

	TP NORTHERN ODISHA DISTRIBUTION LIMITED, BALASORE		
	TECHNICAL SPECIFICATION		
Doc. Title	SPECIFICATION FOR 3.15/5/8MVA POWER TRASNFORMERS		
Doc. No	ENG-HV -131		
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3.15/5.00/8.00 MVA Power Transformers

1. SCOPE

- 1.1** This specification provides for design, engineering, manufacture, assembly, stage inspection, final inspection and testing before dispatch, packing and delivery at destination stores by road transport, transit insurance of 3.15/5/8 MVA, 33/11kV Power Transformer(s), complete with all fittings, accessories, associated equipment's, spares, 10% extra Transformer Oil, required for its satisfactory operation in any of the sub-stations of the purchaser.

The Transformer shall be of outdoor type with tap changers as detailed below.

3.15 MVA - OFF Load Tap Changer

5.00MVA-ON Load in Tank / Flange Mounted type Tap Changer (with TMU Control Panel)

8.00MVA-ON Load in Tank / Flange Mounted type Tap Changer (with TMU Control Panel)

- 1.2** The core shall be constructed from high grade, non-aging Cold Rolled Grain Oriented (CRGO) annealed silicon steel laminations, having low loss and good grain properties, coated with hot oil proof insulation conforming to HIB grade of BIS certified with lamination thickness not more than 0.23mm to 0.27mm or better (Quoted grade and type shall be used) bolted together to the frames firmly to prevent vibration or noise. The grade of core shall be M3 or better. All core clamping bolts (If any) shall be effectively insulated. Only one grade and one thickness of core shall be accepted and no mixing of different grades shall be allowed. The complete design of the core must ensure permanency of the core losses with continuous working of the transformers. The value of the maximum flux density allowed in the design & grade of laminations used shall be clearly stated in the offer.
- 1.3** The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that it should under 10% overvoltage condition should not be more than 1.9 Tesla. The supplier shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.
- 1.4** The scope of supply includes the provision of type test. The equipment offered should have been successfully type tested within five years from date of tender and the designs should have been in satisfactory operation for a period not less than three years as on the date of order. Compliance shall be demonstrated by submitting, (i) authenticated copies of the type test reports and (ii) performance certificates from the users, specifically from Central Govt./State Govt. or their undertakings.
- 1.5** The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the employer shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble free operation.

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Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The Engineer reserves the right to reject the transformers if on testing the losses exceed the declared losses beyond tolerance limit as per IS or the temperature rise in oil and / or winding exceeds the value, specified in technical particular or impedance value differ from the guaranteed value including tolerance as per this specification and if any of the test results do not match with the values, given in the guaranteed technical particulars and as per technical specification.

2. SPECIFIC TECHNICAL REQUIREMENTS

1	Natural Cooling Rating (MVA) (ONAN)	3.15 5.00 8.00 MVA
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz (± 5%)
5	Cooling medium	Insulating Oil (ONAN)
6	Type of mounting	On Wheels, Mounted on rails.
7	Rated voltage	
7 (a)	High voltage winding	33kV
7 (b)	Low voltage winding	11kV
8 (a)	Highest continuous system voltage a) Maximum system voltage ratio (HV / LV)	36KV / 12 KV
8 (b)	b) Rated voltage ratio (HV / LV)	33KV / 11KV
9	No. of windings	Two winding Transformers
10	Type of cooling	ONAN (Oil natural / Air natural)
11	MVA Rating corresponding to ONAN Cooling system	100%
12	Method of connection: HV : LV :	Delta Star
13	Connection symbol	Dyn 11
14	System earthing	Neutral of LV side to be solidly earthed.
15	Percentage impedance voltage on Normal tap and MVA base at 750C corresponding to HV/ LV rating and applicable tolerances (No negative tolerance will be allowed)	% Impedance for 3.15 MVA - 6.25%, 5 MVA - 7.15% 8 MVA - 8.35% (Tolerance +10%)

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16	Intended regular cyclic overloading of windings	As per IEC –76-1, Clause 4.2	
17(a)	Anticipated unbalanced loading	Around 10%	
17(b)	Anticipated continuous loading of windings (HV / LV)	110 % of rated current	
18(a)	Type of tap changer	On load In-tank or flange mounted tap changer for 5 MVA ,8 MVA and OFF load tap changer in 3.15 MVA	
18(b)	Range of taping	+ 5% to – 15% in 8 equal steps of 2.5% each on HV winding, 9 tap positions. Tap no 3 will be the principal tap position	
19	Neutral terminal to be brought out	On LV side only	
20	Over Voltage operating capability and duration	112.5 % of rated voltage (continuous)	
21	Maximum Flux Density in any part of the core and yoke at rated MVA with +112.5% combined voltage and frequency variation from rated voltage i.e. 33 kV/11 kV and frequency of 50 Hz.	1.9 Tesla	
22	Insulation levels for windings: - 1.2 / 50 microsecond wave shape Impulse withstand (KVP)	33kV	11kV
		170kV	75kV
22(a)	Power frequency voltage withstand (KV rms)	70kV	28kV
23	Type of winding insulation		
23(a)	HV winding	Uniform	
23(b)	LV winding	Uniform	
24	Withstand time for three phase short circuit	2 Seconds	
25	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.	
26	Permissible Temperature rise over ambient temperature of 40/45°C		
26 (a)	Of top oil measured by thermometer	40 °C	
26(b)	Of winding measured by resistance	45 °C	

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27	Minimum clearances in air (mm) :-	Phase to Phase	Phase to ground
27(a)	HV	400	320
27(b)	LV	280	140
28	Terminals		
28(a)	HV winding line end 36 KV oil filled communicating type porcelain bushings (Anti-fog type)		
28(b)	LV winding 12KV porcelain type of bushing (Anti-fog type)–for outdoor 11KV breakers (11KV Power cables shall be used for extending supply to 11KV breakers in case of indoor circuit breakers. The termination of 11KV cables on LV bushing shall be Through extended copper bus bars suitable to hold power cables termination. A metallic cable termination box, completely sealed, shall be installed on LV side of the transformer in which cables shall enter from bottom gland plates.)		
29	Insulation level of bushing	HV	LV
29(a)	Lightning Impulse withstand (KVP)	170	75
29(b)	1 Minute Power Frequency withstand voltage (KV – rms)	70	28
29(c)	Creepage distance (mm) (minimum)	900	300
30	Material of HV & LV Conductor	Electrolytic Copper	
31	Maximum current density for HV and LV winding for rated current	2.6tap A/MM ²	
32	Polarization index (HV to LV, HV to Earth & LV to earth)	IR Test = 1 minute value/ 15 seconds value will not be less than1.5. IR Test = 10 minutes value / 1minute value will not be more than 5 and less than1.5.	
33	Core Assembly	Boltless type	
34	Temperature Indicator		
34(a)	Oil	One number	
34(b)	Winding	One number	
35	Paper covering thickness of HV winding	0.6 mm(minimum)	
36	Paper covering thickness of LV winding	0.5 mm(minimum)	
37	Clearances		
37(a)	Gap between HV coil to the inside of the tank on the longer side	65 mm(minimum)	

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37(b)	Gap between HV coil to the inside of the tank on the longer side(LV Side)	65 mm(minimum)
37(c)	Gap between HV coil to the inside of the tank on the Width side (HV side to accommodate delta and tapping leads)	115 mm(minimum)
37(d)	Gap between core yoke to tank bottom	55mm (minimum)
37(e)	Gap between core yoke to tank bottom	55mm (minimum)
37(f)	Gap between core yoke to tank bottom	20 mm(minimum)
37(g)	Gap between core yoke to tank bottom	20 mm(minimum)
37(h)	Radial clearance between core to LV coil	12.5mm(minimum)
38	The difference of Ampere Turns at each location shall not be more than 5 % at all percentages of tapings	
39	Winding to winding clearance should have minimum 20% of sum of pressboard Cylinder/Barrier.	
40	Tap changing gear	
	Type	In Tank/Flange mounted, High speed Resistor type
	Provided on	HV side
	Tap Range	-15% to +5%
	Tap step	2.5% of 33kV (8 equal steps)
	Minimum rated current	For 3.15 MVA-100A, 5MVA- 150A ,8 MVA-200A,
	Minimum rated short circuit current	3kA
	Automatic control required	Yes
	Remote control panel required	Yes
	Marshalling kiosk required	Yes
	Minimum air core reactance of HV winding	20%
	Type of oil preservation	Air-cell-type
34	Losses: - The losses shall not exceed the value given below	

MVA Rating	No-load losses (Fixed loss) KW	Load losses at 75°C KW	Percentage impedance voltage on normal tap and MVA base at 75° C
3.15	3	16	7.15
5	4	23	7.15
8	5.5	40	8.35
10	7	50	8.35

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2.1 MARSHALLINGBOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch etc. shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP 55 or better as per IS: 2147 (Refer Clause3.12).

2.2 CAPITALIZATION OF LOSSES AND LIQUIDATED DAMAGES

Capitalization of losses will be as per Annexure B which is attached herewith. No (+)ve tolerance shall be allowed at any point of time, on the quoted losses after the award. In case, the losses during type testing, routine testing etc. are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.

2.3 PERFORMANCE

- i) Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals.
- ii) The maximum flux density in any part of the core and yoke at rated Voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.
- iii) Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.
- iv) The transformer may be operated continuously without danger on any particular tapping at the rated MVA \pm 1.25% of the voltage corresponding to the tapping.
- v) The thermal ability to withstand short circuit shall be demonstrated by calculation.
- vi) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding.

2.4 DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID

- a) General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.
- b) Assembly drawings of core, windings etc. and weights of main components / parts.
- c) Height of center line on HV and LV connectors of transformers from the rail top level.
- d) Dimensions of the largest part to be transported.

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- e) GA drawings / details of various types of bushing
- f) Tap changing and Name Plate diagram
- g) Type test certificates of similar transformers.
- h) Illustrative & descriptive literature of the Transformer.
- i) Maintenance and Operating Instructions.

2.5 MISCELLANEOUS

- i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.
- ii) Foundation bolts for wheel locking devices of Transformer shall be supplied by the Contractor.

2.6 DELIVERY

The full quantity of the equipment's shall be delivered as per the delivery schedule appended to this specification.

2.7 SCHEDULES

All Schedules annexed to the specification shall be duly filled by the bidder separately.

2.8 ALTITUDEFACTOR

Necessary correction factors as given in the Indian Standard for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given above.

2.9 NAMEPLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part- I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription of Employer's name. The name plate shall also include (i) The short circuit rating , (ii) Measured no load current and no load losses at rated voltage and rated frequency, (iii) measured load losses at 75° C (normal tap only), (iv) D.C resistance of each winding at 75° C.

3. SERVICE CONDITIONS CLIMATIC CONDITIONS

The service conditions shall be as follows:

1. Maximum altitude above sea level 1,000m
2. Maximum ambient air temperature 50°C
3. Maximum daily average ambient air temperature 35°C
4. Minimum ambient air temperature 0°C
5. Maximum relative humidity 95%
6. Average number of thunderstorm days per annum (isokeraunic level) 70
7. Average number of rainy days per annum 120
8. Average annual rainfall 150cm
9. Earthquakes of an intensity in horizontal direction - equivalent to seismic acceleration of 0.3g

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10. Earthquakes of an intensity in vertical direction - equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

13 .Wind velocity: 300 km/hr., 200 km/hr. and 160 km/hr.

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators. Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

4. SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

Frequency	50 Hz ± 5%	
Nominal system voltages	33KV 11KV	
Maximum system voltages	33KV System	36.3 KV
	11 KV System	12 KV
Nominal short circuit level (Basing on apparent power)	33KV System	31.5KA
	11 KV System	13.1KA
Insulation levels : 1.2/50 μ sec impulse withstand voltage	33KV System	170KV (peak)
	11 KV System	75 KV (peak)
Power frequency one minute withstand (wet and dry) voltage	33KV System	70KV (rms)
	11 KV System	28KV (rms)
Neutral earthing arrangements	11 KV System	Solidly earthed

5. CODES & STANDARDS

5.1 The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

5.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

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IS:5	Color for ready mixed paints
IS:325	Three Phase Induction Motors
IS:335	New insulating oil for transformers, switchgears Classification of
IS:1271	insulating materials for electrical machinery and apparatus in relation to their stability in services
IS: 2026(Part I to IV)	Power Transformer
IS:2071	Method of high voltage testing
IS:2099	High voltage porcelain bushings
IS:2147	Degree of protection
IS:2705	Current Transformers
IS:3202	Code of practice for climate proofing of electrical equipment
IS:3347	Dimensions for porcelain Transformer Bushings
IS:3637	Gas operated relays
IS:3639	Fittings and accessories for power Transformers
IS:5561	Electric Power Connectors
IS:6600/BS:CP"10:0	Guide for loading of oil immersed Transformers
IS:10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item. The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

5.3 DRAWINGS

- a) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Six copies each of the following drawings/documents incorporating the transformer rating for approval.
 - i) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.
 - ii) Assembly drawings of core and winging and weights of main components /parts
 - iii) Foundation plan showing loading on each wheel land jacking points with respect to center line of transformer.
 - iv) GA drawings details of bushing and terminal connectors.
 - v) Name plate drawing with terminal marking and connection diagrams.
 - vi) Wheel locking arrangement drawing.

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- vii) Transportation dimensions drawings.
- viii) Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.
- ix) Interconnection diagrams.
- x) Over fluxing withstand time characteristic of transformer.
- xi) GA drawing of marshalling box.
- xii) Control scheme/wiring diagram of marshalling box.
- xiii) Technical leaflets of major components and fittings.
- xiv) As built drawings of schematics, wiring diagram etc.
- xv) Setting of oil temperature indicator, winding temperature indicator.
- xvi) Completed technical datasheets.
- xvii) Details including write-up of tap changing gear.
- xviii) HV & LV bushing.
- xix) Bushing Assembly.
- xx) Bi-metallic connector suitable for connection to 100 mm² up to 232 mm² AAAC Conductor.
- xxi) GA of LV cable Box.
- xxii) Radiator type assembly.

b) All drawings, documents, technical data sheets and test certificates, results calculations shall be furnished.

5.4 Any approval given to the detailed drawings by the Employer's shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the employers shall be general with overall responsibility with contractor.

6. GENERAL CONSTRUCTIONAL FEATURES

6.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.

6.2 Similar parts particularly removable ones shall be interchangeable.

6.3 Pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.

6.4 Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.

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- 6.5** Exposed parts shall not have pockets where water can collect.
- 6.6** Internal design of transformer shall ensure that air is not trapped in any location.
- 6.7** Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated
- 6.8** Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.
- 6.9** All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified stands without injury.
- 6.10** Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- 6.11** No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.
- 6.12** Schematic Drawing of the wiring, including external cables shall be put under the propane sheet on the inside door of the transformer marshalling box.
- 6.13 Painting**
- 6.13.1 All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following:
- Proper storage to avoid exposure as well as extremes of temperature.
 - Surface preparation prior to painting.
 - Mixing and thinning
 - Application of paints and the recommended limit on time intervals between coats.
 - Shelf life for storage.
- 6.13.2 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects. All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of Employer.
- 6.13.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

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6.13.4 Cleaning and Surface Preparation

1. After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
2. Steel surfaces shall be prepared by Sand/Shot blast cleaning or chemical cleaning by seven tank process including Phosphate to the appropriate quality.
3. The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.
4. Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.
5. Protective Coating As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti corrosion protection.

6.13.5 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE. The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS5:1961.

6.13.6 Painting Procedure

1. All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.
2. Particular attention shall be paid to the manufacturer's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.
3. All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.
4. Where the quality of film is impaired by excess film thickness, (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%. In all instances, where two or more coats of the same paints are specified, such coatings may or may not be of contrasting colors.

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- Paint applied to items that are not be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

6.13.7 Damages to Paints Work

- Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.
- Any damaged paint work shall be made as follows:
 - The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
 - A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the originally damaged.
- The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

6.13.8 Dry Film Thickness

- To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be same color.
- Each coat of paint shall allowed to harden before the next is applied as per manufacture's recommendations.
- Particular attention must be paid to full film thickness at edges.
- The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

Sl. No	Paint Type	Area to be painted	No of Coats	Total Dry film thickness (Min)
1	Liquid paint	Outside	02	45micron
	a) Zinc Chromate (Primer)			
	b) POLYURETHANE Paint (Finish Coat)	Outside Inside	02	35micron
	c) Hot Oil paint		01	35 micron

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7. DETAILED DESCRIPTION

7.1 Tank

- 7.1.1 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank shall be of welded construction.
- 7.1.2 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.
- 7.1.3 All beams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.
- 7.1.4 The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760mm of Hg.
The side Tank wall shall be of 6mm thickness (minimum) for 3.15MVA and 8mm (minimum) for 5MVA and 10 mm for 8MVA. The bottom and Top Plate of the Tank shall be of 8mm thickness (minimum) for 3.15MVA, 10mm (minimum) for 5MVA and 12mm. (minimum) for 8MVA. Thickness for conservator tank shall be 06 mm minimum.
- 7.1.5 Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
- 7.1.6 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments, shall be laid in grooves or in groove- equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.
- 7.1.7 Suitable guides shall be provided for positioning the various parts during assemble or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.
- 7.1.8 The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and shall be of adequate thickness.
- 7.1.9 The tank and the cover shall be of welded construction. All seams shall be welded and where practicable they shall be double welded.
- 7.1.10 The tank shall have sufficient strength to withstand without permanent distortion (i) filling by vacuum and (ii) continuous internal gas pressure of 0.35 atmospheric with oil and operating level.
- 7.1.11 The tank material shall be as per IS: 2026 or equivalent with ultrasonic testing done for elimination of defects in rolled plates.

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- 7.1.12 The welding shall be as per prior approved WPS (Welding Procedure Specs) by trained and tested welders.
- 7.1.13 The welding plan shall be shown in general i.e. Category-wise or for each type of weld in the mechanical fabrication drawing, which shall be submitted to Purchaser.
- 7.1.14 All fittings like elbows, bends etc. shall be seamless as per applicable American or Indian Standards.
- 7.1.15 No resistance welding of fasteners shall be done anywhere on the transformer.
- 7.1.16 The tank shall have an oil tight bolted flanged joint near the base of the transformer so that the tank can be lifted off to provide access to the core and coils.
- 7.1.17 To ensure oil tightness, recessed neo prene or equivalent gaskets shall be used.
- 7.1.18 Man holes with welded flange and bolted covers shall be provided on the tank.
- 7.1.19 The manhole shall be of sufficient size to afford easy access to the lower ends of all the bushings, OLTC terminals etc. to permit replacement of auxiliaries without removing tank covers.
- 7.1.20 Inspection covers on elevation (on vertical plane) shall be provided for all HV bushing turrets.
- 7.1.21 Suitable guides shall be provided for positioning the various parts during assembly or dismantling.
- 7.1.22 Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.
- 7.1.23 All joints including bolted as well as flanged, shall have machined matching surfaces/inner edges with smooth finish, to ensure leak proof joints.
- 7.1.24 Lifting eyes or lugs shall be provided on all parts of the transformer requiring independent handling during assembly or dismantling. In addition, the transformer tank shall be provided with lifting lugs and bosses properly secured to the sides of the tank, for lifting the transformer either by crane or by jacks.
- 7.1.25 The design of the tank, the lifting lugs and bosses shall be such that the complete transformer assembly filled with oil can be lifted with the use of these lugs without any damage or distortions.
- 7.1.26 The tank shall be provided with two nos. of suitable copper alloy lugs for the purpose of grounding.
- 7.1.27 The grounding pads should be mirror finished. Two grounding pads, located on opposite sides of the tank shall be provided with two tapped holes for connecting it with station ground mat. Necessary hardware like M10 GS bolts and spring washers shall also be provided for connections.
- 7.1.28 Each tank shall be equipped with the following valves with standard flange connection for external piping:
- One drain valve located on the low voltage side of the transformer and placed to completely drain the tank. At the option of the Purchaser's a large valve may be furnished with an eccentric reducer. This valve shall be equipped with a small sampling cock.
 - One filter valve located at the top of the tank on the high-voltage side. The opening of this valve shall be baffled to prevent aeration of the oil.
 - One filter valve, located slightly above the bottom of the tank.
 - One relief valve to operate at a pressure below the test pressure for the tank.
 - Other two nos. valves shall also be provided, as required for proper functioning of the transformer.
 - A suitable locking arrangement shall be provided for locking these valves in close/open position.

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- 7.1.29 All valves should be provided with clear open/close position indications. Wherever rising spindle type valves are provided the valves should be clockwise rotating for closing operations.
- 7.1.30 For the auxiliary lead wiring from individual instrument to marshalling box, the cables shall be provided in the conduits.
- 7.1.31 All the transformers shall be provided with a ladder having 'anti-climbing' device.
- 7.1.32 Transformer tank shall be of welded sheet steel construction and provided with gaskets steel cover plates.
- 7.1.33 Base shall be suitably reinforced to prevent any distortion during lifting. Base channels shall be provided with skids and pulling eyes to facilitate handling.
- 7.1.34 All seams shall be electrically double welded for absolute oil tightness.
- 7.1.35 Equipotential strips to be provided at the gasket joints and at any other suitable locations.
- 7.1.36 Suitable arrangement shall be made for mounting HV and LV lightning arrestors of the transformer.
- 7.1.37 Guards shall be provided for drain, bottom sampling and filter valves to prevent oil pilferage.

7.2 Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rainwater.

7.3 UNDER CARRIAGE

The transformer tank filled with oil shall be supported on steel structure with detachable plain rollers. Suitable channels for movement of roller with transformer shall be space accordingly, rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication.

7.4 CORE

- 7.4.1 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- 7.4.2 The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better (Quoted grade and type shall be used). The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.69 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.

CRGO steel for core shall be purchased only from the approved vendors, list of which is available at <http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>

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7.4.3 The bidder should offer the core for inspection starting from the destination port to enable Employer for deputing inspecting officers for detail verification as given below and approval by the Employer during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material: The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core- cutting at the manufacturer's or it's sub- vendor's premises as per approved design drawing.

- a) Purchase Order No. & Date.
- b) Invoice of the supplier
- c) Mills test certificate
- d) Packing list
- e) Bill of lading
- f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.

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

7.4.4 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

7.4.5 Purchaser shall impose heavy penalty or black list bidders using seconds/ defective CRGO sheets or load losses found to be more than stipulated limit

7.4.6 The core frame shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.

7.4.7 The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.

7.4.8 The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25mm.

7.4.9 All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

1. The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

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- 7.4.10 The core clamping structure shall be designed to minimize eddy current loss.
- 7.4.11 The framework and clamping arrangements shall be securely earthed.
- 7.4.12 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 7.4.13 Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.
- 7.4.14 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.
- 7.4.15 The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits. The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling
- 7.4.16 The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procurement to be mutually agreed) or by calculation.
- 7.4.17 Suitable buffer locking arrangement to be provided by providing guide channel, stopper and other suitable insulating material so that core and its associated channel do not move during transportation.

7.5 INTERNALEARTHING

All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.

- a) The grounding lead from the core shall be brought out of the tank through a 11 kV class bushing and grounded externally.

7.5.2 A protective cover shall be provided for the bushing.

7.5.3 The core grounding rod (stem) through the bushing shall be solid rod (stem).

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- 7.5.4 The design of core grounding arrangement shall be such that the grounding links shall not come out of core during installation as well service conditions.
- 7.5.5 The supplier shall submit a drawing clearly showing the details of core grounding.
- 7.5.6 The core/frame grounding's both connections shall be brought out through a suitable bushing for provision of external grounding.
- 7.5.7 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.
- 7.5.8 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.

7.6 WINDING

- 7.6.1 Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.
- 7.6.2 All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.
- 7.6.3 Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness. The conductors shall be of electrolytic grade copper free from scales and burrs. The conductor insulation shall be made from high-density (at least 0.75 gm. /cc) paper having high mechanical strength. The barrier insulation including spacers shall be made from high-density pre-compressed pressboard (1.1 gm./cc minimum for load bearing and 1 to 1.3 gm./cc minimum for non-load bearing) to minimize dimensional changes.
- 7.6.4 Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or be otherwise affected under the operating conditions.
- 7.6.5 Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 7.6.6 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.
1. Terminals of all windings shall be brought out of the tank through bushings for external connections. The winding shall be brought out through bushing and provided with suitable terminal connectors, the details of which will be forwarded later.
 2. The tolerance for the winding resistance measurement for different phases but at same taps shall be limited to 1%. The windings shall be brought out through bushing. The windings shall be designed to withstand the specified thermal and dynamic short-circuit stresses.

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3. The end turns of the high voltage windings shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal condition.
4. Winding shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching. All the windings shall be capable of withstanding stresses that may be caused by such switching.
5. Primary and secondary windings shall be constructed from high- conductivity (copper conductors), Double Paper Covered (DPC) with minimum 30% overlapping of insulation at each layer copper conductor.
6. The insulation between core and bolts and core and clamps shall withstand **2.5 kV for one minute**.
7. Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted as per standards.
8. 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.
9. **The joints in the winding shall be avoided but if it is necessary then, these 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.**

- 7.6.7 The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.
- 7.6.8 The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.
- 7.6.9 Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.
- 7.6.10 Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.
- 7.6.11 The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.
- 7.6.12 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.
- 7.6.13 Magnitude of impulse surges transferred from HV to LV windings by electromagnetic induction and capacitance coupling shall be limited to BILL of LV winding.
- 7.6.14 The coils shall be supported between adjacent sections by insulating spacers, and the barriers bracings and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings

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- 7.6.15 Coils should be transposed to minimize magnetic forces and extra supports shall provide for inter-disconnection.
- 7.6.16 All materials used in the insulation and assembly of the winding shall be new, insoluble, non-catalytic, and chemically inactive in the hot transformer oil, and shall not soften or otherwise be adversely affected under the operating conditions.
- 7.6.17 The current density of coil shall not exceed 2.4 Amps/ square mm at min tap of respective PTR's higher rating.
- 7.6.18 All threaded connections shall be provided with locking facilities. All leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

7.7 Insulating paper and insulating pressboard

1. The bidder shall submit characteristics along with make for all the type of insulation papers and Pressboards to be used with the offer.
2. Inter layer insulation both for HV and LV windings shall be Epoxy diamond dotted Kraft paper and compressed pressboard of reputed make (subject to approval of TPNODL).
3. For Winding insulation, only Double Paper Covered insulation is acceptable with laying in opposite direction to each other and each paper must have overlapping more than 60% of its width.
4. 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.
5. Kraft paper and Pressboard should be of class A (105°C) insulation material.
6. All spacers, axial wedges / runners used in windings shall be made of pre-compressed solid pressboard.
7. All axial wedges/runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely.
8. 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.
9. 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.

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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 IS1576 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%

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:

1. Substance (Grammage)(g/m²)
2. Compressibility
3. Tensile strength
4. Conductivity of water extract
5. Shrinkage in air
6. Flexibility
7. Cohesion between plies1.
8. Elongation
9. Air permeability
10. Tear index
11. Heat stability

7.8 INSULATING OIL

- 7.7.1 The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.
- 7.7.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. transformer shall supplied complete with all fittings, accessories and new transformer oil required for first filling plus 10% extra oil. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.
- 7.7.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.
- 7.7.4 The oil parameters shall be as per Table-1 of IS335.

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7.9 VALVES

- i) Valves shall be of forged carbon steel up to 50mm size and of gun metal or of cast iron bodies with gun metal 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.

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.

- ii) 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 contractor shall supply the same.
- iii) Each transformer shall be provided with following valves on the tank:
- Drain valve so located as to completely drain the tank & to be provided with locking arrangement.
 - Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.
 - Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.
 - One 15mm air release plug.
 - Valves between radiators and tank. Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

7.10 ACCESSORIES

7.10.1 Bushing

- All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown color and free from blisters, burns and other defects.
- Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
- Bushing shall be designed and tested to comply with the applicable standards.
- Bushing rated for 400A and above shall have non-ferrous flanges and hardware.
- Fittings made of steel or malleable iron shall be galvanized
- Bushing shall be so located on the transformers that full flashover strength will be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.

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- vii) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
- viii) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bushing terminal and the Employers specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 550 Cover an ambient of 500 C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
- ix) Bushing of identical voltage rating shall be interchangeable.
- x) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.
- xi) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.
- xii) The extended bushing bus bars shall be used for termination of 11 KV cables. LV busing shall be housed in completely sealed metallic enclosure.

Sheet steel, weather, vermin and dust proof cable box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate 11 KV cables etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshaling box. The degree of protection shall be IP-55 or better. To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust. All incoming cables shall enter the kiosk from the bottom and the minimum 4mm thick, non-magnetic, gland plate shall not be less than 600 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench – **for those transformers which are used in partly indoor substation**, if required as per BOQ, a cable box for LV bushings shall be provided.

7.10.2 Protection & Measuring Devices

- i) **Oil Conservator Tank**
 - a) The Conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.
 - b) The conservator tank shall be bolted into position so that it can be remove for cleaning purposes.
 - c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
 - d) Plain conservator fitted with silica gel breather.

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- ii) Oil preserving equipment shall be conservator (expansion tank) type. The conservator shall have two filter valves, one at the bottom at one end, the other at the top, opposite end, in addition to the valve specified in the Accessories for the main tank. The conservator or expansion tank shall also have a shutoff valve and a small drain valve and sampling cock, the latter so arranged as not to interfere with oil lines. The oil level gauges (prismatic and magnetic) shall be mounted on the conservator or expansion tank. The top of the conservator shall have contact with atmosphere through two silica gel breathers to facilitate replacement of breather without having to keep Buchholz relay inoperative. The silica gel breathers shall have Polyurethane Type body & it should be transparent and UV protected.
- iii) Conservator oil preservation bag (at moseal bag) shall be provided with a design such that it can be installed at site with ease without any special tools and tackles. The price for COPS bag shall be clearly mentioned in the price schedule at the specified place. With COPS type conservator shall supply air or nitrogen filling arrangement with all accessories needed at the time of commission and pressure gauge arrangement shall be provided for monitoring COPS bag pressure.
- iv) Proper valve arrangement (Two top valve & one bottom valve on conservator) is to be provided for proper oil filling.
- v) Prismatic oil level indicators with red color float shall be provided on main tank and OLTC tank Conservator. Dual contacts are required for both MOGs (Main Tank & OLTC conservator).

Separate conservator tank shall be provided for OLTC. 120L tank shall be used for 66KV.

vi) **Pressure Relief Device.**

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contact shall be provided for alarm and tripping.

vii) **Buchholz Relay**

A double float type Buchholz relay shall be provided with reed switch. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contracts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

viii) **Temperature Indicator**

a) **Oil Temperature Indicator (OTI)**

The transformers shall be provided with a micro switch contact type thermometer with 150 mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be $\pm 1\%$ or better. One No electrical contact capable of operating at 5 A ac at 230 volt supply.

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b) Winding Temperature indicator (WTI)

A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following.

- i) Temperature sensing element.
- ii) Image Coil.
- iii) Micro switch contacts.
- iv) Auxiliary CTS, if required to match the image coil, shall be furnished and mounted in the local control panel.
- v) 150mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and on for trip.
- vi) Two number electrical contact each capable of operating at 5 Ac at 230 Volt supply.

7.10.3 Oil Preservation Equipment

7.10.3.1 Oil Sealing

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

- i) Passage of air is through a dust filter & Silica gel.
- ii) Silica gel is isolate from atmosphere by an oil seal.
- iii) Moisture absorption indicated by a change in color of the crystals of the silica gel can be easily observed from adistance.
- iv) Breather is mounted not more than 1400 mm above rail top level.

7.11 MARSHALLINGBOX

- i) Sheet steel, weather, vermin and dust proof marshaling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, water- tight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshaling box. The degree of protection shall be IP-55 or better.
- ii) The schematic diagram of the circuitry inside the marshaling box be prepared and fixed inside the door under a propone sheet.
- iii) The marshaling box shall accommodate the following equipment:
 - a) Temperature indicators.
 - b) Terminal blocks and gland plates for incoming and outgoing cables.

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All the above equipment except c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door(s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

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

7.12 TAP CHANGER

7.12.1 OFF-LOAD TAP-CHANGERS (For 3.15 MVA transformers)

- i) The transformers shall be provided with Off-load Taps.
- ii) The Transformer with off-load tap changing gear shall have taps ranging from +5% to -15% in 8 equal steps of 2.5% each on HV winding for voltage variation.
- iii) The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with locking arrangement along with tap position indication, thus enabling the switch to be locked in position.

7.12.2 ON-LOAD TAP-CHANGERS

- i) The 5/8/10 MVA transformers shall be provided with On-load Taps. Specification of OLTC is attached herewith as Annexure.
- ii) The Transformer with off-load tap changing gear shall have taps ranging from +5% to -15% in 9 equal steps of 2.5% each for Off Load Tap.
- iii) The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with locking arrangement along with tap position indication, thus enabling the switch to be locked in position
- iv) The tapping range of On Load Tap Changer shall be +5% to -15% in steps of 1.25% each. The no of taps shall be 17. The On Load Tap Changer shall be supplied with RTCC panel and AVR (Automatic Voltage Regulating Relay)
- v) The Continuous current rating of the tap changer shall be based on connected winding rating and shall have liberal and ample margin. Lower rated tap changers connected in parallel are not acceptable.
- vi) The on-load tap changing equipment shall have the provision for mechanical and electrical control from a local position and electrical control from a remote position. For local mechanical operation

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the operating handle shall be brought outside the tank for operation from floor level with provision to lock the handle in each tap position. Remote electrical operation shall have an AUTO-MANUAL selection at the remote location. When selected AUTO, the tap changing gear shall maintain steady voltage within practical limit on the transformers secondary bus from which the reference shall not respond to transient variation of voltage due to grid disturbance and system fault.

- vii) The required voltage relay shall not be sensitive to frequency variation and shall be suitable for sensing voltage from the secondary of potential transformers mounted on the 33KV, or 11KV bus.
- viii) The tap changer shall be provided with over-current protection in order to prevent the tap- change operation during a short circuit, which would to greatly stress the contacts of the diverter switch. The function of protection shall be arranged as follows;
- (i) Whenever over current occurs, the control circuit for commanding OLTC motor operation shall be blocked by the normally close contacts of the over current relays.
 - (ii) If during tap change over current occurs, the OLTC motor circuit shall be blocked through the mechanical cam switch, which is close from the very beginning to the very end of every tap change operation and to the normally open contacts of the over current relays. The stop action of the motor shall be made through the motor brake contactor.
 - (iii) The design of the tap changing equipment shall be such that the mechanism will not stop in any intermediate position; however, if the mechanism through faulty operation does stop in an intermediate position, the full load must be carried by the transformer without injury to the equipment. The mechanical position indicator shall be equipped in the motor drive cubicle. The motor shall be designed to be of step control. In any case the operation shall be of step by step.
 - (iv) The voltage regulating relay shall be supplied together with the timer and under voltage relay. The signal order from the voltage regulating relay to execute the tap changer operation, when the regulating voltage is out of the voltage regulating level shall be designed to be delayed by the adjustable timer. If the control voltage abnormally falls, the movement of the tap changer shall be locked by the contact of the under voltage relay, even if the contacts of the voltage regulating relay are working.
 - (v) The control circuit of the transformer shall be completely designed and provisions shall be made for parallel operation with another transformer.
 - (vi) The following accessories, control and selector switches and other necessary accessories shall be furnished.

Remote tap changer control board (Placed in the control room)

- Voltmeter
- "AUTO-MANUAL" control switch
- "RAISE-LOWER" control switch
- Tap position indicator
- Tap changer operation program indicator.

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Transformer Tap Changer driving mechanism control cubicle

- “REMOTE-LOCAL-TEST” selector switch
- “AUTOMATIC-MANUAL” control switch
- “RAISE-LOWER” control switch
- Tap position indicator
- Tap changer operation program indicator
- Voltmeter
- Tap change operation counter
- Means for manual operation when power supply is lost

1. OLTC shall have the entire feature to meet the requirement. The equipment shall conform to the latest applicable Indian standard / IEC standard. Equipment complying with any other authoritative standards such as British, VDE etc. shall also be considered if offered.
2. The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded i.e. 120% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.
3. When a tap change has been commenced it shall be completed independently of the operation of the control relays and switches. Necessary safeguards shall be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.
4. OLTC shall be a separate compartment & should be external to transformer tank. Oil in compartments which contain the making and breaking contacts of the OLTC shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. A OSR with shut off valves and MOG shall be installed between OLTC and conservator tank. The OLTC conservator shall be provided with prismatic oil level gauges with red color float. The length and alignment of the MOG and OSR pipe shall be such that, the transformer does not trip by the vibration of the pipe.
5. Oil in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head through valve pipe connections. Any gas leaving these compartments shall pass through the OSR relay before entering the conservator. The cable entry of OSR should be from bottom end instead from side
6. Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasket and bolted cover with lifting handles.
7. The OLTC motor shall be provided with 415 V auto changeover facilities. For the control of OLTC, Tap change control relay (A-Eberle make) shall be provided by purchaser. Tap position indication along with the various alarms of tap changer shall be indicated in the marshaling box.
8. Separate OLTC tank should be provided at a height lower than that of the main conservator tank so that the same is easily accessible for maintenance.

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9. OLTC driving mechanism and its associated control equipment shall be mounted in an outdoor, weather proof cabinet, which shall include:
- Driving motor(415V-3phase, 50Hz, AC squirrel cage)
 - Motor starting contactor with thermal over load relays, isolating switch and HRC fuses.
 - Duplicate sources of power supply with automatic change over from the running source to the standby source and vice versa.
 - End Limit Switch shall be provided to prevent operation beyond extreme taps & Contacts shall be provided for operation through SCADA.
 - Limit switch to cut off electrical operation on insertion of manual handle (Contacts shall be provided for operation through SCADA).
 - Local / Remote selector switches shall be provided with status indication.
 - Control switch: Raise/off/lower (spring return to normal type). (Contacts shall be provided for operation through SCADA).
 - Remote/local selector switch (maintained contact type). (Contacts shall be provided for operation through SCADA).
 - Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.
 - Limit switches to prevent motor over travel in either direction & final mechanical stops.
 - Brake or clutches to permit only one tap change at a time on manual operation.
 - Emergency manual operating device (hand crank or hand wheel).
 - Electrically inter locked reversing contactors (preferably also mechanically interlocked).
 - 240V, 50HZ, AC space heaters with switch and MCB.
 - Interior lighting fixture with lamp door switch and MCB.
 - Gasketed and hinged door with locking arrangement.
 - Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
 - Necessary relays, contactors, current transformers etc.
 - Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, fuses etc. shall be mounted in local OLTC control cabinet and shall be clearly marked for the purpose of identification.
 - A five digit counter shall be fitted to the tap changing equipment to indicate the number of operation completed.
 - The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches which may be required for remote tap position indication.'
 - Operation from the local or remote control switch shall cause one tap movement only until the control switch is returned to the off position between successive operations.
 - OLTC shall be provided with PRV.

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- Suitable manholes covers should be provided on the side walls to give access to the selector switches of the OLTC. There should be ample access for opening /Reconnecting tap-leads to the OLTC from all sides.
- Suitable valves shall be provided to take sample of oil from the OLTC chamber during operation of the transformer.

10. Control Requirements for OLTC-

The following electrical control features shall be provided:

- Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
- Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.
- Cut-off of electrical control when manual control is resorted to. It shall not be possible to operate the electric drive when the manual operating gear is in the use.
- Cut-off of acounter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
- Cut-off of electrical control when it tends to operate the tap beyond its extreme position. Mechanical limit switches shall be provided for this purpose to achieve suitable interlocking.

11. Automatic / Parallel Operation with OLTC

OLTC shall be able to do automatic / parallel operations through Transformer Monitoring Unit (TMU).

12. Alarms-

The following alarms shall be provided with the additional contact arrangement for connection to SCADA.

- End Limit Switch
- Manual Operation Insertion
- A.C. supply failure
- Drive motor auto tripped
- Tap Stuck up change delayed
- OSR trip
- MOG Alarms
- PRV Trip
- TC in Progress.
- Any other protective feature, if considered essential by the Bidder.

13. Tap Changer Control and Transformer Monitoring Unit (TMU) is not to be supplied by the bidder of the Transformer.

14. Auxiliary Power Supply of OLTC, Cooler Control and Power Circuit:

- Two auxiliary power supplies, 415 volt, three phase four wire shall be provided by the Purchaser for OLTC and power circuit.

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- ii. All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the marshalling box for on load tap changer control and cooler circuits.
- iii. Design features of the transfer switch shall include the following:
 - a) Provision for the selection of one of the feeder as normal source and other as standby.
 - b) Upon failure of the normal source, the load shall be automatically transferred after an adjustable time delay to standby sources.
 - c) Indication to be provided at marshalling box for failure of normal source and for transfer to standby source and also for failure to transfer.
 - d) Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.
 - e) Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

15. Manual Control

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing at ground level.

The mechanism shall be complete with the following :

- a) Mechanical tap position indicator which shall be clearly visible from near the transformer.
- b) A mechanical operation counter.
- c) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.
- d) The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operating mechanism shall be able to show the direction of operation for raising the HV terminal voltage and vice-versa.

1. Bushings provided by the bidder shall be as per IS2099-1986. The bushings shall have high factors of safety against leakage to ground and shall be so located as to provide adequate electrical clearance between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size and all external current carrying contact surfaces shall be plated, adequately. The insulation class of the high voltage neutral bushing shall be properly co-ordinate with the insulation class of the neutral of the high voltage winding.
2. All main winding leads shall be brought out through outdoor type bushings as specified which shall be so located that the full flashover strength will be utilized and the adequate phase clearance shall be realized.
3. Each bushing shall be so coordinated with the transformer insulation that all flash-over will occur outside the tank.
4. All porcelain used in bushings shall be of the wet process, homogeneous and free from cavities or other flaws. The insulation (porcelain) shall be without any joint up to 145kV class. The glazing shall be uniform in colour and free from blisters, burns and other defects. Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.

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5. All oil filled bushing shall be provided with prismatic type oil gauge with red colored float inside the gauge for oil level indication. The oil gauge glass shall be so designed that it shall give satisfactory service (without melting/cracking or bulging) at specified site conditions, throughout the life of transformer/bushing. It shall not turn opaque during the service.
6. In case of oil communicating type bushing (for 33 KV & 11 KV), venting screw of the hollow stud, shall be provided with Teflon gaskets, to avoid oil leakage problem through the same. Angle of inclination to vertical for any bushing shall not exceed 30 deg. All bushings shall have puncture strength greater than the dry flash-overvalue.
7. Main terminals shall be solder less terminals, and shall be of the type and size specified in the drawings. The spacing between the bushings must be adequate to prevent flashover between phases under all conditions of operation.
8. The Bidder shall give the guaranteed withstand voltages for the above and also furnish a calibration curve with different settings of the co-ordination gap, to the purchaser to decide the actual gap setting. Bidder's recommendations are also invited in this respect.
9. The following routine tests shall be carried out on all bushings in the presence of purchaser's representative, in addition to any other specified in the IS:
 - a) Visual examination
 - b) One minute dry with stand test
 - c) Oil tight ness test
10. The bushings shall have a link type isolating facility for tap for maintenance tests viz. power factor measurement etc. (Terminal shall be provided for the measurement of power factor and tan delta).

7.13.2 Gaskets

1. All bolted connection to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions. Gaskets shall be of rubber/Nitrate.
2. Special attention shall be given to the methods of making the oil-tight joints between the tank and the cover as also between the cover and the bushings and all other outlets to ensure that the joints can be remade satisfactorily and with ease, with the help of semi-skilled labor.
3. Where compressible gaskets are used, steps shall be provided to prevent over compression.
4. All the bolts provided shall be of hot dip galvanized.
5. All bolts shall be provided with one spring washer and two numbers of flat washers and with locking bolts.

All gasket joints shall be provided with equalizing links to extend earth connections.

7.13.3 Radiators

1. The radiators of cooler units shall be epoxy painted the entire surface including edges should be cleaned properly before painting to avoid peeling of paint at the edges.
2. Radiators shall be metal spray painted.

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3. Bidder shall submit procedure for surface preparation and painting/galvanizing of radiators along with the bid.
4. Price for galvanized radiators shall be quoted separately.
5. The color shade for the radiator shall be shade 631 as per IS:5.
6. Tank mounted radiators/coolers shall be of the detachable type with bolted and gasketed flanged connections.
7. The following accessories shall be provided for radiator:
 - a) Shut off valves and blanking plates on transformer tank at each point of connection.
 - b) Top and bottom shut off valves and blanking plates on each radiator.
 - c) Lifting lugs
 - d) Top oil filling plug.
 - e) Air release plug at top.
 - f) Oil drain plug at bottom.
 - g) Top oil filling pump.
8. All radiators shall be tested for:
 - a) Vacuum test for one hour
 - b) Hydraulic pressure test using transformer oil for one and half hour (as per ASME)
 - c) Air test can be done in place of hydraulic pressure test provided.
 - d) Water tank will be made available for submerging the radiators in to water for leak detection.
 - e) All the tests shall be done in black condition (i.e. before applying any paint).
9. The transformer design shall be such that the radiators and conservator can be mounted on either side of the tank.

7.13.4 Cooling equipment and its control

1. Expansion joint shall be provided, one each on top and bottom cooler pipe connections. Air release device and oil plug shall be provided on oil pipe connections.
2. Drain valves shall be provided in order that each section of pipe work can be drained independently
3. Anodized aluminum plate showing details of all terminals nos. & drawing shall be provided along with marshalling box.
4. Wiring from the current transformers and other control and alarm equipment shall be carried out in conduits or alternatively in concealed trays and terminated in marshalling box.
5. All terminal blocks for WTI, OTI etc. shall be of disconnecting type. Terminal blocks for short circuiting the current transformer shall be provided separate from the terminal blocks accommodating the control and indicating circuits. The direct and alternating current terminals shall be isolated from each other.
6. All tapings of all CTs shall be brought to terminals in the marshalling box. The terminals for the current transformer leads shall be suitable for accommodating , 6 sq.mm cable leads, with disconnecting type

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links, while the terminals for the control and other circuits shall be suitable for accommodating 4 sq.mm. cable leads. All wires shall be stranded copper, 1.1kV grade insulation, fire resistant and shall be of reputed make. A minimum of ten spare terminals for control wiring shall be provided.

7. Suitably rated switches shall be provided to enable the control supply to the transformer to be cut off from the cabinet.
8. Enough Space shall be provided at the bottom of the operating cabinet to mount the Purchaser's control cables double compression type glands. The number and size of the cable glands shall be intimated later. All terminal blocks for control shall be rated for 10Amps.
9. Wire and cable bunching rods shall be provided on all terminal blocks on either side. The wire terminals shall be engraved or otherwise indelibly marked ferrules and the wires shall be color coded.
10. All terminal blocks shall have terminal nos. on either side of terminals.
11. Stud type fuse mounts shall be provided with an insulating cover as protection against accidental contact with live terminals.
12. Drawing pouch with cooler control scheme drawings and TB Schedule covered in the polythene paper shall be provided inside marshalling box on the door.
13. Additional 230V, 15Amps, 3 pin plug point shall be provided for testing purposes inside the marshalling box.
14. A suitably rated light point with its associated control switches shall be provided inside the housing for use in emergency.
15. All alarm and control devices shall be ungrounded.
16. Bidder shall furnish a list of the relays, control switches, timers, and other accessories like Bidder, bushing, MOG etc. indicating the make, type, auxiliary supply requirements, contact rating etc. along with quotation.
17. The make of devices shall be subject to approval by purchaser, after finalization of order. The bidder shall furnish O&M manual for all the auxiliary equipment's.
18. Asinglemetal-enclosed main isolating switch, with HRC fuses, shall be provided for the cooling plant.
19. The contactors, starters and relays provided in the marshalling box shall be reputed make such as Siemens, L&T, ABB or equivalent make as per purchaser's approval.
20. The switching in or out of the cooling equipment shall be controlled by winding/oil temperature and there shall be provided for automatic switching in or out at predetermined temperature levels which should be capable of adjustment in settings.
21. The local mechanical indication scheme for all annunciation shall be provided in the marshalling box with mechanical target relays/contactors.
22. The following alarm indication shall be provided each with 2NOcontacts.
 - i. Failure of power supply/control supply.
 - ii. Conservator oil level low (MOG)/ Oil Level High
 - iii. PRD Trip./PRV TRIP
 - iv. Buchholz relay trip / alarm.

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- v. Winding Temperature high.
- vi. Winding Temperature high-high.
- vii. Oil Temperature high.
- viii. Oil Temperature high-high.
- ix. Buchholz/OSR of OLTC trip
- x. OLTC oil level low / OLTC oil level high SPR Trip

7.13.5 Indicating devices

Following lamp indications shall be provided in Marshalling Box:

- a) Control Supply failure.
- b) Common thermal over load trip.
- c) One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of marshalling box cabinet

7.13.6 Valves

1. All valves up to and including 100 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.
 2. Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.
 3. Each valve shall be provided with the indicator to show clearly the position of the valve.
 4. All valves flanges shall have machined faces.
 5. All valves in oil line shall be suitable for continuous operation with transformer oil at 100°C.
 6. The oil sampling point for main tank shall have two identical valves to be put in series. Oil sampling valves shall have provision to fix rubber hose of 10mm size to facilitate oil sampling.
 7. A valve or other suitable means shall be provided to fix the on line dissolved gas monitoring system to facilitate continuous dissolved gas analysis. The location & size of the same shall be finalized during detail engineering stage.
 8. After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint conforming to IS: 2932 and of a shade (preferably red or yellow) distinct and different from that of main tank surface.
 9. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate conforming to IS:2074 followed by two coats of fully glossy finishing paint.
- All hardware used shall be cadmium plated/electro galvanized

7.13.7 Insulation

1. The dielectric strength of the winding insulation and of the bushings shall conform to the values given in IS 2026 (latest version).

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2. For rated system voltage 36 the following impulse test voltage shall be offered. System voltage : 12 KV, 36KV, Impulse Test Voltage: 75 kV,170KV,
3. The transformer shall be capable of operating continuously at its normal rating without exceeding temperature limits as specified below:

	Type of cooling	Temperature rise
Winding	Natural-oil Natural-air cooled (ONAN)	55 deg.C
Oil	All types	45 deg.C

7.13 FITTINGS AND ACCESSORIES

The following fittings and accessories shall be provided on the transformers:

- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.
1. Magnetic type oil level gauge (150 mm dia.) with low oil level alarm contacts. **One magnetic- type oil-level gauge** each in Main Tank and OLTC Tank with low and high level alarm contacts for main tank MOG and low level alarm for OLTC tank MOG and a dial showing minimum, maximum and normal oil levels. The gauge shall be readable from the transformer base level. It should have cable disconnecting facility at top of MOG, to facilitate testing of MOG. Along with MOG, prismatic type oil level indicator (glass window) shall also be provided on conservator.

MOG technical parameters should be according to the below mentioned specifications.

General Technical Requirements for MOG:			
S No	DESCRIPTION	UNITS	
1	Mounting Pad Diameter	Mm	150
2	Electric Switch		Two no's Micro Switches
3	Contact Rating		5 Amps 240V AC, 0.25 Amp 24V DC.
4	Switch Operation		Normally open, closes when oil level drops to near empty condition. Switch recovers automatically on rising of oil level
5	Mounting of indicator		Vertical
6	Dial Marking		Maximum, Minimum, 1/4, 1/2 & 3/4
7	Movement of float Arm		In the plane perpendicular to seating face
8	Conservator Dia	mm	900 mm

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9	Air cell in conservator		Yes
10	Switches for		Low Oil level Alarm, High oil level Alarm.
11	Color		Black marking with white/yellow background.
12	Readable from Transformer base level		Yes
13	Cable disconnecting facility at top of MOG to facilitate testing of MOG		Yes
14	Mechanical Protection degree		IP55
15	Suitable for transformer rating	MVA	
16	Packing		Supplier shall ensure that the equipment covered by this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner so as to protect the equipment from damage in transit.
17	Marking		The unit shall be appropriately marked as "P PROPERTY OF TPNODL, BALASORE" and with the name of the vendor, Manufacturer type/serial no. , and year of manufacturing at suitable location.
18	Warranty		2 years from the date of purchase. In case any defects are found, the vendor shall replace the product free of cost.
19	Test Reports		Test certificates to be provided : 1) Specified levels. 2) Switch operation 3) HV Test 4) Leakage Test 5) Insulation Test
20	Acceptance test		Following tests shall be carried out: 1) Specified levels 2) Switch operation 3) HV Test 4) Leakage Test 5) Insulation Test

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2. One oil filling valve(inlet)
 3. One oil drain valve
 4. One filter valve located at the top of the tank on the HV side.
 5. Oil sampling valves.
- ii) Prismatic/ toughened glass oil level gauge.
- iii) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
- iv) **One double float gas detector relay (Buchholz relay)** with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressure complete with shut off valves between Relay and Conservator Tank flange-couplings to permit easy removal without lowering oil level in the maintank, a bleed valve for gas venting and test valve. The installation shall be weather proof to avoid any water seepage inside the relay. The cable entry should be from bottom end of Buchholz relay instead from side.
- v) **Buchholz relays:** should be according to the following general technical parameters as mentioned in below table.

S.No.	Description	Unit	Requirements
1	Type of relay		Magnetic reed switch type Buchholz relays suitable for nominal pipe bore of 80 mm with 2 sets of potential free contacts suitable for 24V to 48VDC.
2	No. of Switching systems		2
3	Suitable for Transformer Rating	MVA	above 10
4	Nominal Pipe Bore	mm	80
5	Type of Flange		Round
6	Diameter of flange	mm	185
7	Diameter of bolt circle	mm	145
8	Number of the bolts		4
9	Size of the bolts		M16

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10	Flange Thickness	mm	16
11	Surge Test (TRIP)	cm/s	90 to 160
12	Gas Volume (ALARM)	cc	200 to 300
13	Velocity Test	cm/s	90 to 160
14	Relay range: Oil operating Temperature		10°C to 100°C
15	Relay operating Viscosity range: Oil		65 to 75 centistokes at 10°C, 2 to 3.5 centistokes at 100°C
16	Element Test		With oil, at 1.75Kg/cm ² for 15 minutes,
17	High Voltage Test		Shall be able to withstand 2000 V at 50 Hz for 1 minute
18	Insulation Resistance Test		Shall be Greater than 10 Mega ohms with 500 V megger
19	Porosity Test		With oil, at 1.5 kg/cm ² for 4 hours - There shall not be any leakage or mechanical damage
20	Mechanical Strength Test		With oil at 8 kg/cm ² for 1 minute
21	Resistance of the Switch		Not to exceed 0.1 ohm across the electrodes of magnetic switch
22	Cable entry in terminal box		From bottom side

- vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.

Pressure relief device

- Spring-loaded Pressure Relief Device (PRV) with mechanical flag indicator shall be provided on the main tank top of the transformer.
- Oil splashguard along with draining arrangement (with wire net on both side) up to ground level to be provided for prevention of oil splashing.
- Arrangement for air-release through a gate valve should be provided at the base of the PRV.
- The PRV shall not be located in the vicinity of the Marshalling Box or OLTC Box for safety of operating personnel.

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- e). A pair of potential free contacts shall be provided to trip the transformer on action of the pressure relief device.
- f). It shall have the limit switch with 2NO and 2NC contacts, flag, switch operated rod etc.
- g). PRV shall be tested for all the applicable test such as Leakage Test, Switch operation, break down test.
- vii) Air release plugs in the top cover.
- viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
- ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding Temperature Indicator (WTI) in one winding of each phase as described below:
- a) It 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.
- b) The winding temperature detector shall operate a remote alarm in the event the hottest spot temperature approaches a dangerous level and in the case of ONAN (Oil Natural and Air Natural) Thus WTI shall have 4 independent NO contacts for alarm and trip and cooler control.
- x) Equipment for remote winding and oil temperature Indicators including these to be installed in the Purchaser's control room shall be provided. Pocket with heater coil and CT for RTD for winding hot spots shall be provided.
- xi) **For purpose of remote recording and data acquisition system** Top oil temperature detector along with suitable transducer and other necessary devices to provide two sets of 4- 20 mA signals with PT-100 type of sensors. Winding temperature indicator shall have two set of contacts to operate at different settings:
- a) To provide winding temperature high alarm
- b) To provide temperature too high trip
- xii) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.
- xiii) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xiv) Jacking pads
- xv) Haulage lugs.
- xvi) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xvii) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xviii) Top and bottom sampling valves.
- xix) Drain valve with pad locking arrangement
- xx) Rating and connection diagram plate.
- xxi) Two numbers tank earthing terminals with associated nuts and bolts for connections to Employer's grounding strip.
- xxii) Marshaling Box(MB)

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- xxiii) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxiv) Cooling Accessories:
- Requisite number of radiators provided with:-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top
 - Drain and sampling device at bottom
 - Lifting lugs.
 - Air release device and oil drain plug on oil pipe connectors:
- xxv) Terminal marking plates for Current Transformer and Main Transformer
- xxvi) On Load Tap changer as per BOQ
- xxvii) Oil Preservation Equipment
- Oil Temperature indicator. A dial-type indicating thermometer of robust pattern mounted on the side of the transformer at a convenient height to read the temperature in the hottest part of the oil and fitted with alarm and trip contacts and contacts for switching in and switching out the cooling system at predetermined temperatures.
 - Tap changer indicator of OLTC along with suitable transducer and other necessary devices to provide two sets of 4-20 mA signals along with one set of 1-16K resistance output shall be provided.
 - All digital outputs for remote annunciation/control/DAS shall be provided with two changeover (NO) contacts for alarm condition and two changeover (NO) contacts for trip condition. The OTI & WTI shall be provided with micro switches, instead of mercury switches for alarm and trip purpose. All the interconnected wiring between TJB, Marshalling box and OLTC etc. shall be done by the bidder and schematics drawings of the same shall be supplied.
 - Oil Surge Relay** should be according to the following general technical parameters as mentioned in below table.

S. No.	Description	Unit	Requirements
1	Type of relay		Magnetic reed switch type OSR suitable for 25mm nominal pipe bore with 1 set of potential free contact to be used for 24 to 48V
2	No. of Switching systems		1
3	Suitable for		OLTC
4	Nominal Pipe Bore	mm	25
5	Type of Flange		Square
6	Diameter of flange	mm	78 square
7	Diameter of bolt circle	mm	72
8	Number of the bolts		4

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9	Size of the bolts		M10
10	Flange Thickness	mm	6 mm
11	Surge Test (TRIP)	cm/s	70 to 130
12	Velocity Test	cm/s	70 to 130
13	Relay operating range: Oil Temperature		10°C to 100°C
14	Relay operating range: Oil Viscosity		66 to 75 centistokes at 10°C, 2 to 3.5 centistokes at 100°C
15	Element Test		With oil, at 1.75Kg/cm ² for 15 minutes,
16	High Voltage Test		Shall be able to withstand 2000 V at 50 Hz for 1 minute
17	Insulation Resistance Test		Shall be Greater than 10 Mega ohms with 500 V megger
18	Porosity Test		With oil, at 1.5 kg/cm ² for 4 hours - There shall not be any leakage or mechanical damage
19	Mechanical Strength Test		With oil at 8 kg/cm ² for 1 minute
20	Resistance of the Switch		Not to exceed 0.1 ohm across the electrodes of magnetic switch
22	Cable entry in terminal box		From bottom side

- xxviii) Transformer shall be supplied with all control cable, WTI & OTI, sensing cable, glands, lugs etc (complete control).
- xxix) Oil Preserving Equipment
- xxx) Eye bolts and lugs on all parts for ease of handling.
- xxxi) Two grounding terminals.
- xxxii) Diagram and rating plate.
- xxxiii) One set of equipment for control, protection, indication and annunciation for each transformer comprising motor contactors, detecting elements or devices, indicating apparatus instruments, relay, annunciators, etc.
- xxxiv) Separate tank mounted marshalling box for terminal blocks for current transformer secondary only with Cable conduits for cables from devices to marshalling box.

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- xxxv) Provision shall be made for installing resistance temperature detectors for temperature recording instruments arranged separately for the following:
- Hot oil
 - Winding hotspot
- xxxvi) Two silica gel breathers (more than 5kg) each of 100% capacity for main tank.
- xxxvii) Ladder with ant-climbing arrangement and lock. Ladder should mount on side of transformer and not on HV/ LV side bushing.
- xxxviii) Inspection covers for transformer inspections on all phases (on vertical plane)
- xxxix) The equipment and accessories furnished with the transformer shall be suitably mounted on the transformer for ease of operation, inspection and maintenance, and the mounting details shall be subject to the approval of the purchaser. All valves shall be provided either with blind companion flanges or with pipe plugs, for protection. All valves shall have open/close position clearly marked.

Indication, alarm and relay equipment shall have contacts suitable for operation with 24/48V Volts DC supply. Any other accessories or appliances recommended by the Bidder for the satisfactory operation of the transformers shall be supplied

Note:

- The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.

The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

ANTI RUSTING/ CORROSION TREATMENT

- The bidder shall ensure that all fabrication i.e. transformer tank, radiators, marshalling boxes and other accessories are treated for highest quality performance for the entire life of the transformer. The Bidder shall submit plan for extra measures he is taking for prevention of corrosion, along with the offer.
- Finishes on transformer and appurtenant parts, edges (exposed to atmosphere)
- NO GAS CUT EDGE OR SURFACE shall be acceptable unless smoothly ground to plane surface without irregular projections and corners (which cannot be blasted to the required roughness).
- For all radiators the following painting procedure shall be followed. The metal spray (99.95% assay zinc) to a thickness about 100 microns with surface roughening and two coats of paints with proper supervision and quality checks. Bidder shall indicate separate price for metal spray of radiators.
- In this corrosion prevention measure it is imperative that the job is fully monitored for optimizing the proper conduct of the procedure as given in the various national standards. The coating shall be as per BS: 2569 (latest revision). The coating requirement shall be to BS: 5493 Gr. SC10Z.

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6. The Bidder shall submit a Quality Plan, giving the parameters and checking methods, (major, critical, minor).
7. The paint shade used shall be shade 631 as per IS:5.

The following shall be the check points for the metal spray of Radiators:-

- a) Metal Spray
- b) Surface preparation
- c) Chemical analysis of actual material used for spray (batch wise identification).
- d) Coating Process (the first trial job will be witnessed to see if the written procedure is followed).
- e) Coating thickness test, adhesion test as per BS.
- f) Repair area classification major or minor and accordingly the repair from blasting onwards otherwise.

Bidder may quote for galvanized radiators instead of metal spray radiators as an alternative.

Centre of Gravity

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

CENTRAL LINE MARKING

Central line of the transformer, tank, cooler bank, cable box etc. shall be marked properly with indication to avoid any confusion during installation of the transformer

Painting

1. Before painting, surface preparation shall be done by sand blasting and procedure for sand blasting has to be submitted by the Vendor along with the bid. The surface preparation for all external surface prior to painting or coating shall be witnessed by customer or shall be treated as customer hold points. After sand blasting at all edges Belzona E metal to be applied.
2. Before shipment all steel work not under oil shall be painted with a primary coat of anti-corrosive paint of durable nature and two coats of battleship grey paint (Shade 631 of IS: 5). Paint shall be epoxy type. The interior surfaces shall be painted as per bidder's standard practice. All the paint including primer shall be applied after testing such as air test, hydraulic test etc. Bidder shall submit their procedure for painting for Purchaser's approval, along with the offer.
3. Painting of Marshalling box: Two coats of red oxide primer & two coats of synthetic enameled paint after chemical treatment.
4. Metal parts not accessible for painting shall be made of corrosion resistant material.
5. Paint shall be as per Indian Standard/International Standard for quality, surface preparation, application method, thickness check and any other test.

Additional paint shall be supplied along with the transformer for applying touch up paint at site during installation. The shade of the paint used shall be shade 631 as per IS: 5

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NITROGEN INJECTION DRAIN AND STIR SYSTEM

1. Fire prevention and extinguishing system shall work on the oil drain, nitrogen injection and stir method. The system shall operate during internal fault in transformer or external fire on transformer, which includes fire due to bursting of transformer bushing and Fire in OLTC tank.
2. Fire detector provided on the transformer shall take minimum time for detection of fire and initiate the fire protection system on receipt of other required signals.
3. System shall operate on station’s DC auxiliary supply (24/48VDC). The system shall be capable of working in Auto/Remote Electrical/Local manual modes.
4. Provision shall be available to keep the system “ISOLATED” / “OUT OF SERVICE” which is necessary for preventing any mal-operation during transformer maintenance.
5. The protection system shall be compatible of being hooked on to the SCADA or fire alarm system. Suitable spare contacts shall be made available for operation of fire system. System using PLC shall be only considered.
6. Fire protection system shall operate in Auto mode under two logic:
 - a. In Transformer Explosion prevention Logic it shall operate on receipt of minimum three positive feedback signals, namely differential relay, pressure relief valve or rapid pressure rise relay or Buchholz relay and electrical isolation of transformer through master trip relay or HV & LV circuit breaker in series to avoid any mal-operation of system.
 - b. In Transformer Fire Prevention logic, Fire protection system shall operate in Auto mode on receipt of minimum three positive feedback signals, namely fire detector, pressure relief valve or rapid pressure rise relay or Buchholz relay / OSR (in case of fire in OLTC and electrical isolation of transformer through master trip relay or HV & LV circuit breaker in series to avoid any mal-operation of system.
 - c. Provision shall be made in system so that any of the above two logic can be disabled by operator from local panel only.
 - d. Supply and installation of Rapid Pressure Rise Relay shall be in the scope of the bidder.
7. Fire protection system shall operate in Remote electrical mode on receipt of signal for electrical isolation of transformer and by operating switch provided in a box which shall be accessible only after breaking the glass cover on control panel.
8. The Local manual operating system shall be used only in case if the system fails in Auto mode/ Remote electrical mode/ power failure. System if kept in manual mode must be clearly visible by a different alarm /LED.
9. The system shall start operation in auto or remote electrical or local manual, initially draining a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and simultaneously closing Isolation valve in the conservator line and then inject nitrogen gas with appropriate flow rate at high pressure from lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

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10. Isolation valve in the conservator line shall operate mechanically on transformer oil flow rate with electrical signal for monitoring on control panel. However in case of bursting of transformer bushing conservator oil should be isolated from main transformer tank without any additional signal to operate isolation valve.
11. Provision shall be available so that in case of accidental leakage of Nitrogen, the same should not affect the operation of Transformer.
- 6 The system shall have built in facility for monitoring or display of the following.
- Open /Close status of valves.
 - Healthiness of all sensors.
 - Operation of PRV
 - Healthiness of control cable
 - Healthiness of control supply
- 7 Provision shall be available for annunciation (along with audible alarm) and a mimic panel of the following.
- Detection of fire due to external causes
 - Low nitrogen pressure.
 - System initiated
 - Tank pressure beyond the set limit
 - Operating signal cable faulty.
 - Operation of conservator isolation valve(PNRV)
 - Supply failure.
12. However bidder shall confirm whether it is advisable to initiate the system even when transformer is not electrically isolated due to stuck breaker problem etc.
13. The system shall have built-in-on-line testing facility, which will be operable without affecting the functioning of the transformer.
14. All valves used in system shall be stainless steel ball / butterfly type and of Legris make or equivalent as per the purchaser's approval. Limit switches shall be provided wherever required.
15. The connecting cables shall be fire retardant low smoke (FRLS) armored cable. Cables passing along the top of the transformer shall be the fire survival (FS) type.
16. The Pipe Line used for the system shall be of Class 'C' type.
17. All the hardware used in the system shall be stainless steel.
18. Limit switches used in the panel shall be of Schmersal make or equivalent as per the purchaser's approval.
19. Control cable gland used in system shall be of Lapp, Germany make or equivalent as per the purchaser's approval.
20. Fire extinguishing cubicle shall be of 3mm thick CRCA sheet with PU painting and IP 55 enclosure protection class and shall accommodate nitrogen gas cylinder of adequate capacity and associated accessories like regulator, high pressure tubing etc.

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21. The remote control panel, to be mounted inside the control room shall accommodate the necessary control units, operating switches push buttons etc. and also alarm annunciation unit.
22. The bidder shall, furnish the complete details including bill of materials of the fire prevention and extinguishing system offered. The list of all accessories including FRLS, fire survival cable, pipes, valves, sensors, control cubicle, nitrogen gas cylinder etc. shall be listed out and furnished in the offer.
23. The bidder shall ensure that fire prevention and extinguishing system offered is full proof and reliable. Installation, testing and commissioning of the fire protection system shall also be in the successful bidder's scope.
24. Bidder shall ensure that fire prevention and extinguishing system shall not affect the normal operation of power transformer.
25. Fire protection scheme to the power transformer should have authentic certification regarding performance similar to one issued by LAPEM (MEXICO)/TAC/RDSO /any other approved standard laboratory.
26. Similar units offered by bidder shall be in successful operation for a minimum period of two years.
27. The bidder shall also furnish performance certificate for similar systems in proof of the satisfactory operation.
28. NIDS is to be supplied with transformer unless specified elsewhere in the Bidding document.
29. In All conditions Transformer shall have provision for future implementation of NIDS. In any condition OEM (PTR) guarantee shall remain the same as mentioned in "Guarantee" clause

Surface preparation and painting

1. The paint shall be applied by airless spray.
2. 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 (IS3618).
3. **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) 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 Outside	01 01	30 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 glossy and non-fading paint of shade 631 as per IS 5 or RAL 7032.

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4. The dry film thickness shall not exceed the specified minimum dry film thickness by more than 25%.
5. 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.
6. Painting shall not be affected by weather changes & performance against pilling out or fading etc. to be guaranteed for 5 Years.

Name plate and marking

1. A stainless steel rating plate, of at least 1 mm thickness, shall be fitted to each transformer in a visible position and shall carry all the information as specified in the standards.
2. The letters on the rating plate shall be engraved black on the white/silver background.
3. Fixing screws for outdoor use shall be of stainless steel or any other corrosion resistant metals.
4. The Name plate shall be embossed with "PO No. with date" & "PROPERTY OF TPNODL".
5. Danger notice shall have red lettering on a white background or they may be pictorial as approved by the Purchaser.

The name plate shall contain following information:

- a) Type of transformer (Two Winding Transformer)
- b) Relevant standard.
- c) Manufacturer's Name
- d) Manufacturer's Serial No.
- e) Year of Manufacture
- f) No. of phases
- g) Rated kVA
- h) Rated frequency
- i) Rated Voltage
- j) Rated current
- k) Connection symbol
- l) Percentage impedance voltage at rated current.
- m) Type of cooling (ONAN).
- n) Total Mass.
- o) Mass and Volume of insulating Oil.
- p) Connection diagram showing the internal connections.
- q) Temperature rise
- r) Insulation levels of the windings, including neutral end of windings with non-uniform insulation.
- s) Transportation weight
- t) Un-tanking weight.

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- u) Core and windings weight
- v) Table giving the tapping voltage, tapping current and tapping power for each tapping.
- w) Values of short circuit impedance on the extreme tapings and on the principal tapping and indication of the winding to which the impedance is related.
- x) A table of all guaranteed particulars.
- y) Quantity of oil required for normal filling.
- z) HV and LV phase to phase clearances.
- aa) Vector diagram
- bb) Indication of the winding which is fitted with tapping.
- cc) Table giving the tapping voltage, the tapping current and the tapping power of each winding, for each tap.
- dd) Value of short circuit impedance on the extreme tapping and on the principal tapping and indication of the winding to which the impedance is related.
- ee) Information of the ability of the transformer to operate at a voltage exceeding 110 % of the tapping voltage or, for the principal tapping, 110 % of the rated voltage

Valve schedule plate

The name plate shall contain information of all the valves, their locations, quantities and schematic for the valves

On load tap changer plate

The name plate shall contain following information:

- a) Type
- b) S.No.
- c) Year of Manufacturing
- d) Motor
 - Operating Voltage
 - Normal Working Current
 - Max. rated Though current
- e) Phase
- f) Frequency(Hz)
- g) Steps(Numbers)
- h) Step Voltage
- i) Weight /Volume
- i. Tap Changer without Oil(Kg)
- ii. Oil(Kg)
- iii. Total
- i) Control Voltage(V)
- j) Transition resistance(ohms)

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Marshalling box

- a) Manufacture's Name.
- b) Manufacture's Serial No.
- c) Year of Manufacturing.
- d) Purchase Order No.

The following shall be clearly mentioned / Engraved on the Plate: "Property of TPNODL, Berhampur" Engraved drawing of control circuit, CT / PT circuit and TB shall be available on Marshalling Box and OLTC Box

Oil filling instruction plate for conservator

The name plate shall contain

- a) Step wise process for filling oil in conservator
- b) Table of fittings with functions
- c) Conservator diagram with oil filling process
- d) Precautions in detail

7.14 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES

- i) Normally no fuses shall be used anywhere instead of fuses MCB's (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.
- ii) All wiring connections, terminal boards, fuses MCB's and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.
- iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.
- iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.
- v) When 400 volt connections are taken through junction boxes or marshaling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshaling box. Proper color code for Red, Yellow, Blue wires shall be followed.
- vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48 strands) of 1100 Volt grade and size not less than 2.5sq.mm
- vii) All wires on panels and all multi-core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.
- viii) At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

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- ix) The same ferrule number shall not be used on wires in different circuits on the same panels.
- x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.
- xi) Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.
- xii) All circuits in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.

Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq. mm where strip is used, the joints shall be sweated. The copper wire shall have green colored insulation for earth connections.
- xiii) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
- xiv) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
- xv) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails.
- xvi) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminals shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.
- xvii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshaling box is included in the scope of this specification and shall be done by the Transformer supplier.
- xviii) The schematic diagram shall be drawn and fixed under a transparent propane sheet on the inner side of the marshaling box cover.
- xix) To avoid condensation in the Marshaling Box, a space heater shall be provided with an MCB and thermostat.
- xx) Suitable MV, CFL light shall be provided in the Marshaling Box for lightning purpose.

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7.15 RADIO INTERFERENCE AND NOISE LEVEL

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimize interference with communication circuits. Transformer noise level when energized at normal voltage and frequency shall be as per NEMA stipulations.

8. INSPECTION AND TESTING

- (i) The Contractor shall carry out a comprehensive inspection and testing program during manufacture of the transformer. This is, however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by the Employer.
- (ii) Transformer of each rating will be as per pre-type tested design.
- (iii) The pre-shipment checks shall also be carried out by the contractor.
- (iv) The requirements on site tests are as listed in the specifications.
- (v) Certified test report and oscillograms shall be furnished to the Employer Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the Employers evaluations of the tests without any extra charges to the Employer. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
- (vi) The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.

8.1 INSPECTION

Transformers not manufactured as per Type- Tested design shall be rejected.

I. Tank and Conservator

- a) Inspection of major weld.
- b) Crack detection of major strength weld seams by dye penetration test.
- c) Check correct dimensions between wheels, demonstrate turning of wheels, through 900 and further dimensional check.
- d) Leakage test of the conservator.

II. Core

- a) Sample testing of core materials for checking specific loss, properties, magnetization characteristics and thickness.
- b) Check on the quality of varnish if used on the stampings.
- c) Check on the amount of burrs.
- d) Visual and dimensional check during assembly stage.
- e) Check on completed core for measurement of iron loss, determination of maximum flux density,
- f) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- g) High voltage DC test (2 KV for one minute) between core and clamps.

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

iii) Insulating Material

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

iv) Winding

- a) Sample check on winding conductor for mechanical and electrical conductivity.
- b) Visual and dimensional checks on conductor for scratches, dent mark etc.
- c) Sample check on insulating paper for PH value, electric strength.
- d) Check for the bonding of the insulating paper with conductor.
- e) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- f) Check for absence of short circuit between parallel strands.

v) Checks Before Drying Process

- a) Check condition of insulation on the conductor and between the windings.
- b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- c) Check insulating distances between low voltage connections and earth and other parts.
- d) Insulating test for core earthing.

vi) Check During Drying Process

- a) Measurement and recording of temperature and drying time during vacuum treatment.
- b) Check for completeness of drying

vii) Assembled Transformer

- a) Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- b) Jacking test on the assembled transformer.

viii) Oil: All standard tests in accordance with IS: 335 shall be carried out on transformer oil sample before filling in the transformer.

ix) Test Report for bought out items: The contractor shall submit the test reports for all bought out / sub contracted items for approval.

- a) Buchholz relay
- b) Sudden pressure rise relay on main tank
- c) Winding temperature indicators
- d) Oil temperature indicators
- e) Bushings
- f) Marshaling box
- g) On/Off Load Tap changer as per BOQ
- h) Any other item required to complete the works.

- i) Porcelain, bushings, winding coolers, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS. If such requirement is purchased by the contractor on a sub-contract, he shall have them tested to comply with these requirements.

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8.2 FACTORY TESTS

- i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.
- ii) All routine, acceptance & type tests shall be carried out in accordance with the relevant IS/IEC. All routine/acceptance tests shall be witnessed by the purchaser/his authorized representative. All the components and fittings shall also be type tested as per the relevant standards. Following tests shall be necessarily conducted on the Power Transformers in addition to others specified in IS/IEC standards. Test for the OLTC shall be done as per the IS8468
- iii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.
- iv) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.
- v) Following additional routine tests shall also be carried out on each transformer:
 - a) Magnetic Circuit Test Each core shall be tested for 1 minute at 2000 Volt AC
 - b) Oil leakage test on transformer

8.2.1 Type Test

8.2.1.1 The measurements and tests should be carried out in accordance with the standard specified in each case as indicated in the following table if the same tests were not conducted earlier at CPRI or any NABL accredited Laboratory on the transformers of the offered design without any cost implication on employer.

8.2.1.2 Transformer type tests

Type Test Standard	
Temperature Rise Test	IEC 76/IS 2026/IS6600
Impulse Voltage Withstand Test, including Full Waves and Chopped Waves as listed below	IEC 76/IS 2026
Noise Level Measurement	IEC 551

- In accordance with IEC 76-3 the following sequence of impulses should have been/ should be applied;
- One full wave at 50%BIL;
- One full wave at 100%BIL;
- One chopped wave at 50%BIL
- Two chopped waves at 100% BIL and
- Two full waves at 100%BIL.

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The type tests to be carried out by the Bidder shall include but not limited to the following:

1. Measurement of winding resistance.
2. Measurement of voltage ratio and check of voltage vector relationship.
3. Measurement of impedance voltage / short-circuit impedance (Principal tapping) and load loss.
4. Measurement of no load loss and current.
5. Measurement of insulation resistance.
6. Dielectric Test.
7. Temperature rise for determining the maximum temperature rise after continuous full load run. The ambient temperature and time should be stated in the test certificate.
8. Tests on on-load tap-changer.
9. Short Circuit with stand test
10. Test to verify IP55 of Marshalling and cable boxes.
11. Lightning Impulse voltage test with chopped wave.

Note: The bidder shall submit the test report from CPRI or ERDA for g, i and k of the above mentioned.

Following type tests shall be carried out on one transformer of each rating, at the works of the bidder, in presence of Purchaser's representative.

1. Temperature rise test including DGA (DGA shall be done before & after the heat run test).
2. Impulse Test (Including chopped wave on all the three limbs of HV & LV).

The NIDS shall be subjected to the operational test at manufacturing works of Nitrogen Injection Fire Prevention and extinguishing system in presence of Purchaser's representative. The manufacturer's test certificates of various accessories of NIDS shall be furnished at the time of inspection to the inspecting officer.

8.2.1.1 If the type test report(s) submitted by the bidder do not fulfill the criteria, as stipulated in this technical specification/ Bidder's offer, the relevant type test(s) has/ have to be conducted by the Bidder at his own cost in CPRI/ NABL accredited laboratory in the presence of employers representative(s) without any financial liability to employer in the event of order placed on him.

The offered transformer must be manufactured as per type tested design. A copy of type test certificate must be submitted by manufacturer to Engineer/Employer. Transformers offered without type tested however design shall not be accepted. In case manufacturer agrees for type testing of transformers, testing shall be conducted on manufacturer's cost. No claim shall be acceptable towards type testing. The transformers shall be accepted only on acceptance of type testing results by employer.

8.2.1.2 The supplier shall furnish calculations in accordance with IS: 2026 to demonstrate the Thermal ability of the transformers to withstand Short Circuit forces.

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8.2.1(A) Special Test

The short circuit test shall be a mandatory test for each design shall be supplied by the manufacturer and no exception shall be allowed. The test shall be conducted as per latest standard tabled below:

Short Circuit Test	IEC 76 / IS2026
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The following tests shall be carried out by mutual agreement between the purchaser and the bidder. All Tests shall be done as per the relevant standard. Test certificates shall be submitted for bought out items. High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

- a) Measurement of the harmonics of the No-Load Current.
- b) Determination of transient voltage transformer characteristics.
- c) Measurement of insulation resistance to earth of the windings, and / or measurement of Dissipation factor ($\tan \delta$) of the insulation system capacitances. (These are reference values for comparison with later measurement in the field. No limitation for the values are given here).
- d) Lightning impulse test on Neutral terminals.
- e) Long duration induced AC voltage test (ACLD) transformer winding $72.5 < U_m \leq 170$ kV.
- f) Magnetic circuit (isolation) test.
- g) SFRA Test.

8.2.2 Stage Inspection

The supplier shall offer the core, windings and tank of each transformer for inspection by the Employers representative(s). During stage Inspection, all the measurements like diameter, window height, leg Centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the Employer.

8.2.3 Routine Tests

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following:

- (i) Measurement of winding DC resistance.
- (ii) Voltage ratio on each tapping and check of voltage vector relationship.
- (iii) Impedance voltage at all tapping's.
- (iv) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.
- (v) Measurement of Load losses at normal tap and extreme taps.
- (vi) No load losses and no load current at rated voltage and rated frequency, also at 25% to 120 % of rated voltage insteps.

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- (vii) Absorption index i.e. insulation resistance for 15 seconds and 60 seconds (R 60/R 15) and polarization index i.e. Insulation Resistance for 10 minutes and one minute (R 10 mt / R 1 mt).
- (viii) Induced over voltage with stand test.
- (ix) Separate source voltage with stand test.
- (x) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (xi) Measurement of zero sequence impedance
- (xii) Tests on On/Off Load Tap changer as per BOQ (fully assembled on transformer) as per IS2026
- (xiii) Auxiliary circuit tests
- (xiv) Oil BDV tests
- (xv) Measurement of neutral unbalance current which shall not exceed 2 % of the full rated current of the transformer.
- (xvi) Magnetic balance test
- (xvii) Leakage test.

Sr. No.	Test to be done	Reference BIS	Clause no.
1	Measurement of Winding Resistance	IS 2026 (Part 1)	16.2.1 & 16.2.3
2	Measurement of voltage ratio, polarity and vector group check	IS 2026 (Part 1)	16.3, 8.6, 8.7
3	Measurement of short impedance 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	Dielectric Test.	IS : 2026 (Part III)-2009	
7	Test on -Load Tap Changer.	IS : 2026-2011 (Part I)	10.8
8	Measurement of Zero-sequence impedance on three phase transformer.	IS : 2026-2011 (Part I)	3.7.3
9	Bushing shall be tested for Capacitance and Power factor and shall meet the manufacture's requirement.	IS : 2026 (Part III)	10
10	All CTs and resistance of image coil for winding temperature indicator shall be checked for ratio test, polarity and knee point voltage test.		

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11	Determination of Capacitances and dissipation factor winding – to - earth and between windings.		
12	Magnetic balance test.		
13	Measurement of Magnetizing current at low Voltage		
14	Vacuum with stand test on tanks And radiators.		
15	The total Losses shall comprise of the No Load Losses, Load Losses (I^2R loss + stray loss) and Auxiliary Losses at rated output duly converted at 75 °C average winding temperature and shall also be indicated in the test report. Load losses shall be that corresponding to rated load on HV, LV windings.		
16	Physical Verification of complete Transformer with all assembly including test rollers, radiators, cable boxes etc.		
17	Voltage Regulation at rated load and at unit, 0.9, 0.8 lagging power factor.		
18	Measurement of Acoustic Noise Level.		
19	Functional tests on auxiliary equipment:-		
	i. Test on OTI and WTI ii. High Voltage test on insulation test for Auxiliary Wiring. iii. High Voltage test on insulation test for Auxiliary Wiring		
20	Test on Oil filled in Transformer: i. Dielectric Strength of Oil ii. Water Content. iii. Dielectric Dissipation factor (tan delta at 90°C. iv. Resistivity		
6	Induced over voltage withstand test	IS 2026 (Part 3)	11
7	Separate Source voltage withstand test	IS 2026 (Part 3)	10
8	Oil Pressure test on completely assembled transformer at 0.35kg/sq.cm. for 8 hrs.	IS 1180 (Part 1)	21.5.1.2 & 21.5.1.3
9	BDV and moisture content of oil in transformer (Type-2oil)	For mineral oil : IS 335 (2018)	For mineral oil: IS 335 Table 2

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Six (6) set of certified test reports and oscillo graphs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and Employers evaluation of the tests without charge to the Employer.

Acceptance Tests

1. 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 TPNODL representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:2026.
2. Oil Leakage test for acceptance shall be conducted at pressure of 0.35kg/sq.cm for one hour as per :IS:2026.
3. Temperature Rise Test (on one unit of first lot against every release order / PO for each rating, for further lots, TPNODL also reserves the right to perform Temperature rise if required) [As per IS 2026 (Part 2) Clauseno.4]
4. The painted surface shall pass the Cross Adhesion Test (IS1180 part 1 clause no.21.4.d).

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.

5. At Final inspection, the incoming raw material and its movement/consumption record in the related jobs of TPNODL will be verified by inspecting officer. In case of any deviation or non- availability of such records, the offered lot may get rejected.

The format of final inspection as per annexure

Further tests

The purchaser reserves the right of having any other reasonable tests carried out at his own expense either before shipment, or at site to ensure that the transformer complies with the requirements of this specification.

8.2.4 TANK TESTS

a) Oil leakage Test:

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS : 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/ m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the Employer, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN / m² whichever is lower, measured at the base of the tank and maintained for one hour.

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a) Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m² (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

8.3 PRE-SHIPMENT CHECK AT MANUFACTURERSWORKS

- i) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.
- ii) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
- iii) Gas tightness test to conform tightness.
 - 1. Equipment shall be subject to inspection by a duly authorized representative of the Purchaser. 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.
 - 2. Bidder shall grant free access to the places of manufacture to Purchaser's representatives at all times when the work is in progress.
 - 3. Inspection by the Purchaser or its authorized representatives shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications.
 - 4. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by Purchaser. Following documents shall be sent along with material:
 - a) Test reports
 - b) MDCC issued by TPNODL
 - c) Invoice in duplicate
 - d) Packing list
 - e) Drawings & catalogue
 - f) Guarantee / Warrantee card
 - g) Delivery challan
 - h) Other Documents (as applicable)
 - 5. In respect of raw material such as score 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 purchaser. 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

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6. After the main raw-material i.e. core and coil material and tanks are arranged and transformers are taken for production on the shop floor, to ensure the quality of transformers, the inspection shall be carried out by the purchaser's representative at following stages:

Stage Inspection I – Bidder has to facilitate for stage inspection of Tank, HV and LV windings and Core of the offered transformers. Bidder has to facilitate for stage inspection of Tank, HV and LV windings in one inspection call without any extra charges. Multiple inspections calls for stage inspection-I will not be considered and the delay will be accountable at bidder end. At this stage checking of weights, dimensions, tank sheet thickness, Pressure and vacuum test and quality of material, finish & workmanship as per GTP/QA plan and approved drawings. During stage inspection TPNODL reserves the rights to dismantle the assembled core to ensure that the CRGO laminations used are of good quality.

i. Stage inspection II – Bidder has to facilitate for stage inspection -II for Core coil assembly of the offered transformers in without any extra charges. The testing shall be carried out in accordance with IS: 2026 and as per GTP/QA plan/Drawing.

Note: For Stage inspection, Annexure –II will be referred.

ii. Final Inspection - Bidder has to facilitate for final inspection once the offered transformer is ready for dispatch. Inspection will be done as per w.r.t tests mentioned in Clause 7.2 and inspection test plan format in Annexure-III.

iii. To ascertain the quality of the transformer oil, the original manufacturer's tests report shall be submitted at the time of inspection. 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 purchaser's representative.

iv. The Bidder shall intimate the purchaser in advance for inspection, so that an officer for carrying out inspection could be deputed, as far as possible within 07days (Within Berhampur)/ 12Days (outside Berhampur) from the date of intimation.

v. Further, about the readiness of the transformers, for final inspection for carrying out tests as per relevant IS/IECs shall be sent by the Bidder along with routine test certificates. The inspection shall normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection.

vi. In case of any defect/defective workmanship observed at any stage by the purchaser's inspecting officer, the same shall be pointed out to the Bidder in writing for taking remedial measures. Further processing shall only be done after clearance from the inspecting officer/purchaser.

vii. All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase/tender.

viii. The manufacturer shall offer the inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as during Acceptance Tests.

ix. The bidder shall provide all services to establish and maintain quality of workmanship in his works and 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 ISO9000.

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The Purchaser 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. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser have every right to reject the entire lot or penalize the bidder, which may lead to blacklisting, among other things

8.4 INSPECTION AND TESTING AT SITE

On receipt of transformer at site, shall be performed detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

8.4.1 Receipt and Storage Checks

- i) Check and record conditions of each package visible parts of the transformers etc. for any damage.
- ii) Check and record the gas pressure in the transformer tank as well as in the gas cylinder.
- iii) Visual check of core and coils before filling up with oil and also check condition of core and winding in general.
- iv) The material received at Purchaser's stores shall be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.
- v) 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 the Purchaser. 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. 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.
- vi) The Purchaser 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.
- vii) The Purchaser 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 the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the bidder.
- viii) Test at TPNODL store/Site: after receipt of transformers at TPNODL stores/Site, following minimum tests will be carried out.
 - a) Total weight of the transformer. (It should be as per the offer, subjected to tolerance as per approved drawings & GTPs).

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- b) Oil level in the transformer
- c) Verifications of all the fittings.
- d) Physical verification of all the transformers for any damages, oil leakage, quality of painting etc.
- ix) Test at site: The purchaser 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.

Shock/impact recorder data analysis to be submitted by bidder to ascertain the concealed damage if any during transportation/movement of transformer.

8.4.2 Installation Checks

- i) Inspection and performance testing of accessories like tap changers etc.
- ii) Check choking of the tubes of radiators
- iii) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.
- iv) Check the whole assembly for tightness, general appearance etc.
- v) Oil leakage tests.

8.4.3 Pre-Commissioning Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

- i) Megger Test
- ii) Phase relationship test (Vector group test)
- iii) Buchholz relay alarm & surge operation test(Physical)
- iv) Ratio test on all taps
- v) Low oil level (in conservator)alarm
- vi) Temperature Indicators(Physical)
- vii) Marshaling kiosk (Physical)

8.4.4 The following additional checks shall be made:

- i) All oil valves are incorrect position closed or opened as required
- ii) All air pocket are cleared.
- iii) Thermometer pockets are filled with oil
- iv) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.
- v) Earthing connections are made.
- vi) Bushing arcing horn is set correctly and gap distance is recorded.
- vii) C T polarity and ratio is correct.

8.5 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

- i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and $\pm 10\%$ corresponding to the voltage of the tapping

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- ii) Radio interference and Noise Level
- iii) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.
- iv) The all accessories of transformer viz. OTI, WTI, buchholz relay, etc. shall be SCADA compatible.

8.6 FAULT CONDITIONS

- a) The transformer shall be capable of withstanding for two(2) seconds without damages any external short circuit to earth
- b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS :2026.
- c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

8.7 WITNESSING OF TESTS AND EXCESSIVE LOSSES

The Employer reserves the right to reject the Transformer if losses exceed the maximum specified as per Clause No 2. SPECIFIC TECHNICAL REQUIREMENTS (STANDARD CONDITIONS), item-35 of this specification or if temperature rise of oil and winding exceed the values specified at item -26 of the above clause.

9. LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES

There is no positive tolerance on the guaranteed losses offered by the bidder. However, the transformer(s) shall be rejected out rightly, if any of the losses i.e. no load loss or load loss or both exceed (s) the guaranteed maximum permissible loss figures quoted by the bidder in the Technical Data Schedule with the bid.

10. SPARE PARTS

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the Employer to fabricate or procure spare parts from other sources.

Mandatory Spare Parts

The suppliers shall provide the following mandatory spare parts for each of Transformer supplied

1. H.V. & L.V. Bushing & Studs – Each 2 No's
2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

10.1 INSTRUCTION MANUAL

Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

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- a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
- b) Detailed dimensions, assembly and description of all auxiliaries.
- c) Detailed views of the core and winding assembly, winding connections and tapings tap changer construction etc. These drawings are required for carrying out overhauling operation at site.
- d) Salient technical particulars of the transformer.
- e) Copies of all final approved drawings.
- f) Detailed O&M instructions with periodical check lists and Performa etc.

10.2 COMPLETENESS OF EQUIPMENT

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without extra charges. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the Employer under any circumstances.

11. COMMISSIONING

The utility will give a 10 days' notice to the supplier of transformer before commissioning. The manufacturer will depute his representative to supervise the commissioning. In case, the manufacturer fails to depute his representative, the utility will go ahead with the commissioning and under these circumstances, it would be deemed that commissioning is done as per recommendations of manufacturer.

Packing

1. 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.
2. The packing may be in accordance with the bidder's standard practice but he should give full particulars of packing for the approval of the purchaser. Special arrangement should be made to facilitate handling and to protect the projecting connections from damage in transit.

The transformer shall be shipped filled with oil/without oil but with the tank filled with Nitrogen under pressure complete with gas cylinder reducer, connection and pressure gauges. (After testing dew point of the Nitrogen filled. Dispatch clearance will be given only after achieving satisfactory dryness i.e. dew point measurement results). These accessories will be part of purchase. However, if neutral grounding transformer and reactors are included in the scope, these can be transported with oil. (Whichever way desired by the purchaser depending on the size etc.)

3. Provisions for monitoring of oil and gas pressure during transport and storage and a make-up Nitrogen cylinder shall be made.
4. A shock recorder also shall be provided during transport.
5. Bushings shall be packed in proper containers for transport.

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6. All parts shall be adequately marked to facilitate field erection.
7. Boxes and crates shall be marked with the contract number and shall have a packing list enclosed showing the parts contained therein.
8. Unloading, dragging of transformer up to 50 meters & keeping it on foundation at TPNODL site/stores will be in the scope of supplier. The bidder shall take care of this point while quoting the rates for Freight & Insurance charges.
9. Impact recorder to be mounted on the transformer at strategic locations after discussing with purchaser so that any impact due to transportation can be recorded and accordingly necessary action can be taken. Suitable software and diagnosis tool to be provided that of impact recorder.

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

12. GUARANTEE

The manufacturers of the transformers shall provide a guarantee of 60 months from the date of receipt of transformer at the stores of the Utility. In case the transformer fails within the guarantee period, the supplier will depute his representative within 15 days from date of intimation by the utility for joint inspection. In case, the failure is due to the reasons attributed to supplier, the transformer will be replaced/repared by the supplier within 2 months from the date of joint inspection.

1. 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.
2. 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.
3. 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 Purchaser, failing which the Purchaser will be at liberty to get it replaced / rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@20% of expenses incurred), from the Bidder or from the "Security cum Performance Deposit" as the case may be.
4. In case of Two Winding Power Transformer fails within the guarantee period the purchaser will immediately inform the Bidder who shall take back the failed Two Winding Power 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.
5. 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.
6. 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

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Quality control

1. 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.
2. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished.
3. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections.
4. The Bidder shall invariably furnish following information along with his bid, failing which the bid shall be liable for rejection. Information shall be separately given for individual type of equipment offered.
 - i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested.
 - ii. List of tests normally carried out on raw materials in the presence of Bidder's representative, copies of test certificates.
 - iii. Information and copies of test certificates as in (i) above in respect of bought out accessories.
 - iv. List of manufacturing facilities available.
 - v. Level of automation achieved and list of areas where manual processing exists.
 - vi. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.
 - vii. List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports shall be furnished with the bid. Manufacturer shall possess 0.1 class instruments for measurement of losses.
 - viii. Quality Assurance Plan (QAP) withholds points for purchaser's inspection.
5. The successful Bidder shall within 30 days of placement of order, submit following information to the purchaser.
 - i. List of raw materials as well as bought out accessories and the names of sub-Suppliers selected from those furnished along with offer.
 - ii. Type test certificates of the raw materials and bought out accessories.

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

Minimum 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.

The bidder shall have minimum testing facilities in house for following:

- a) Heat run test
- b) SFRA
- c) Pre dispatch inspections.

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Manufacturing activities

1. The successful bidder will have to submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity.
2. This bar chart should be in line with the Quality assurance plan submitted with the offer.

This bar chart will have to be submitted within 15 days from the release of the order.

Spares accessories and tools

1. Bidder shall provide a list of recommended spares with quantity and unit prices for 5years of operation after commissioning.
2. The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works.
3. The Purchaser may order additional spares at any time during the contract period at the rates stated in the Contract Document.
4. Bidder shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment which shall be 25 years minimum.
5. However, the Purchaser shall be given a minimum of 12 months' notice in the event that the Bidder or any sub-vendor plans to discontinue manufacture of any component used in this equipment.
6. Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the equipment and must be suitably marked and numbered for identification.

The bidder shall also provide the following mandatory spares along with the transformer.

- i) HT Bushing (1no.)
- ii) LT Bushing (1no.)
- iii) Neutral Bushing (1no.)
- iv) Buchholz Relay (1no.)
- v) Valves(1Set)
- vi) OTI, WTI (1each)
- vii) PRV (1 no); OSR (1 no); MOG (1no)
- viii) Transducers for OTI, WTI,PTI
- ix) Air cell (1 no.)
- xii) Set of gaskets (1no.)
- xiii) Set of mandatory spares for tap changer (1set)
- xiv) Oil – 10%extra
- xv) Radiator tube plug – 5No
- xvi) Radiator tube valves – 2No
- xvii) Radiator tube plug oil seals – 12No
- xviii) MCCB (1no.)
- xix) MCB (1no.)
- xx) L/R switch (1no.)
- xxi) R/L switch (1no.)
- xxii) OLTC counter (1no.)
- xxiii) Space heater & thermostat (1 no.)

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Drawing and Documents

a. Following drawings and documents shall be prepared based on TPNODL specifications and statutory requirements and shall be submitted with the bid:

- b.** Completely filled in Technical Particulars and compliance to each clause of the specification General Technical Requirements to Additional Details.
- c.** Description of the transformer and all components including brochures.
- d.** General arrangement for Transformer.
- e.** Bill of material.
- f.** Experience Certificate and list
- g.** Type test certificates.
- h.** List of makes of major components as listed above.

1. Drawings / documents to be submitted after the award of the contract are as under:

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1.	Technical Parameters	√	√	√
2.	GA Drawing of Transformer	√	√	√
3.	HV and LV bushing internal view with terminal connector	√	√	√
4.	Internal coil arrangement with dimensions	√	√	√
5.	Breather Drawing		√	√
6.	Rating Plate	√	√	√
7.	Cooling calculation with no. of radiators and fins mentioned specifically	√	√	√
8.	Prismatic oil level gauge drawing			√
9.	Installation Instruction		√	√
10.	QA & QC Plan		√	√
11.	Test Certificates	√	√	√
12.	Shipping drawings showing dimensions and weights of each package.	√	√	√
13.	Assembly drawings and weight of main component parts.	√	√	√
14.	Drawings giving Weights for foundations	√	√	√
15.	Tap changing and name plate diagram.	√	√	√

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16.	Schematic control along with logic block diagram and wiring diagram for all auxiliary equipment.		√	√
17.	Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross-sectional views showing the duct sizes, cooling pipes etc.	√	√	√
18.	Large scale drawings of high and low tension windings of the transformers showing the nature and arrangement of insulation and terminal connections.	√	√	√
19.	Bushing drawing and specifications.	√	√	√
20.	Crane requirement for assembly and dismantling.		√	√
21.	Overhead Conductor Connections.		√	√
22.	Foundation drawing of transformer, radiator supports, etc.	√	√	√
23.	Valve Schedule details	√	√	√
24.	HV , LV Bushing fixing and connection Details		√	√
25.	Radiator drawing and their fixing arrangement.		√	√
26.	Marshaling junction box details	√	√	√
27.	Thermo junction box details.	√	√	√
28.	Neutral arrangement	√	√	√
29.	Drawing showing conservator with air bag and oil filling instructions	√	√	√
	In addition to the above, the following drawing/information for each Item pertaining to marshaling box and OLTC shall also be supplied.			
30.	General arrangement drawing of the marshaling box	√	√	√

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31.	Shipping drawings showing dimensions and weight of each package	√	√	√
32.	Drawing giving the weight for its foundation.	√	√	√
33.	Schematic control drawing and TB schedule / wiring diagram for all elements	√	√	√
34.	Valve Schedule	√	√	√
35.	Test report of all bought out elements.	√	√	√
36.	Cooler Control drawing	√	√	√
37.	The tightening torque chart	√	√	√

1. List of Calculations to be submitted:

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.

1. Resistance Calculation (75 deg. C)
2. Load Losses Calculation (at 75 deg. C)
3. No load Loss Calculation.
4. Auxiliary & Stray Loss Calculation.
5. Weight of Copper (Bare and with Insulation also).
6. Weight of Core.
7. BH curve & Loss/Kg graph of core material offered.
8. Flux Density calculations.
9. Efficiency vs Load curve of the offered design.
10. Current Density Calculations.
11. Short Circuit withstand.
12. Temperature Rise Calculations.
13. Cooling Calculations.
14. Calculation sheet for Lifting lug design and mounting lug design to be submitted by Bidder.

Additional Documents to be submitted:

1. List of raw materials as well as bought out accessories and the names of sub- supplier selected from those furnished along with offer.

Type test certificates of the raw materials and bought out accessories.

The successful Bidder shall submit the **routine test certificates of bought out accessories** and central excise passes for raw material at the time of routine testing.

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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 TPNODL for approval.

Instruction Manuals: Bidder shall furnish two softcopies (CD) and four (4) hard 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

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Annexure - A

Check-list for Inspection of Prime quality CRGO for Transformers

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

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

Review of documents:

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

Invoice of the

Supplier Packing

List

Bill of Lading

Bill of Entry Certificate by Customs Dep't.

Reconciliation Statement as per format below

Certificate of Origin

BIS Certification

Format for Reconciliation/Traceability records

Packing List No. /date /Quantity of PRIME CRGO

received Name of Manufacturer

Manufacturer test certificate no. /date

Serial No.	Details of Package/Job	Drawing Reference	Quantity Involved	Cumulative Quantity Consumed	Balance Stock

(i) 2.1 Inspection of PRIME CRGO Coils:

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

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

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

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

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

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Inspection Clearance Report would be issued after this inspection

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

Inspection at the time of core building:

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

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

Inspection Clearance Report would be issued after this inspection

(i) In case PRIME CRGO cutting is at Sub-vendor of Transformer Manufacturer:

Review of documents:

Purchase Order (unpriced) to PRIME CRGO supplier/ Authorized Agency

Purchase Order (unpriced) to Core Cutter

Manufacturer test certificate Invoice of the

Supplier Packing List Bill of Lading

Bill of Entry Certificate by Customs Dep't.

Reconciliation Statement as per format below

Certificate of origin

BIS Certification

Format for Traceability records as below:-Packing List No. /date

/Quantity of PRIME CRGO received Name of Manufacturer

Manufacturer test certificate no. /date

Serial No.	Name of Customer	Details of Package/Job	Drawing Reference	Quantity Involved	Cumulative Quantity Consumed	Balance Stock	Dispatch details

1 Inspection of PRIME CRGO Coils:

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

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

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

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

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

Inspection Clearance Report would be issued after this inspection

3 Inspection of PRIME CRGO laminations:

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

Inspection Clearance Report would be issued after this inspection

vi) Inspection at the time of core building:

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

Inspection Clearance Report would be issued after this inspection

NOTE:-

a) Transformer Manufacturer to ensure that PRIME CRGO is procured from POWERGRID approved vendors and CRGO manufacturer should have valid BIS Certificate for respective offered Grade.

14.1 Transformer Manufacturer should also involve themselves for ensuring the quality of CRGO laminations at their Core Cutter's works. They should visit the works of their Core cutter and carryout necessary checks.

(a) General

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

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

Sampling Plan (PRIME CRGO)

33 /11kV	-1 st transformer and subsequently at random 10% of Transformers (min. 1) offered for inspection.
DTs and other ratings	-1 st transformer and subsequently at random 2% of Transformers (min. 1) offered for inspection.

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

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

<http://apps.powergridindia.com/ims/ComponentList/Power-former%20upto%20420%20kV-CM%20List.pdf>

Annexure-B

Methodology for computing total owning cost for Power Transformer

TOC = IC + (A xWi) + (B xWc) ; Losses in KW			
Where,			
TOC	=	Total Owning Cost	
IC	=	Initial	taxe of transform a quote b the cos t s y manufacturer
A factor	=	Cost of no load losses in Rs/KW	(A =334447)
B factor	=	Cost of load losses in Rs/KW	(B =151616)
Wi	=	No load losses quoted by the manufacturer in KW	
Wc	=	Load losses quoted by the manufacturer in KW	

9. Technical data schedule for 3.15/5/8/10 MVA, 33/11 kV Power Transformer

S.No.	Description	Bidder offer
1	Name of Manufacturer	
2	Address	
3	Country of origin	
4	Applicable standard	
5	Maximum continuous rating (in MVA) in ONAN conditions	
6	No load voltage ratio at Principal (Nominal) tap (in KV/KV)	
7	Rated frequency (in Hz)	
8	Number of phases	
9	Type of cooling	
10	Connections	
	(i) H.V. Winding	
	(i) L.V. Winding	
11	Vector Symbol	

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12	Tapping		
	(a) Range		
	(b) Number of Steps		
	(c) Variation of voltage in each step (in KV)		
	(d) No load voltage ratio in each tap (in KV/KV) for 33/11 KV		
	Tap Number	Voltage Ratio in KV/KV	
	1	5.456	
	2	5.391	
	3	5.326	
	4	5.261	
	5	5.196	
6	5.131		
7	5.066		
8	5.001		
9	4.936		
13	(i) Temperature rise under normal operating condition above 50 Deg C ambient temperature		
	(a) Top oil (in degree C)		
	(b) Windings (in degree C)		
	(ii) Maximum hot spot temperature of copper windings (in degree C)		
14	Magnetizing current referred to H.V. AT Rated frequency		
	(a) at 90% rated voltage : (in Amps)		
	(b) at 100% rated voltage ; (in Amps)		
	(c) at 110% rated voltage ; (in Amps)		
15	Power factor of magnetizing current at 100% Rated Voltage & Frequency		
16	No load current at rated voltage and at rated frequency		
17	No load loss in KW at rated frequency and voltage		
	(a) at Lowest Tap		
	(b) at principal Tap		
18	(c) at highest Tap		
	Load loss in KW AT 75 Deg. C. at rated output and frequency		
	(a) at Lowest Tap		
8	(b) at principal Tap		
	(c) at highest Tap		

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1 8	Load loss in KW AT 75 Deg. C. at rated output and frequency	
	(a) at Lowest Tap	
	(b) at principal Tap	
	(c) at highest Tap	
1 9	Percentage Regulation at full load 75 Deg.C	
	(a) at unity power factor	
	(b) at 0.8power factor lagging	
2 0	Efficiencies at 75 Deg.C (I percentage)	
	(a) at full load	
	(i) at unity power factor	
	(ii) at 0.8power factor lagging	
	(b) at 3/4 full load	
	(i) at unity power factor	
	(ii) at 0.8power factor lagging	
	(c) at 1/2 full load	
(i) at unity power factor		
(ii) at 0.8power factor lagging		
2 1	Impedence voltage on rated MVA base at rated current and frequency for the Principal tapping 75 Deg. C. (in percentage)	
2 2	(a) Reactance voltage at rated current and frequency for the principal tapping at 75 degree C. (in percentage)	
	(b)resistancevoltageatratedcurrentandfrequencyfor the principal tapping at75 degree C. (in percentage)	
2 3	Resistance at 75 Deg, C.	
	(a) HV at Principal Tap	
	(b) LV	
2 4	Reactance at H.V. base at 75 Deg, C.	
	(a) at Lowest Tap	
	(b) at principal Tap	
2 5	(c) at highest Tap	
	Withstand time without injury for three phase dead short circuit at terminal (in seconds)	
	Short time current rating for short circuit with duration	
2 6	(a) HV winding (in K.Amps)	

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	(b) LV winding (in K. Amps)	
	(c) Duration (in seconds)	
27	Permissible overloading with time	
2	Core :	
8	i) Type	
	ii) Flux density of core and yoke at principal tap	
	iii) Type of construction	
	iv) Core assembly details	
	a) at 100% rated voltage at 50 Hz (in Tesla)	
	b) at 112.5% rated voltage at 50 Hz (in Tesla)	
	iii) Thickness of stamping (in mm)	
	iv) Type of insulation between core laminations	
	v) Core bolt withstand insulation (in KV rms for 1 min)	
	vi) Approximate area of cross section of core and yoke (on sq.mm)	
	vii) Material of core clamping plate	
	viii) Thickness of core clamping plate (in mm)	
	ix) Insulation of core clamping plate	
	x) Describe location / Method of core grounding	
2	Terminal Arrangement	
9	i) High voltage	
	ii) Low voltage	
3	Positive sequence Impedance at reference temperature of 75	
0	Deg. C at principal tap (in percentage)	
	i) at principal tapping (in percentage)	
	ii) at lowest tapping (in percentage)	
	at highest tapping (in percentage)	
31	Zero sequence impedance at reference temperature of 75 degree .C at principal tap (in percentage)	
3	Details of Windings	
2	i) Type of winding	
	(a) High voltage	
	(b) Low voltage	
3	Winding conductor	
3	Material of the conductor	
i)	(a) High voltage	
	(b) Low voltage	
	(c) LV conductor size (mm)	
	(d) HV conductor size (mm)	

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ii)	(e) HV conductor size (mm)	
	Conductor Area	
	(a) High voltage (in sq. mm)	
	(b) Low voltage (in sq. mm)	
iii)	Current density of windings at rated MVA	
	(a) High voltage (Amp. per sq. mm)	
	(b) Low voltage (Amp. per sq. mm)	
	Insulation material used for	
IV)	(a) High voltage Winding	
	(b) Low voltage winding	
	Insulation material used between	
	(a) High Voltage and low voltage winding	
v)	(b) Low Voltage winding and core	
	Whether adjustable coil clamps are provided for H.V. & L.V. winding (if yes, details may be given)	
VI)		
VII)	Type of axial coil supports	
	(a) HV winding	
	(b) LV winding	
	Type of Radial Coil Supports	
VIII)	(a) HV winding	
	(b) LV winding	
34	Insulation withstand Test voltages	
	i) Lightning Impulse withstand test voltages (kv peak)	
	ii) Power frequency withstand test voltage (in kvrms for 1 min)	
	iii) Induced over voltage with stand test (in kvrms)	
35	Current in the winding at rated MVA	
	(a) High voltage (in Amps)	
	(b) Low voltage (in Amps)	
36	Voltage per turn (kv per turn)	
37	Ampere turn	
38	Number of turns	
	(a) High voltage	
	(b) Low voltage	
39	Details of tap changer	
	i) Number of steps	
	ii) Number of Plus taps	

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	iii) Number of minus taps	
	iv) Position of taps on HV	
	v) Type of tap changing arrangement	
40	Bushing:	
i)	Make	
ii)	Type	
	Application standard	
iii)	Bushing:	
iv)	Lightning Impulse with stand test voltage (1.2x50mcs in kv Peak)	
a)	Power frequency with stand test voltage (in KV rms for 1 min)	
b)	1) Dry	
	2) Wet	
v)	Creepage distance (total in mm)	
vi)	Minimum height of the bushing	
	Mounting	
41	Minimum clearance (in mm)	
	i) H.V.	
	ii) L.V.	
	iii) Core- LV	
	iv) LV-HV	
	v) Ph-Ph	
	vi) HV-Tank	
42	Particulars of bushing & Neutral	
	C.T.	
	i) Type	
	ii) Ratio	
	iii) Accuracy class	
	iv) Knee point voltage	
	v) RCT at 75 deg.C	
	vi) Magnetizing current at knee point voltage	
	vii) Additional winding particulars of testing on CT	
	viii) Short time rating	
	ix) Reference standard	
43	Approximate weight of transformers in KG	
	i) Core with clamping	

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	ii) Core with insulation	
	iii) Core and winding	
44	Tank and fitting with accessories	
	i) Un-tanking weight	
	ii) Oil required for first filling	
	iii) Total weight with core ,winding , oil, fittings (Kg)	
45	Details of tank	
i)	Type of tank	
	a) Tank length (mm)	
	b) Tank width (mm)	
	c) Tank Height (mm)	
	Approximate thickness of sheet (in mm)	
ii)	a) sides	
	b) Bottom	
	c) Cover	
	d) Radiators	
iii)	Vacuum recommended for hot oil	
iv)	Vacuum to which the tank can be subjected without distortion (in torr.)	
v)	Under carriage dimensions	
	a) No. of directional wheels provided	
	b) Track gauge required for the wheels	
vi)	Dimension of base channel (in mm x mm)	
	Type of pressure relief device/Explosion Vent and pressure at which operates	
	Tank Material	
46	Conservator	
	i) Total volume (in liter)	
	ii) Volume between the highest and lowest visible oil level (in liters)	
	iii) Type	
	iv) Thickness of sheet	
	v) Dimension (Dia x Length) (mm x mm)	
47	Oil Quality	
	i) Applicable standard	
	ii) Total quantity of oil (in liter)	
	ii) BDV value of oil	
	a) New unfiltered oil (KV rms) (Min)	
	b) After Filtration of oil (KV rms) (Min)	
48	Radiator	

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	i) Number of radiators banks	
	ii) Number of tubes/fins in each radiator bank	
	iii) Thickness of tubes/fins (in mm)	
	iv) Overall dimensions (in mm)	
	a) Center to center	
	b) Breadth	
	c) Number of tubes/fins in each radiator bank	
	v) Type of mounting	
	vi) Vacuum withstand capability	
49	Gas and Oil Actuated relay	
	i) Make	
	ii) Type	
	iii) Number of float contacts	
50	Temperature indicators	
	i) Make	
	ii) Type	
	iii) Permissible setting ranges for alarm and trip	
	iv) Number of contacts	
	v) Current rating of each contact	
51	Approximate overall dimensions (in mm)	
	a) Length	
	b) Breadth	
	c) Height	
	d) Minimum height of bottom most portion of bushing from bottom of base channel	
52	Minimum clearance height for lifting tank cover (in mm)	
53	Make of OLTC	
54	Whether OLTC is Type tested	
55	Whether OLTC is in line with the specification	
56	Make of RTCC	
57	Highest System voltage	
58	Maximum system voltage ratio	
59	System earthing details	
60	No of winding	
61	Type of Mounting (Transformer)	
62	MVA Rating corresponding to ONAN cooling system	
63	Paint Shade	
64	Polarization Index	

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65	Absorption index	
66	Noise Level at rated voltage	
67	Specify transport dimension	
68	Anticipated unbalanced loading	
69	Overvoltage operation capability & duration	
70	Anticipated continuous loading of winding	
71	Performance criteria	
72	Temp. gradient between core & surrounding oil	

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A) INSPECTION TEST PLAN FOR STAGE INSPECTION- II OF POWER TRANSFORMER

S No.	Particulars	Details
(A)	GENERAL INFORMATION:	
1	Name of firm	
2	Order No. and Date	
3	Details of offer	
a)	Rating	
b)	Quantity	
c)	Serial Numbers	
4	Details of last stage inspected lot:	
a)	Total quantity inspected	
b)	Serial Numbers	
c)	Date of stage inspection	
d)	Quantity offered for final inspection of (a) above with date	
(B)	Position of manufacturing for the offered quantity:	
a)	Complete tanked assembly	
b)	Core and coil assembly ready	
c)	Core assembled	
d)	Coils ready for assembly	
	i) HV coils	
	ii) LV coils	

Note: i) The stage inspection-II shall be carried out in case:-

- a) 100% quantity of core coil assembly shall be ready for inspection.

Quantity offered for stage inspection should be offered for next level of Inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

Initiator		HOG (Engg)	
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ANNEXURE-C

Inspection Test Plan for Power Transformers

1	Name of the firm / BA	
2	Date of inspection	
3	Details of offer made	
	(i) Order No. and date	
	(ii) Rating	
	(iii) Quantity	
	(iv) Sl. No. of transformers	
4	Date of stage inspection of the lot	
5	Reference of stage inspection clearance	
6	Sample Quantity (10% of the offered lot, min. one)	Sr. No.-----

S. No.	Name of test	Specified value(Range)	Reference documents	Test Result	Pass/Fail
1	Visual inspection for material, finish and workmanship	Free from cracks, nicks, protrusion and other visible defects.	TPNODL specification		
2	Physical Verification of complete Transformer with all assembly including test rollers, radiators, cable boxes etc. and Checking of weights, Dimensions.	GTP Values	TPNODL specification		
3	Measurement of Winding Resistance	GTP Values	IS :2026-2011 (Part I) cl.10.2		
4	Measurement of voltage ratio and phase displacement	GTP Values	IS :2026-2011 (Part I) cl.10.3		

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5	Verification of vector group relationship	DYn11	IS : 2026-2011 (Part I) cl. 8.6, 8.7		
6	Measurement of short-circuit impedance and Load Loss.	GTP Values	IS :2026-2011 (Part I) cl.10.4		
7	Measurement of No-Load Loss and Current (Losses at 90, 100 and 110% of rated voltage).	GTP Values	IS :2026-2011 (Part I) cl.10.5		
8	Measurement of insulation resistance.	GTP Values	IS : 2026-2011 (Part I) cl. 10.1.3		
9	Dielectric Test	GTP Values / TPNODL Specification	IS : 2026 (Part III)- 2009		
10	Test on ON-Load Tap Changer	GTP Values / TPNODL Specification	IS :2026-2011 (Part I) cl.10.8		
11	Zero-Phase sequence Measurement	GTP Values	IS :2026-2011 (Part I) cl.10.7		
12	Oil Pressure/leakage test on completely assembled transformer at 0.35kg/sq.cm for 8 hrs.	Should withstand	TPNODL Specification		
13	Bushing shall be tested for Capacitance and Power factor and shall meet the manufacture's requirement.	GTP / TPNODL Specification	IS : 2026 (Part III) cl. 10		
14	All CTs and resistance of image coil for winding temperature indicator shall be checked for ratio test, polarity and knee point voltage test	GTP / TPNODL Specification	TPNODL Specification		
15	Determination of Capacitances and dissipation factor winding-to-earth and between windings.	GTP / TPNODL Specification	IS : 2026 (Part I) cl.10.1.3		
16	Magnetic balance test	GTP / TPNODL Specification			
17	Measurement of Magnetizing current at low voltage		IS : 2026-2011 (Part I) cl. 10.1.3		

Initiator		HOG (Engg)	
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18	Voltage Regulation at rated load and at unit, 0.9, 0.8 lagging power factor	GTP/TPNODL specification	TPNODL		
19	Measurement of Acoustic Noise Level	GTP/TPNODL specification	TPNODL		
20	Functional tests on auxiliary equipment: i. Test on OTI and WTI ii. High Voltage test on insulation test for Auxiliary Wiring.	GTP/TPNODL specification	TPNODL specification		
21	Test on Oil filled in Transformer i. Dielectric Strength of Oil ii. Water Content. iii. Dielectric Dissipation factor (tan delta at 90°C. iv. Resistivity	GTP/TPNODL specification	TPNODL specification,		
22	Temperature rise test	GTP/TPNODL specification	IS : 2026 (Part II)		
23	Short Circuit withstand test	Should withstand	IS : 2026 (Part V)		
24	Test to verify IP55 of Marshalling and cable boxes.	Should Confirm IP55	TPNODL Specification		
25	Lightning Impulse voltage test with chopped wave.	GTP/TPNODL Specification	IS : 2026 (Part III) cl. 13		

PURCHASER'S OFFICER

BIDDER'S REPRESENTATIVE

Initiator		HOG (Engg)	
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Annexure-D

SOURCE OF MATERIAL/PLACES OF MANUFACTURE, TESTING AND INSPECTION

S No.	Item	Source of Material	Place of Manufacture	Place of testing and Inspection
1.	Core Laminations			
2.	Copper Conductor			
3.	Insulating winding wires			
4.	Transformer Oil			
5.	Press Boards			
6.	Kraft paper			
7.	Tank material			
8.	Gaskets			
9.	Bushing HV/LV			
10.	Paint			
11.	OLTC			
12.	NIDS			
13.	CTs			
14.	WTI			
15.	OTI			

Sachin M Rawool
HOG-Sub Transmission System

Mani Bhushan Prasad
HoD-Sub Transmission System

Initiator		HOG (Engg)	
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