 part3 section 2 for metal part and Complete bushing shall comply IS 2099.
Primary/Secondary Bushing on Top with Bird Guard
- III. The Primary Side bushing shall be fitted with bird guard on the bushing connector.
- IV. Complete Tinned Brass joint less connectors shall be provided on Primary Side bushing rods suitable for bare panther conductor connections. The connector should have large contact area. Hardware shall be Hot Dipped Galvanized or Aluzinc coated or SS material

LA of suitable voltage rating shall be mounted at both ends of the transformer

5.10 TERMINAL CONNECTORS

Primary/Secondary Side Bushing:

- I. Tinned Brass connectors shall be provided connected with Primary & Secondary Side bushing rods for bare top plate bushings .

5.11 INTENTIONALLY KEPT BLANK.

5.12 EQUILISING/ EQUIPOTENTIAL STRIP

- I. The Transformer top cover shall be connected with main tank using **tinned copper strip (30mm wide, 0.7mm thick)** at two places (diagonally opposite with each other).
- II. The strip should touch bare surface of tank in order to ensure proper electrical connection of tank body with top cover with the strip.
- III. All the covers like inspection cover, Conservator cover must be electrically connected using **tinned copper strip (30mm wide, 0.7mm thick)**.
- IV. Separate arrangement to be made and cover tightening bolt not to be used for equipotential strips.

5.13 EARTHING CONNECTIONS

NEUTRAL EARTHING:

- I. 36 KV Grade of neutral bushing shall be provided

BODY EARTHING:

- I. Two body earthing terminals pads boss arrangement (up to 500sq.mm) shall be provided on Transformer tank with M12 SS Bolt with 70 sq. mm lug. with SS plain washer and spring washer.
- II. It shall be located on the lower side of the transformer, diagonally opposite to each other.
- III. Each Earthing terminal pad on Transformer shall be provided with two SS M12 bolts on each pad on each side with two 70 sq.mm AL Lugs and washers.

5.14 OIL

Note: Default Oil shall be Mineral oil only if not specified / asked for other oil.

Mineral Oil: In case of Mineral Oil below are the requirements to be fulfilled:

1. All transformers shall be filled with new, unused, clean, standard mineral oil in compliance with IS 335-2018 / IEC 296 type-II and shall be free from all traces of polychlorinated biphenyl (PCB) compounds.
2. The use of recycled oil is not acceptable.

3. Oil shall be filled under vacuum before filling it shall be filtered and tested (as per IS 6103).
4. The test parameters should be as per the table below:

Test parameters	Values
Break Down Voltage (min)	70 kV
Water content ppm, (max.)	30 ppm
Specific resistance (min.) (at 27°C)	2.5 × 10 ¹² ohm-cm

Bidder has to provide the oil data in below table:

Sl. No.	Description	Unit	To be furnished by bidder
1	Type of oil		
2	Oil Qty. for first filling	Ltr.	
3	Grade of Oil		
4	Maker's name		
5	BDV at the time of first filling	kV	

5.15 CONSERVATOR

- I. The conservator shall be supported / fixed on the main body of the transformer tank.
- II. The capacity of the conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain **10% quantity of the oil used in transformer**. Normally, at least **30% volume of conservator** shall be filled with Oil.
- III. The connecting pipe of the conservator shall be so fitted to transformer tank that the pipe can be detached from the tank.
- IV. Joint less pipe shall be used which shall be connected with round flanges.
- V. The inside diameter of the pipe connecting the conservator to the main tank shall be within 25 to 50 mm and it should be projected into the conservator so that its end is approximately 20mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level corresponding to -5°C should be above the sump level.
- VI. The conservator oil filling cap/hole shall be of 32mm diameter & female type cap to be provided.
- VII. The conservator to be fitted with MOG such that it shall operate/open contact when the oil level in conservator goes below -5 degree C /Minimum mark. The float switch shall be with normally closed type. This contact shall be wired up in auxiliary terminal box.
- VIII. Buchholz relay: The pipe should not contain any right angle elbows. Its diameter should correspond to the diameter of the hole for the passage of oil of the relay. The pipe must be arranged to slope upwards towards the conservator at an angle of about 2 to 4 degrees to the horizontal (max 5 degrees). The part of the pipe preceding the relay should be straight for a length equal to at least five pipe diameters; the part of the pipe leading to the conservator

immediately adjacent to the relay should be straight for a length equal to at least three pipe diameters.

- IX. The Oil conservator shall be provided with:
- a. **Oil level indicator** (as per clause no. 5.18).
 - b. **Dehydrating breather** (as per clause no. 5.22).
 - c. **Drain plug**
 - d. **Oil filling hole** (1.25 inch/32mm with thread size of BSP 1.25inch, 11TPI) with cover.
 - e. **Detachable end plate** on one side (the side on which the gauge glass is fitted), to enable the maintenance staff to periodically clean the inside of the conservator tank

Center of Gravity

The transformer should be designed in such a way that the centre of gravity of complete transformer with oil and with all accessories shall fall at the vertical centre at lower height such that the transformer should be stable on flat surface ground and while lifting at lifting hooks.

5.16 OIL LEVEL INDICATOR

- I. Oil level indicator with **prismatic glass and red colour background** shall be provided.
- II. The oil gauge glass shall be removable and so embodied in the end plate so as to prevent oil leakage.
- III. The Oil level indicator should indicate oil level at minimum, normal and maximum as -5°C, 30°C and 90°C respectively.

5.17 PRESSURE RELEASE VALVE

- I. PRV shall be provided with auxiliary contacts. The contact to be wired up in the auxiliary terminal box.
- II. PRV shall be provided to operate before reaching the test pressure as specified in the above class.
- III. PRV shall not have air release arrangement.
- IV. The PRV shall seal-off after the excess pressure has been released and it shall have mechanical flag arrangement.
- V. The PRV shall have NO, NC contacts wired up in auxiliary terminal box.

5.18 AIR RELEASE PLUG

The cover of the main tank shall be provided with an **air release plug on all ratings.**

5.19 VALVE

Valves shall be of forged carbon steel upto 50mm size and of gun metal or of cast iron bodies with gunmetal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

II. Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

III. All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements, Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the OEM shall supply the same.

IV. Each transformer shall be provided with following valves on the tank:

- a) Drain valve so located as to completely drain the tank & to be provided with locking arrangement.
- b) Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.
- c) Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.
- d) One 15mm air release plug.
- e) Valves between radiators and tank.
- f) Drain and filter valves shall be suitable for applying vacuum as specified in the specifications

5.20 DEHYDRATING BREATHER

- I. The breather pipe shall enter the conservator from the upper side of the conservator.
- II. The silica gel shall be blue colored as per IS: 3401 – 1992. The granules size should be 3-5 mesh (4 to 6.73mm).
- III. It shall be suitably sized for 2.5 MVA , 5 MVA, 10 MVA
- IV. The body of the breather shall be unbreakable, transparent, UV stabilized seamless polycarbonate tube of minimum thickness 3mm
- V. The top cover shall be of pressure die cast aluminum and powder coated.
- VI. The oil cup shall be of UV protected polycarbonate.
- VII. Oil cup shall have marking of oil filling level
- VIII. The breather shall be supplied as per approved make and as per specifications.
- IX. The gasket should be of Class 3B, Type III as per IS 11149 Nitrile rubber (Oil resistant gaskets)
- X. All tie rods and all hardware should be of stainless steel material (SS 304)
- XI. While fixing of breather on transformer Teflon tape should be used to make it air tight & water tight. This shall be checked during inspection and after receipt at our stores on each transformer.
- XII. The breather should have passed air pressured test as per our specification i.e. Breather shall be tested at an air pressure of 0.35kg/cm2 (5 PSI) for period of 30 minutes. NABL lab test report to be submitted from OEM. For further details please refer our specifications of breathers.

5.21 OIL TEMPERATURE INDICATOR

- I. Range: 0- 120 °C, Accuracy: ± 4 °C.
- II. The OTI shall have auxiliary contacts for alarm and trip contacts at preset temperatures, both the contacts should be wired up in the auxiliary terminal box.
- III. The IP65 gland should be used for dial for taking out auxiliary wires.
- IV. The OTI shall be IP55 tested.
- V. OTI/WTI shall be mounted inside Marshalling Box.

5.22 FASTENERS

- I. All the bolts or studs shall be **at least 6 mm in diameter** except when used for small wiring terminals. **All bolts shall be of grade 8.8.**
- II. All nuts/bolts/washers exposed to atmosphere shall be as follows:

Size 12mm (or below)	(or)	Stainless Steel
----------------------	------	-----------------

Above 12mm	Steel with antirust coating (aluzinc coated) ,Hot dip galvanized
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- III. All ferrous bolts, nuts and washers placed in outdoor positions shall be hot dip galvanized to prevent corrosion (except high tensile steel bolts and spring washers which shall have electrolytic action between dissimilar metals).
- IV. In case the galvanization is removed due to welding or manufacturing, the parts should be properly cleaned and painted to avoid exposure to atmosphere.
- V. The cup type washers to be used as spring washers, cut spring washers are not accepted.
- VI. Taper washers shall be provided where necessary. Protective washers of suitable material shall be provided on front and back of the securing screws.
- VII. Each bolt shall project at least one thread but more than three threads through the nut. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided. The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- VIII. Core bolts shall be black colored high tensile grade-8.8

5.23 SURFACE PREPARATION AND PAINTING

- I. The paint shall be applied by airless spray.
- II. Steel surfaces shall be prepared by shot blast cleaning (IS-9954) to grade Sq.2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).
- III. Heat resistant (Hot oil proof) paint shall be used for the inside surface and whereas for external surface one coat of thermosetting powder paint or one coat of epoxy primer (zinc chromate/Zinc Phosphate) followed by two coats of polyurethane (P.U.) base paint. as per table given below

S.No.	Paint type (should be UV restraint, non-fading)	Area to be painted	No of coats	Total dry film thickness (min); micron
1.	Thermosetting powder paint	Inside	01	30
		Outside	01	60
2.	Liquid Paint			
a.	Epoxy (primer)	Outside	01	30
b.	P.U. Paint (finish paint)	Outside	02	25 (each)
c.	Hot oil resistant paint	Inside	01	35

The two coats shall be of oil and weather-resistant nature with final coat as flossy and non-fading paint of shade 631 as per IS 5.

- IV. The dry film thickness shall not exceed the specified minimum dry film thickens by more than 25%.

- V. Any damaged part shall be cleaned to bare metal with an area extending 25 mm around its boundary. A priming coat shall be immediately applied followed by full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage. The repainted surface shall present a smooth surface which shall be obtained by carefully chamfering the paint edges before and after priming.
- VI. Painting shall not affect by weather changes & performance against pilling out or fading etc. to be guaranteed for 5 Years.
- VII. Paint thickness shall be 120 Microns

5.24 RADIO INTEREFENCE

When operated at voltages up to **12.5%** in excess of the normal system rating, transformers shall be substantially free from partial discharges (i.e. corona discharges in either internal or external insulation) which are likely to cause interference with radio or telephone communication.

5.25 OVERLOAD CAPACITY

The transformer shall be suitable for loading as per IS 2026 part 7

5.26 FITTINGS

The following standard fittings shall be provided:

- I. Two earthing terminal pads/ boss with earthing symbol \perp for body earthing on opposite sides with 70sq.mm AL lug and M12 SS bolt and washers.
- II. Air Release Device.
- III. Thermometer Pocket with cap.
- IV. Drain cum Sampling Valve & filter valve
- V. Pressure relief valve with auxiliary contacts
- VI. Detachable type Radiators
- VII. Load and Source side bushing shall be bare type. .
- VIII. For Load side bare bushing bird guard on bushings terminals connectors
- IX. Conservator with Dehydrating Breather
- X. Prismatic Oil level Gauge and MOG in conservator.
- XI. Lifting lugs (enclosed type) for the top cover, complete transformer and core and winding assembly.
- XII. Pulling Lugs.
- XIII. Jacking Pads
- XIV. Stiffener Angle.
- XV. Marking Plates as asked in clause 6.1
- XVI. OTI/WTI with alarm & trip contact
- XVII. Two GI earth strip of Size 50x6 mm for neutral earthing from both side of Secondary Sidebox with minimum GI coating thickness of 86 microns. With SS nut bolts and washer.
- XVIII. Magnetic Oil level Gauge , Winding Temperature Indicator , Magnetic Reed type Buchholz relay in line with IS 1180.
- XIX. Marshalling Box with stud type terminals

5.27 WINDING TEMPERATURE INDICATOR (WTI)

- I. WTI shall be **indicating type**, responsive to the combination of top oil temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding.
- II. WTI shall operate a remote alarm and trip in the event of attaining the predefined temperature.
- III. WTI shall be housed inside Marshalling Box.

5.28 BUCHHOLZ RELAY

- I. Magnetic Reed type Buchholz relay shall be provided with alarm and tripping contacts to detect accumulation of gas.
- II. The installation shall be fixed and weather proof to avoid any water seepage inside the relay.
- III. Round flange of nominal pipe bore of **50mm diameter** shall be used.
- IV. In addition, pocket with heater coil along with Resistance Temperature Indicator (RTD) shall be provided for WTI and OTI. CT for RTD for winding hot spots shall be provided.

5.29 Two Separate Marshalling Box shall be provided

- 1. For Transformer OTI, WTI, etc
 - I. Marshalling Box of suitable size, made up of Mild Steel and with theft proof locking arrangement shall be provided.
 - II. Marshalling box shall have IP 55 protection.
 - III. Marshalling Box shall have provision for wiring the WTI, OTI, MOG, PRV, Buchholz relay and LT CT terminals. The terminals shall be provided as per table below:

Element	Alarm	Trip
Oil Temperature Indicator	NO,NC,COM	NO,NC,COM
Winding Temperature Indicator	NO,NC,COM	NO,NC,COM
Buchholz	NO,NC,COM	NO,NC,COM
Magnetic Oil Level Gauge	NO,NC,COM	
PRV	NO,NC,COM	
LT Voltage terminals	RYBN	
Spare TB	4 No.	
Tap Position		

- IV. WTI meter shall be wired/ installed in the marshalling box.
- V. 10 core PVC wire (4 sq.mm Cu FRLS PVC stranded panel wires) shall be used to terminate connections from CTs at Secondary Sideside to the Marshalling box.
- VI. Plastic ferrules engraved with black letters shall be used to mark the wires in the marshalling box.

- VII. Wiring in Marshalling box shall be done by 2.5 sq.mm Cu FRLS PVC stranded panel wires.
- VIII. All the cables and conduits between the transformer and control cabinet shall be included in the scope of supply by the bidder.

2 . For AVR Controls

- I. Marshalling Box of suitable size, made up of Mild Steel and with theft proof locking arrangement shall be provided.
- II. All necessary arrangement for local operation /Remote operation to be provided.
- III. All the cables and conduits between the transformer and control cabinet shall be included in the scope of supply by the bidder.
- IV. Marshalling box shall have IP 55 protection.
- V. All necessary protection for OLTC/AVR to be provided.
- VI. AVR should have SCADA compatibility using Modbus or IEC60870-104 Protocol for remote monitoring and control.

5.30 MAKE OF MAJOR COMPONENTS & RAW MATERIALS

The BA shall procure the following constituent items from the designated vendors as follows:

S.no	RAW MATERIAL/EQUIPMENT	MAKE
a)	Copper	M/S Sterlite, M/S Hindustan Copper, M/S Hindalco.
b)	Core	M/S AK Steels, POSCO, Kawasaki/JFE, Nippon Steel,
c)	Insulation paper and Pressboards	ITC paper, ABB, Raman Boards-Mysore, Senapathy Whiteley – Bangalore
d)	Transformer Oil (Mineral oil)	Savita, Apar, Gandhar
e)	Gaskets & Corks	Nu Cork, Anchor Corks
f)	Steel For Tank	M/s, TATA Steel, M/s SAIL, M/s. JSW Steel, M/s. IISCO, M/s. RINL/Vizag Steel, M/s. Jindal Steel,
g)	Dehydrating Breather	Yogya, Anushree, Electrical engineers
h)	Bushings Primary Side & Secondary Side	Genesis Electric, Hindustan Chemicals, Rashtriya Electricals,LAMCO



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i)	Buchholz, PRD, SPR, OTI , WTI, and other devices	Reputed make to be approved by TPCODL/TPWODL/TPNODL/TPSO DL during detailed engineering.
j)	AVR, Relay, Tap Changer Controller	Reputed make to be approved by TPCODL/TPWODL/TPNODL/TPSO DL during detailed engineering.

Also, Bidder has to provide all test certificates from original manufacturers & relevant sourcing documents. BA shall also have shot blasting facility.

6. MARKING:

6.1 MARKING PLATES

I. Name Plate (Rating) Plate : SS material

A rating plate shall be fitted to each transformer in a visible position and shall carry all the information as **specified in clause no. 6.2**

II. Terminal Marking Plate : on same name plate also accepted

- The terminal marking plate shall be provided which shall be strictly in accordance with **figure 4 of IS 1180-Part 1 or IS2026 (Whichever is applicable)**. This plate may be combined with the rating plate or can be provided separately.
- Value of short circuit impedance on extreme tapping and on principal tapping and indication of winding to which impedance is related has to be displayed additionally.

III. Details Plate : MS sheet of 2.5mm with punched details and welded on tank.

A separate plate of **size 125 mm x 125 mm** shall be provided having following details:

- Name of the firm.
- Serial No.
- Rating of transformer.
- Order no. and date.
- Date of dispatch.

IV. Guarantee Plate :

A separate warranty plate made of **Stainless Steel** with following clause written on it.

“THE EQUIPMENT GUARANTEED UPTO A PERIOD OF 48 MONTHS FROM THE DATE OF COMMISSIONING OR 60 MONTHS FROM THE DATE OF LAST SUPPLY”

All the plates described above (clause 1 to 4) should be as followings:

Material	Stainless Steel
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Thickness	1 mm
Engraving	The letters on the rating plate shall be engraved black on the white/silver back ground.
Fixing	Fixing screws shall be of stainless steel.

V. Danger Plate:

Danger notice shall have red lettering on a white background on a plate as specified in IS: 2551 – 1982.

- a. Equipment is a Line Voltage Regulator
- b. Oil filled, naturally cooled type
- c. Name of the manufacturer and brand
- d. Capacity in KVA as tested
- e. Total losses
- f. Model and year of manufacturing.
- g. Bureau's authorisation number

VI. Control Circuit drawing Plates:

Engraved drawing for control circuit unit shall be available on Marshalling box.

6.2 NAME PLATE DETAILS

The name plate shall be strictly as per **IS 1180: 2014 or IS 2026 Whichever is applicable (figure 1)**. Additionally, following points shall be displayed :

- I. Actual no load losses of transformer.
- II. Actual total losses of transformer at 100% load.
- III. "PROPERTY OF TPCODL/TPWODL/TPNODL/TPSODL" shall be written in bold letters.
- IV. PO number with date has to be mentioned.
- V. Overall dimensions of the transformer

6.3 MARKING

- I. All transformers shall have Source Side phase windings marked in both, the terminal boards inside the tank and outside with capital letter 1U, 1V, 1W.
- II. The Load Side winding for the same phase shall be marked by corresponding small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter N.
- III. The markings shall be done by steel strips in which marks had been engraved in black colour.
- IV. Colour marking of the bushings shall be done.
- V. On the top cover of tank and the core channel, Manufacturer's name and Manufacturer's serial no. shall be engraved.
- VI. On the body of tank, Manufacturer's name, rating, serial no. and year of manufacturing shall be written with black paint on yellow base. It should be written in suitable place in approved format that it is readable from ground after installation on pole.

7. TESTS:

- I. All routine, acceptance & type tests shall be carried out in accordance with the IS 2026 and IS 1180: Part-1 (2014).
- II. All routine & acceptance tests shall be witnessed by the TPCODL/TPWODL/TPNODL/TPSODL /his authorized representative.
- III. All the components shall also be type tested as per the relevant standards. Following tests shall be necessarily conducted on the Distribution Transformers in addition to others specified in IS/IEC standards.

7.1 TYPE TESTS

- I. Lightning Impulse Test [As per IS 2026 (Part 3) Clause no. 12].
- II. Temperature Rise Test [As per IS 2026 (Part 2) Clause no.4].
NOTE: Maximum measured total loss (No load at Rated excitation load loss at maximum current tap converted to 75°C reference temperature) at 100 percent loading shall be supplied during temperature rise test.
- III. Short Circuit Withstand test [As per IS 2026 (Part 5)].
NOTE: Routine tests before and after short circuit test shall be conducted as per IS 2026(Part 1).
- IV. Pressure Test [As per IS 1180: Part 1 (2014)].
- V. Determination of sound levels [IS 2026 (part 10)].
- VI. No load current at 112.5% voltage
- VII. BDV and moisture content of oil in transformer (IS 335).
- VIII. Magnetic balance test.
- IX. Measurement of Zero-phase sequence impedance.
- X. Measurement of Harmonics of no-load current.
- XI. Test to verify IP 55 for Marshalling Box.

Note: - Out of the above mention type test, the tests under sl. No. 1, 2 ,3 and 4 shall be conducted at CPRI/ERDA labs and the balance tests to be conducted at TPCODL/TPWODL/TPNODL/TPSODL recommended NABL lab.

7.2 ROUTINE TESTS

Sr. No.	Test to be done	Reference BIS	Clause no.
1	Measurement of Winding Resistance on each tap.	IS 2026 (Part 1)	16.2.1 & 16.2.3
2	Measurement of voltage ratio, check of voltage displacement, polarity, phase sequence and vector group	IS 2026 (Part 1)	16.3
3	Measurement of short circuit impedance (principal tapping, when applicable) and load loss at 100% load	IS 2026 (Part 1)	16.4
4	Measurement of no load losses and	IS 2026 (Part 1)	16.5

	magnetizing current at rated frequency and 90%, 100% and 112.5% of rated voltage		
5	Measurement of insulation resistance	IS 2026 (Part 1)	16.6
6	Induced over voltage withstand test	IS 2026 (Part 3)	11
7	Separate Source voltage withstand test	IS 2026 (Part 3)	10
8	Oil leakage test	IS 1180 (Part 1)	21.5.1.3
9	Neutral current measurement	IS 1180	7.9.2
10	BDV and moisture content of oil in transformer (Type-2 oil)	For mineral oil : IS 335 (2018) For Ester oil : IEC 60247 & IEC61099	For mineral oil : IS 335 Table 2

7.3 ACCEPTANCE TESTS

- I. Temperature Rise test on one unit of first lot against every release order / PO for each rating. For further lots, TPCODL/TPWODL/TPNODL/TPSODL reserves the right to perform Temperature rise if required. [As per IS 2026 (Part 2) Clause no.4]
- II. Oil leakage test for acceptance shall be conducted at pressure of 0.35kg/sq.cm for one hour. (IS 1180 (Part 1) clause 21.5.1.3)
- III. The painted surface shall pass the Cross Adhesion Test (IS1180 part 1 clause no. 21.4.d).
- IV. Calibration of WTI and OTI.
- V. Magnetic Balance Test.
- VI. OEM test reports for CT if used.
- VII. OEM test reports for breather for air pressure test.
- VIII. At stage inspection -Checking of weight, dimensions, fitting and accessories, tank sheet thickness, oil quantity, material finish and workmanship, physical verification of core coil assembly and measurement of flux density on one unit of each rating of the offered lot with reference to the GTP and contract drawings. Oil BDV of all offered lot.
- IX. At least 10% transformer of the offered lot (minimum of one) shall be subjected to all the tests mentioned under the section 'ROUTINE Test" in presence of TPCODL/TPWODL/TPNODL/TPSODL's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS: 1180 and IS: 2026.
- X. Device trails & test (Buchholz trip, Buchholz alarm, PRV trip, WTI alarm, WTI trip and OTI alarm).
- XI. At Stage and Final inspection, the incoming raw material and its movement/consumption record in the related jobs of TPCODL/TPWODL/TPNODL/TPSODL will be verified by inspecting officer. In case of any deviation or non-availability of such records, the offered lot may get rejected.

8. TYPE TEST CERTIFICATES:

- I. The Bidder shall furnish the type test certificates of the offered rating and design of transformer for the tests as mentioned above as per the corresponding standards.
- II. All the tests shall be conducted at CPRI / ERDA or as defined in 7.1 as per the relevant standards.



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- III. In the event of any discrepancy in the test reports, i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to TPCODL/TPWODL/TPNODL/TPSODL.
- IV. Type tests should have been conducted in CPRI/ERDA during the period not exceeding 5 years from the date of opening the bid.

9. PRE-DISPATCH INSPECTION:

- I. Bidder to raise the inspection calls for stage inspection and only after getting clearance from TPCODL/TPWODL/TPNODL/TPSODL shall proceed for further manufacturing. The bidder shall raise the inspection call for Final Inspection or prototype Inspection in TPCODL/TPWODL/TPNODL/TPSODL format.
- II. If the prototype inspections asked for during drawing approval then bidder to make one unit of transformer and raise for inspection call for stage and final for prototype inspection.
- III. Equipment shall be subject to inspection by a duly authorized representative of the TPCODL/TPNODL/TPSODL/TPWODL
- IV. Inspection may be made at any stage of manufacture at the option of the purchaser and the equipment if found unsatisfactory as to workmanship or material, the same is liable to rejection.
- V. Bidder shall grant free access to the places of manufacture to TPCODL/TPWODL/TPNODL/TPSODL's representatives at all times when the work is in progress.
- VI. Inspection by the TPCODL or its authorized representatives shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications.
- VII. The BA shall ensure that 100% of the lot must be ready for inspection and atleast 10% must be ready with all mounting and accessories during inspection.
- VIII. Material shall be dispatched only after getting MDCC (Material Dispatch Clearance Certificate) from TPCODL/TPNODL/TPSODL/TPWODL
- IX. Following documents shall be sent along with material:
 - a) Test reports
 - b) MDCC issued by TPCODL/TPNODL/TPSODL/TPWODL
 - c) Invoice in duplicate
 - d) Packing list
 - e) Drawings & catalogue
 - f) Guarantee / Warrantee card
 - g) Delivery Challan.
 - h) Other Documents (as applicable)
- X. To ascertain the quality of the transformer oil, the original manufacturer's tests report shall be submitted at the time of inspection.
- XI. Arrangements shall also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of TPCODL/TPNODL/TPSODL/TPWODL's representative.
- XII. In respect of raw material such as core stampings, winding conductors, insulating paper and oil, bidder shall use materials manufactured/supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the TPCODL/TPWODL/TPNODL/TPSODL.
- XIII. The bidder shall furnish following documents along with their offer in respect of the raw materials:

- a) Invoice of supplier.
 - b) Mill's certificate
 - c) Packing List.
 - d) Bill of Landing
 - e) Bill of entry certificate by custom.
- XIV. To ensure about the quality of transformers, the inspection shall be carried out by the TPCODL/TPNODL/TPSODL/TPWODL's representative at following two stages:
- a) Online anytime during receipt of raw material and during manufacturing/assembly Stage.
 - b) At finished stage i.e. transformers are fully assembled and ready for dispatch.
- XV. Advance intimation of 7Days (Within Odisha)/12 Day (Outside Odisha) is required for both Stage and final inspections.
- XVI. All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and TPCODL/TPNODL/TPSODL/TPWODL at the time of purchase.
- XVII. The manufacturer shall offer the inspector representing the TPCODL/TPNODL/TPSODL/TPWODL all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as Active Inspection during Acceptance Tests.
- XVIII. During the stage inspection a few assembled core coil and assembled Tanked transformer shall be dismantled (only in case of CRGO material) to ensure that the CRGO laminations, Windings and workmanship are of good quality. TPCODL/TPNODL/TPSODL/TPWODL also reserves the right to review any document or certificates related to material, manufacturing process, quality checks at any point of stage inspection.
- XIX. TPCODL/TPNODL/TPSODL/TPWODL also reserves the right to inspect the tank of transformer before surface preparation and painting. The same shall be informed to TPCODL/TPNODL/TPSODL/TPWODL accordingly.
- XX. Final inspection Call for carrying out acceptance tests as per relevant IS/IECs shall be sent by the Bidder along with routine test certificates.
- XXI. The bidder shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical / electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.
- XXII. The TPCODL/TPWODL/TPNODL/TPSODL has the right to have the test carried out at his own by an independent agency wherever there is a dispute regarding the quality supplied. **Also TPCODL/TPNODL/TPSODL/TPWODL has right to test 1% of the supply selected either from the stores or field** to check the quality of the product. In case of any deviation TPCODL/TPNODL/TPSODL/TPWODL have every right to reject the entire lot or penalize the bidder, which may lead to blacklisting, among other things.
- XXIII. At the time of inspection the material should be ready as specified, In case of material non-readiness or material failure in acceptance, Cost of re-inspection shall be borne by bidder.

10. INSPECTION AFTER RECEIPT AT STORE:



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- I. The material received at the TPCODL/TPWODL/TPNODL/TPSODL store shall be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection.
- II. In case the transformers proposed for supply against the order are not exactly as per the tested design, the Bidder shall be required to carry out the short circuit test and impulse voltage withstand test at its own cost in the presence of the representative of TPCODL/TPNODL/TPSODL/TPWODL.
- III. The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.
- IV. Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations
- V. TPCODL/TPNODL/TPSODL/TPWODL reserves the right to conduct all tests on Transformer after arrival at site / stores and the manufacturer shall guarantee test certificate figures under actual service conditions.
- VI. TPCODL/TPNODL/TPSODL/TPWODL reserves the right to conduct short circuit test and impulse voltage withstand test in accordance to IS, afresh on each ordered rating at purchaser cost, even if the transformer of the same rating and similar design are already tested. This test shall be carried out on a transformer to be selected by TPCODL/TPWODL/TPNODL/TPSODL either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to TPCODL/TPWODL/TPNODL/TPSODL stores. The findings and conclusions of these tests shall be binding on the bidder.

11. GUARANTEE:

- I. Bidder shall stand guarantee towards design, materials, workmanship & quality of process/ manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Purchaser up to a period of 48 months from the date of commissioning or 60 months from the date of last supplies made under the contract, whichever is earlier.
- II. Bidder shall be liable to undertake to replace/rectify such defects at his own costs within mutually agreed timeframe and to the entire satisfaction of the TPCODL/TPWODL/TPNODL/TPSODL, failing which the TPCODL/TPNODL/TPSODL/TPWODL will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the TPCODL's own charges (@ 20% of expenses incurred), from the Bidder or from the "Security cum Performance Deposit" as the case may be.
- III. In case of Distribution transformer fails within the guarantee period TPCODL/TPWODL/TPNODL/TPSODL will immediately inform the Bidder who shall take back the failed Distribution Transformer within 15 days from the date of intimation at his own cost and replace / repair the transformer within forty five days of date of intimation with a roll over guarantee. The outage period i.e. period from the date of failure till unit is repaired / replaced shall not be counted for arriving at the guarantee period.
- IV. Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

12. PACKING AND TRANSPORT:

- I. Bidder shall ensure that all the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit.
- II. Transformers shall be delivered filled with oil and supplied with all accessories mounted. Screws and bolts shall be thoroughly tightened to ensure no leakage of oil.

Note: One use plastic not to be used for packing of the material.

13. TENDER SAMPLE:

All offered transformer detailed documents to be submitted as per clause no.18. The sample shall be not applicable

14. QUALITY CONTROL:

The bidder shall submit with the offer Quality assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. T TPCODL/TPNODL/TPSODL/TPWODL 's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections.

The following information shall necessarily be submitted with the bid:

- I. List of important raw materials, names of sub-suppliers for raw materials, standards to which raw material is tested and the copies of test reports of the tests carried out on raw materials in presence of Bidder's representatives.
- II. List of manufacturing facilities available, level of automation achieved and the areas where manual process exists.
- III. List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of these tests and inspections
- IV. List of testing equipment for final testing with valid calibration reports. Manufacturer shall possess 0.1 class instruments for measurement of losses.
- V. QAP withhold points for TPCODL/TPNODL/TPSODL/TPWODL inspection.

15. TESTING FACILITIES:

Bidder shall have adequate in house testing facilities for carrying out all routine tests, acceptance tests and pre-dispatch inspection as per relevant International / Indian standards.

16. MANUFACTURING FACILITIES:

The successful bidder will have to submit (after placement of RC) technical compliance document and drawing of each part along with CCA, breather, bushings, terminal box etc. as per RC line items to be submitted for getting approval before mass manufacturing.

The first time supplier will have to make one prototype sample of each line tem of RC as per

CAT-B approved drawing within 30 days of drawing approval. Inspection call to be raised by bidder before 7 days of date of proposed inspection. TPCODL/TPNODL/TPSODL/TPWODL shall arrange inspectors and intimate or confirm the date. Any observation during inspection shall have to be addressed within 7 days and revised improved drawing & technical details to be shared to TPCODL/TPWODL/TPNODL/TPSODL for final approval.

Manufacturing mass quantity to start only after getting CAT-A approved drawings or as per intimation from TPCODL/TPWODL/TPNODL/TPSODL

17. SPARES, ACCESSORIES AND TOOLS

Bidder shall give an assurance that the reparability of transformer is ensured by using standard spare parts and accessories available in market in India.

18. DRAWINGS AND DOCUMENTS:

Following drawings and documents shall be prepared based on TPCODL/TPNODL/TPSODL/TPWODL specifications and statutory requirements and shall be submitted with the bid:

- a. Completely filled in compliance to each clause of Technical Specification and any Additional Details and Fittings.
- b. Description of the transformer and all components drawings.
- c. General arrangement for Transformer.
- d. Bill of material.
- e. Design calculation details of transformer losses, cooling, efficiency and current density, weight of coils and components
- f. Experience Certificate and list
- g. Type test certificates.
- h. List of makes of major components as listed above.

Drawings / documents to be submitted for approval after the award of the order within 7 days before mass manufacturing are as under:

List of Drawings/Parameters to be submitted:

- a. Technical Parameters as asked in Specification (General Technical Particulars, General Technical Requirements, Additional Details, Fittings, Type test Reports and Routine test certificates of bought out accessories).
- b. General Arrangement Drawing of the Transformer (Front view, Top view and both sides view. Complete list of fittings to be displayed and quantities to be mentioned with the drawing).
- c. Internal Core arrangement drawing.
- d. Internal Core-coil assembly drawing.
- e. Foundation Plan drawing.
- f. Marking plates and Markings (as mentioned in clause 6)
- g. Primary Side and Secondary Side bushings drawing (with internal view and metal parts)
- h. Conservator drawing.
- i. Prismatic oil level gauge drawing.
- j. Silica Gel Breather drawing.



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- k. Auxiliary Terminal Box drawing with internal wiring arrangement.
- l. Gland plate of drawing
- m. BH curve & Loss/Kg graph of core material offered.
- n. The tightening torque chart to be provided for all bolts used in specific rating.
- o. Type Test Certificates.
- p. Installation/ Mounting Instructions/Drawing.
- q. Efficiency vs Load curve of the offered design.
- r. Quality Assurance plan.

List of Calculations to be submitted:

- a. All the calculations shall be step by step showing the use of formulas and other practical considerations. **Concise calculations in table or excel sheet shall not be accepted.** Also, the reference (only standard sources as IS, IEC or any such standard is acceptable) of the formulas shall be mentioned.
- b. Resistance Calculation (75 deg. C)
- c. Load Losses Calculation (at 75 deg. C)
- d. No load Losses.
- e. Stray Losses.
- f. Weight of Copper (Bare and with Insulation also).
- g. Weight of Core.
- h. Flux Density calculations.
- i. Current Density Calculations.
- j. Short Circuit withstand.
- k. Temperature Rise Calculations.
- l. Conservator Volume calculations
- m. Cooling Calculations showing cooling with tank and radiators separately with no. of radiators and fins mentioned specifically (For both Mineral oil and Ester oil)
- n. Calculation sheet for Lifting lug design and mounting lug design to be submitted by Bidder.

Additional Documents to be submitted :

- a. List of raw materials as well as bought out accessories and name of sub-suppliers selected from those furnished along with offer.
- b. Type test certificates of the raw materials and bought out accessories.
- c. The successful Bidder shall submit the **routine test certificates of bought out accessories** and central excise passes for raw material at the time of routine testing.

All the documents & drawings shall be in English language. After the receipt of the order, the successful bidder will be required to furnish all relevant drawings/parameters/calculation to TPCODL/TPNODL/TPSODL/TPWODL for approval.

Instruction Manuals:

Bidder shall furnish soft copies of nicely bound manuals (In English language) covering erection and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices.

19. SCHEDULE- "A" GUARANTEED TECHNICAL PARTICULARS:

All clauses and points in the Specification to be complied for along with GTR and offered design details.



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20. SCHEDULE “B” DEVIATIONS:

(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

SL. No	Clause No.	Details of deviation with justifications

We confirm that there are no deviations apart from those detailed above.

Seal of the Company:

Signature

Designation