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1. SCOPE

- 1.1. This standard covers the design, manufacture, testing at works and dispatch in well packed condition and delivery FOR destination of Power Transformers as per this specification and enclosed specification sheets.
- 1.2. This standard shall be applicable for core type power transformers rated above 100 KVA.
- 1.3. This standard shall be read in conjunction with the specification sheets and other relevant reference as specified.

2. STANDARDS TO BE FOLLOWED

- 2.1. The transformer shall comply with the latest edition of the following and other relevant Indian Standards/Manual:

IS:335	-	Insulating oil
IS:1271	-	Thermal evaluation and Classification of electrical insulation.
IS:2026	-	Power transformers
IS:2099	-	Bushing for Alternative voltages above 1000 V.
IS:2705	-	Current transformers.
IS:3347	-	Dimensions for porcelain Transformer Bushings
IS:3637	-	Gas operated relays.
IS:3639	-	Fitting & accessories for power transformers
IS:4201	-	Application guide for CTs.
IS:8478	-	Application guide for ON-load tap changers
IS:8468	-	On-load tap changers (Amendment 1)
IS:13947	-	LV switchgear and control gear - Part 1 General rules.
IEEE:32	-	Neutral Grounding Devices- Standard Requirements, Terminology and Test Procedure
STI 1180	-	Outdoor type oil immersed Distribution Transformers up to and including 2500 KVA

ASTM standard A240-304

CBIP Manual on Transformers

- 2.2. The design and operational features of the equipment offered shall comply with the provisions of the latest version of the following Acts and Statutory Regulations: -
 - Indian Electricity Act.

- The Indian Electricity Rules.
- The Factory Act.
- Fire Insurance Regulations.

2.3. Transformer shall also conform to the provisions of the latest revisions of the Indian Electricity rules and any other statutory regulations currently in force.

3. OPERATING REQUIREMENT

3.1. Ambient Conditions

Transformer and all its accessories and allied systems shall be suitable for operating satisfactorily in humid and corrosive atmospheres found in fertilizer plants, refineries and petrochemical plants. Service conditions shall be as specified in the data sheets. If not specifically mentioned therein, design temperature of 40°C and an altitude not exceeding 1000m above mean sea level shall be considered.

3.2. System Details

These shall be as indicated in the specification sheet.

3.3. Service

3.3.1. The transformers shall be suitable for operating at the specified rated capacity continuously at any of the taps with the voltage and frequency variations under the ambient conditions indicated in the specification sheet without exceeding the temperature rise limits specified and any detrimental effect on any parts.

3.3.2. The transformers shall also be capable of delivering rated current at a voltage equal to 105% of the rated voltage.

3.3.3. The vendor shall be responsible for design, engineering and manufacturing of the equipment to fully meet the intent and requirements of this specification and attached data sheets.

3.4. Overload capacity

The transformers shall be designed to be overloaded as permitted in IS 6600.

3.5. The transformers shall be so designed as to be able to operate in parallel satisfactorily with similar transformers.

4. DESIGN FEATURES

The design of the transformers shall be in accordance with the latest practice.

4.1. Electrical Features

4.1.1. Rated Voltage and Frequency

These shall be as indicated in the specification sheet.

4.1.2. Phase Connections

These shall be as indicated in the specification sheet.

4.1.3. Tapping

(a) Each transformers shall be provided with ON load/OFF circuit tap changing equipment on the high voltage winding with taps, as specified in the specification sheet to provide for a constant voltage on the secondary side with HT side varying. The tap changing mechanism shall be complete with the tap position indicator, limit switches, lock and key. The switch shall be mounted on one side and in an easily accessible position. The transformer shall be capable of operating continuously at its rated KVA on any tap without any detrimental effect on any part.

(b) The off circuit tap changing shall be effected by an externally operated handle capable of being padlocked in any position. The range of taps shall be $\pm 2.5\%$ and $\pm 5\%$ unless otherwise specified in the specification sheet.

(c) For transformers specified with on load tap changing devices, necessary control panel shall be supplied along with the transformer. The range and number of taps shall be as indicated in the specification sheet. Provision shall be made for auto-manual operation. The manual operation shall be possible both from the panel as well as field. In case the tap changer is located in a separate housing, the housing shall be connected with the conservator for oil connection. A separate BUCHHOLZ relay shall be provided in such a case. Emergency manual mechanical device shall also be provided,

4.1.4. Impedance Voltage

The impedance voltage at 75°C of the transformers shall be as specified in the specification sheet.

4.1.5. Losses

The various losses under the full load conditions at the rated voltage and frequency shall be indicated by the supplier in the technical particular sheet at 75°C. These shall be guaranteed within the tolerable limits specified in IS for all position of taps. The purchaser has the right to reject the transformer due to difference in the test and guaranteed values.

4.1.6. Temperature Rise

The temperature rise of the winding, oil and core shall not exceed the values specified in IS:2026 when the transformer is delivering its rated output continuously under the service conditions specified in the specification sheet.

4.1.7. Insulation Level

All windings up to maximum system voltage of 72 KV shall have uniform insulation to earth. For windings having higher maximum system voltage, graded insulations are acceptable. Test voltage for the windings shall be as per relevant IS.

4.1.8. Terminal Arrangements

Terminal arrangement shall be provided as specified in the specification sheet. Disconnecting link chambers shall be provided on the transformer primary side in all cases as well as on secondary sides except where the termination is through bus duct arrangement. The disconnecting chambers shall be oil filled, preferably connected with main tank through an isolating valve and also provided with a drain valve.

4.2. Mechanical Features

- 4.2.1. The transformers shall be able to withstand the electrodynamics stress due to terminal short circuit of the secondary assuming the primary side fed from an infinite bus. All leads, windings in cores shall be properly supported, clamped and tightened after vacuum drying to insure the short circuit withstand ratings. The short circuit withstand duration shall be 3 sees. or more.
- 4.2.2. The short circuit test results of the similar transformers shall be furnished.
- 4.2.3. The transformer shall be so designed as to minimize any undue noise and vibration. The noise level shall be furnished in the technical particulars by the Tenderer.
- 4.2.4. Due attention shall be given in the design for the suppression of harmonics.

5. CONSTRUCTIONAL DETAILS

5.1. CORE

- 5.1.1. The transformer core shall be of high grade non-ageing electrical silicon cold rolled magnetic sheet steel of low hysteresis loss and high permeability. The iron loss of core material to be used shall not exceed 1.10 W/Kg. For an induction of 1.5 TESLAS. The core structure shall be securely grounded to prevent electrostatic potential. Lifting eyes and lugs shall be provided on the limbs and coils assembly. Preferably no bolt shall be used in the cores. Clamping shall be done external to the limb. Bolts passing through the yoke, if any, shall be insulated for 2 KV for transformers rated up to 33 KV and 5 KV for higher rated voltages.
- 5.1.2. The manufacturer shall furnish the exact type of core material, its B-H curve, design flux density at normal tap and the source of procurement.
- 5.1.3. The temperature of the core shall not exceed that permitted in I.S.S.

5.2. TANK

- 5.2.1. The tank shall preferably be made of mild steel plate of adequate thickness capable of withstanding stress not less than 0.40 kg/cm², properly welded and gusseted to ensure a rigid construction. It shall be also able to withstand normal transportation shocks without any deformation and shall be sufficiently strong to withstand partial vacuum against standard atmospheric pressure.
- 5.2.2. For outdoor transformer, the top of the tank, the marshalling box and the headers of radiators shall be of sloping construction to prevent accumulation of water.
- 5.2.3. Guides shall be welded on the internal side of the tank to facilitate tanking and un-tanking of the core with the coil assembly. The details of anchoring of core and coil assembly of the tank shall be furnished.
- 5.2.4. Radiators, where necessary, shall be provided on the tank to facilitate cooling. These shall be provided with isolating valves at both ends. The valves shall be butterfly type and leak proof. The radiators shall be constructed out of minimum 1.0 mm thick pre-stressed steel of welded construction steel. For sizes up to 500/630/750 cooling tubes shall be acceptable.

5.3. WINDINGS

- 5.3.1. Each coil shall be made out of paper insulated electrolytic grade copper conductor. Similar coils shall be interchangeable. Successive coils of a winding shall be connected by inaccessible joints and shall be brazed and finished smooth to prevent abrasive damage to insulation. There shall be no sharp bends in the connections on leads to prevent corona discharge.
- 5.3.2. The winding assembly shall be dried and impregnated in the vacuum with tested insulating coil. The insulation resistance of the windings measured after impregnation shall be furnished in the test certificate.
- 5.3.3. The magnitude of impulse surges transferred from HV to the LV windings by inductive and capacitive coupling shall be limited to a value below the rated impulse strength of the LV winding. The impulse voltage test results and surge distribution on windings of similar transformer shall be furnished.

5.4. INSULATION MATERIALS

- 5.4.1. Class 'A' insulating materials specified in IS: 1271 shall be used. Paper insulation shall be new and free from punctures.
- 5.4.2. The mineral oil shall comply with IS: 335, 10% extra oil shall be supplied along with the transformer in non-returnable drums.
- 5.4.3. For the transformers required to be filled up with inert gas for transport purpose, the required amount of oil including 10% extra shall be supplied in a non-returnable drums.

5.5. BUSHINGS

The bushing insulator shall be rated for the maximum system voltage and comply with the requirements laid down in I.S. The minimum current rating shall be 400 Amps. In case of O/H line connected transformers, the bushings shall be outdoor type having required creepage distances to suit the atmospheric condition and complete with arcing horns. In case of transformers, Bus duct/cable connected, the bushings shall be enclosed in the terminal box. In either case they shall be detachable from outside of the tank. The hardware shall be of tinned copper or brass suitable to receive the conductor sizes as specified. Neutral bushings shall be provided for earthing the neutral, if specified, in the specification sheet. All bushings shall be marked with the symbols corresponding to the connection diagram indicated in the diagram plate and in accordance with I.S.S.

5.6. TAPPINGS & CONTROL

- 5.6.1. These shall be provided on high voltage side and connected to off circuit or on-load tap changing gear as specified on data sheet. Under conditions of external short circuit, the tap changing equipment shall be capable of carrying the same current as the windings.
- 5.6.2. **Off circuit tap changing gear**
Off circuit tap changing gear shall have an external operating handle mounted on the transformer side and shall meet the following requirements:
 - ✓ Positive snap-action contact changing

- ✓ The mechanism shall be such that it is impossible for the contacts to be set in a position whereby the windings remain open-circuited or partly short-circuited.
- ✓ Mechanical stops at the ends shall be provided to prevent overrun.
- ✓ The driving rod through cover or tank wall shall be properly sealed against oil leakage under all service conditions.

The handle shall be metallic and adequately sized in order to allow operation without the need of tools and be located in a directly accessible position.

The handle shall be provided with padlock facilities to lock the tap changer in the desired position.

Tap positions shall be clearly marked in line with the data given on the rating plate.

5.6.3. On Load Tap Changer (OLTC)

High speed on load tap changing gear with number of steps as specified on the data sheet shall be provided and mounted on the transformer. The OLTC gear shall have diverter resistance and the current diverting contacts shall be housed in a separate oil chamber segregated from the main tank of the transformer. The contacts shall be accessible for inspection and their tips shall be replaceable. OLTC oil chamber shall have oil filling, drain and sampling facility. It shall be provided with oil-level indicator, connection orifices, valves and silica gel breather shall be provided.

OLTC shall be provided with local and remote controls.

Local Control

✓ **Manual-Mechanical Control**

The cranking device for operation of the OLTC gear shall be removable and located at a height not exceeding 1500mm above ground level for easy operation. The mechanism shall be complete with normal accessories including at least the following:-

- a. A mechanical tap position indicator (Rated tap voltages shall be marked on the diagram plate).
- b. A mechanical operation counter.
- c. Mechanical stops to prevent over cranking of the mechanism beyond extreme tap positions.

✓ **Electrical Control**

Control circuit shall incorporate the following:

- a. Local/remote manual electrical operation.
- b. Device to ensure a positive and full completion of tap change once it is initiated even if there is loss of power.

- c. An interlock to cut-off electrical control automatically upon recourse being taken to manual mechanical control in emergency.
- d. Electrical interlock to cut-off a counter impulse for a reverse tap change, being initiated during a progressive tap change and until the mechanism comes to rest and resets circuits for a fresh operation.
- e. All auxiliaries and devices for electrical control of OLTC gear should be housed in a weather-proof cabinet mounted on the transformer and shall include:
 - Local tap position indicator
 - 5 digit operation counter
 - Cubicle lighting
 - Thermostatically controlled space heater.
 - Miniature circuit breaker with magnetic and thermal overload devices for controlling the incoming supply to the OLTC motor.
 - Padlocking arrangement for the hinged cabinet door.
 - Removable plate with cable glands.
 - Inside tag with control scheme indelibly marked.

✓ **Remote Tap Changer Control Panel**

Remote Tap Changer control panel shall comprise of the following:

- Individual/parallel control on Master follower sequence selector switch.
- Raise/lower control switch.
- Potentiometer type tap position indicator. Out of step relay.
- Time delay relay.
- Indicating lamp for out of step.
- Out of step buzzer.
- Indicating lamp for tap changer supply available.
- Indicating lamp for tap change in progress.

RTCC panel shall be dust & vermin proof, floor mounting, and freestanding type. The enclosure shall be cold rolled sheet of 2.5 mm for front and back and 2.5mm thick for the rest. All doors and opening shall be provided with neoprene gaskets.

- ✓ Automatic tap changing control shall be provided complete with voltage sensing relay if specified on data sheet.
- ✓ OLTC wherever called for shall be suitable for bi-directional power flow.
- ✓ OLTC shall also be rated for basic insulation level value as specified for the transformer in the data sheet.

6. FITTINGS

- 6.1. Fittings as listed in the Annexure-I shall be provided. Any other fittings which may be necessary for the satisfactory operation of the transformer shall also be provided on each transformer.

- 6.2. Fittings such as conservator and associated pipes, explosion vent, pipe etc. shall be designed to withstand partial vacuum against atmospheric pressure.
- 6.3. Fittings such as Rating plate, dehydrating breather, off circuit tapping switch, dial type thermometer, etc. which need to be observed/ operated, shall be mounted at convenient heights of not more than 1.5 m from base of the transformer and located so as to be clearly visible from the front.
- 6.4. All valves shall be made of gunmetal and flanged type in construction. Further they shall be provided with blanking plates.
- 6.5. The rating, diagram and terminal marking plates shall be made of aluminium and contain relevant details as per I.S.S.
- 6.6. All terminals shall be anti-loosening type and complete with connectors of required size. The earthing terminals shall have identification marks.
- 6.7. **Marshalling Box**
 - 6.7.1. Marshalling box complete with terminal block and compression type cable gland as required shall be provided. The contacts from buchholz relay, winding temperature indicator, dial type thermometer, CTs etc. shall be wired by means of 2.5 sq.mm copper conductor mineral insulated fire resistant cables up to the terminal block in the marshalling box. All cable entries shall be from bottom only.
 - 6.7.2. The marshalling box shall be dust and weather proof type. The box shall be rectangular in shape having sufficient space for easy termination of cables. The control terminals shall be pressure clamp type.
 - 6.7.3. The outgoing cables to the purchaser's control panel shall be by means of PVC-A-PVC cable of sizes as indicated in the specification sheet. Suitable size compression type cable glands shall be provided for this purpose.
 - 6.7.4. The alarm and trip contacts of all protective devices shall be potential free and rated for !4 Amps. At 220/110 volts DC respectively.
 - 6.7.5. The current transformers (CT), if specified, in the specification sheet shall comply with IS:2705. The CT terminals shall be accessible through a weatherproof removable cover for the purpose of testing etc. CT polarity shall be clearly marked. The CT ratio shall be as indicated in the specification sheet. The CT for stand by earth fault protection shall be 15 VA, 5P10. The CTs for differential and restricted earth fault protection shall be of class X accuracy. The values of VK and Imag for these CTs shall be furnished at the order stage.

7. COOLING SYSTEM

- 7.1. The cooling system shall be as indicated in the specification sheet in accordance with IS:2026. In case the transformer is designed for two types of cooling, the output of rating for each type of cooling should be clearly indicated in the offer. The minimum acceptable output shall be 70% of the rated output when forced type of cooling system is not in operation.

- 7.2. In case of transformers with detachable radiators, shut-off valves shall be provided both in top and bottom headers.

8. PAINTING

- 8.1. The surface to be painted shall be shot or sand blasted to remove all dust and scale or foreign adhering matter. All traces of oil and greases should be removed by suitable treatment.
- 8.2. All steel surfaces in contact with insulating oil, shall be painted with heat resistant oil insoluble insulating varnish.
- 8.3. All steel surfaces exposed to outside shall be painted with suitable anti-rust and anticorrosive paints. Epoxy paints shall be provided, if specified, in the specification sheet.
- 8.4. All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.
- 8.5. 1 litre of paint per transformer shall be included in the scope of supply for touch up at site.

9. NAME PLATE

A centrally located engraved nameplate shall be provided for the transformer. Transformer shall have engraved nameplate-bearing data as per approved drawings and reference standards. Name plate or polyester adhesive stickers shall be provided for each transformer.

Identification tags shall be provided inside the RTCC matching with those shown on diagram. Special warning labels shall be provided on removable covers or doors.

Material used for name plate shall incorrodible in nature for indoor/outdoor installation. The material, dimensions, legends and the method of printing/engraving shall be subject to approval of OWNER. Material

10. INSPECTION, TESTING AND ACCEPTANCE

- 10.1. Owner's representative shall be given free access in the works from time to time for stage-wise inspection and progress reporting. Four weeks advance notice shall be given to witness the final routine test as per IS: 2026 and other tests as agreed upon. These tests shall be performed on the complete assembly at manufacturer's works. Test certificates duly signed by owner's representative shall be issued as part of final document.
- 10.2. Routine Tests: Routine tests as per IS: 2026 shall be carried out.
- 10.3. **Additional Tests:**
- 10.3.1. **Oil leakage Test** - All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air/oil of a viscosity not greater than that of insulating oil to IS: 335 at an ambient temperature and subjected to a pressure equal to the normal pressure plus 35 kN/m²

measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours for oil and 1 hour for air, during which time no leakage shall occur.

- 10.3.2. Vacuum Test – The transformer tank shall be subjected to a vacuum of 34.7kN/m² gauge pressure (250 mm Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified below without affecting the performance of the transformer.

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Upto & including 750mm	5
750 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

- 10.3.3. **Pressure Test** - One transformer tank of each size shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35kN/m² whichever is lower as measured at the base of the tank and will be maintained for one hour. The permanent deflection of the flat plates after the excess pressure is released shall not exceed the figures specified above.
- 10.3.4. The transformer shall be subjected to heat run test, if specified in data sheet.
- 10.3.5. Impulse test, if specified in the data sheet, shall be carried out on all three limbs of the transformer.
- 10.3.6. Transformer shall be subjected to short circuit test, if specified in the data sheet.
- 10.3.7. The following tests shall be conducted for the NGR.

- ✓ Measurement of resistance value at the prevailing ambient temperature by Kelvin Double Bridge.
- ✓ One minute power frequency high voltage withstand test.
- ✓ Insulation resistance measurement, both before and after the power frequency high voltage test.
- ✓ Heat run test.

The temperature rise / heat run test may be conducted by passing the rated current for rated time on a limited resistor section in a proportionately sized test enclosure. The temperature rise shall be measured under simulated conditions ensuring that heat produced ($I^2 RT$) in the test enclosure is more than or equal to the calculated value of energy dissipation required for the test enclosure in proportion to the complete Neutral Grounding Resistor enclosure as per the thermal model adopted. Details of the calculation /modelling considered shall be furnished.

Vendor shall submit QAP/FAT well in advance (3 weeks before supply of Power Transformers) for GGL approval; inspection shall be carried out only after QAP is approved.

Bidder shall appoint a Third Party Agency approved by GGL to witness all tests at the manufacturers at work shop.

11. PACKING AND DESPATCH

All the equipment shall be divided into multiple sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship, rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates / cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'volume' 'Owner's particulars', 'P.O. no.' etc. shall be clearly and indelibly marked on the packages together with other details as per purchase order. The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. In order to prevent movement of equipment/components within the crates, proper packing supports shall be provided.

12. DRAWINGS & DOCUMENTS

6 sets of Drawings and documents shall be supplied for approval.

13. SPARES

Tenderer shall quote itemized unit prices for spare parts as listed in Annexure-II recommended for use during the stipulated period and also other essential spares recommended to be kept in stock at all times.

14. DEVIATIONS

Deviations, if any, from this specification shall be clearly indicated in the offer.

15. SCHEDULE & PROGRESS OF MANUFACTURE & DELIVERY

The bar chart indicating the various activities till the time of final inspection and delivery of the equipment shall be duly filled in by the tenderer.

16. PREFERRED LIST OF MANUFACTURERS

Power Transformer (On-Load/Off Load)

- CGL
- VOLTAMP TRANSFORMER LTD
- ALSTOM LTD.
- BHARAT BIJLEE
- KIRLOSKAR
- ROYAL, V.U. NAGAR
- ABB LTD.
- SCHNIEDER ELECTRIC INDIA LTD


OLTC Unit with RTCC

- BHEL
- TELK
- EASUN MR (Formerly HHE)
- CGL
- CTR

17. ATTACHEMENTS -

- | | | |
|--------------------|---|-------------------------------------------------------------|
| 17.1. Annexure-I | - | Technical Datasheet : 315/500/630/750 Amp Power Transformer |
| 17.2. Annexure-II | - | LIST OF FITTINGS |
| 17.3. Annexure-III | - | LIST OF SPARES |
| 17.4. Annexure-IV | - | Schedule of Rates |

18. TYPICAL QAP

		QUALITY ASSURANCE PLAN - POWER TRANSFORMER								
Sr. No.	Component/ Operation	Characteristics	Type of Check	Quantum of Check	Reference Documents	Acceptance Standards	Types of records	Inspection By		
								M	TPIA	GGL
1	Bill of materials	OTI/WTI	-DO-					P	R	R
		Radiators Detachable	-DO-							
		Bushings – HV/LV	-DO-							
		Lifting Lugs	-DO-							
		Explosion vent	-DO-							
		Earthing terminals	-DO-							
		Oil Sampling Valve	-DO-							
		Drain Valve with plug	-DO-							
		Radiator Shut-off valve	-DO-							
		Oil Level Indicator	-DO-							

		Marshaling Box	-DO-							
		Conservator	-DO-							
		Silica gel	-DO-							
		Bi-directional rollers	-DO-							
		RTCC Panel with AVR	-DO-							
		Thermometer Pockets	-DO-							
2	Visual Inspection- Power Transformer	Dimension	Measurement	100%		Approved Drg.	REPORT	P	W	W
		Painting Shade	Phy. Test			IS:5, 631, 80-100 micrn	TC	P	R	R
		Name Plate details	-DO-			Filled Details				
		Type of Cooling	-DO-			ONAN				
		Marshaling box – type	-DO-			Indoor type				
3	Lamination	Core Material	Phy. Test	Sample		Silicon Cold Rolled Magnetic Sheet Steel	TC	P	R	R
		Specific Watt Loss	Elec. Test			1.10 W/Kg				
4	Radiator	Dimensions	Measurement	100%		Approved Drgs	REPORT	P	W	W
		Thickness	Phy. Test			1.0 mm thick pre-stressed steel	TC	P	R	R



		Valve Type	-DO-			butterfly type and leak proof	-	P	R	R
5	Tank	Dimensions	Measurement	100%		Approved Drgs	REPORT	P	W	W
		Withstanding stress Capacity	Phy. Test	-DO-		0.40 kg/cm2	TC	P	R	R
		Paint Shade	-DO-	Sample		IS:5, 631	TC	P	R	R
6	Transformer Oil	Electrical Strength in Air-BDV	Elec. test	Sample per Lot		72 kV	REPORT	P	W	W
		Qty.	Phy. Test	100%		10 % Extra				
7	Bushing	System Voltage	Phy. Test	100%		28 kV / 1.1 kV	TC	P	R	R
		Leakage Gasket	-DO-			No Leakage				
8	Winding	Conductors Materials	Phy. Test	100%		Copper	TC	P	R	R
		Type of Insulation	Elec. Test			Class 'A' paper				
		Winding resistance	-DO-			IS 2026				
9	Tap Changer	Dimension	Measurement	100%		DrGs.	REPORT	P	W	W
		Visual Condition	-DO-			No Leakage	—	P	R	R
		Cooling Type	Phy. Test			Oil Cooled				
		Nos. of Taps	-DO-			±10% in step of 2.5%				
		Tap Provision	-DO-			HT Side				



10	Final Testing, Routine test	Turn Ratio Test	Measurement	100%		IS-2026	REPORT	P	W	W
		Vector Group	-DO-			DYn11				
		% Impedance	Elec. test			4.5%				
		Insulation Resistance	-DO-			>50 M Ohm				
		No Load Loss	-DO-			Limit as specified in IS 2026				
		Full Load Loss	-DO-							
		Voltage Regulation (All Stage)	-DO-			±10% in step of 2.5%				
<i>P : Perform, R= Review, W= Witness, TC – Test Certificates, M-Manufacturer, TPIA- Approved Third Party Agency .</i>										
<i>Note:</i> <i>This QAP is for reference. Vendor shall submit QAP/FAT well in advance (3 weeks before supply of Power Transformers) for GGL approval; inspection shall be carried out only after QAP is approved.</i> <i>Bidder shall appoint a Third Party Agency approved by GGL to witness all tests at the manufacturers at work shop.</i>										