MODEL TECHNICAL SPECIFICATION

SECTION: LT TRANSFORMER

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1.0 SCOPE

1.1 This specification covers design, engineering, manufacture, testing, delivery at site including all materials, accessories, spares, Transportation inclusive of insurance and delivery FOR site basis, unloading, handling, proper storage at site, erection, testing and commissioning of the equipment specified.

1.2 The Transformer offered by the contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. If the IS standard is not available, then other applicable international standard (IEC/Equivalent), as per the specification, shall be accepted.

1.3 Any material and equipment not specifically stated in this specification, but which are necessary for satisfactory operation of the equipment shall be deemed to be included unless specifically excluded and shall be supplied without any extra cost.

1.4 Components having identical rating shall be interchangeable.

2.0 GENERAL INFORMATION

2.1 The transformer & all its accessories etc, shall be designed to withstand without injury the thermal & mechanical effects of any external short circuit to earth & of short circuits at the terminal of any winding as per IS 2026-5.

2.2 The transformers shall be capable of being overloaded in accordance with IS 2026 (PART 7) IEC-60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

2.3 "No-load" current shall not exceed 2 percent of the full load current and shall be measured by energizing the transformer at rated voltage and frequency. Increase of 12.5 percent of rated voltage shall not increase the no-load current by 5 percent of full load current.

2.4 Alarm and trip contacts of Oil &Winding Temperature Indicators, Buchholz relays and other auxiliary devices shall be suitable for 220 V DC Control supply.

2.5 DYNAMIC SHORT CIRCUIT TEST REQUIREMENT

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit Test on 33kV or above voltage class LT Transformer as on the Last date of bid opening.

The offered transformer should comply the requirement of similarity clause specified in IS 2026 (PART 5) / IEC 60076-5 with respect to short circuit tested transformer. Further, design review of offered transformer shall be carried out based on the design of short circuit tested transformer.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

3.0 CORE

The core shall be constructed from Cold rolled grain-oriented silicon steel electrical steel as per IS 3024 (conventional or better).

Permissible Flux Density and Over fluxing: 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 does not exceed 1.9 Tesla. Manufacturer should furnish the design calculations in support of flux density.

4.0 WINDINGS

The conductors shall be of electrolytic grade copper free from scales and burrs. Oxygen content shall be as per IS 12444. Copper conductor shall be as per IS 191, IS 1897, IS 7404, IS 12444, IS 13730.

The windings shall be designed to withstand the dielectric tests specified elsewhere in the specification. The type of winding shall be used of proven design and similar type of winding have already manufactured, type tested and is under operation without failure.

5.0 TANK

Tank shall be of welded or bolted construction and fabricated from tested quality low carbon steel of adequate thickness. Unless otherwise approved, metal plate, bar and sections for fabrication shall comply with BS-4360 / IS 2062. Tank stiffeners shall be provided for general rigidity, and these shall be designed to prevent retention of water. The tank cover shall be designed to prevent retention of water and shall not distort when lifted. The internal surface of the top cover shall be shaped to ensure efficient collection and direction of free gas to the Buchholz relay.

6.0 GASKET FOR TANK & COVER

All tank gaskets used shall be of HNBR and properties of all the above gaskets / O-Rings shall comply with the requirements of IS-11149 (Grade III) Material selected shall suit temperature conditions expected to be encountered. Neoprene / cork sheets gaskets are not acceptable. The Gaskets and O-rings shall be replaced

every time whenever the joints are opened. Compatibility test to be done for the gaskets with ester fluid proposed to be supplied.

7.0 FOUNDATION

Suitable locking arrangement along with foundation bolts shall be provided to prevent accidental movement and during earthquake.

8.0 CONSERVATOR

Conservator shall be fitted with magnetic oil level gauge with potential free high and low oil level alarm contacts and prismatic oil level gauge. Conservator tank shall have adequate capacity with highest and lowest visible levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to top oil temperature of 110 deg C. The capacity of the conservator tank shall be such that the transformer shall be able to carry the specified overload without overflowing of oil. Conservator shall be positioned so as not to obstruct any electrical connection to transformer.

9.0 DEHYDRATING SILICA GEL FILTER BREATHER

Conservator of Main Tank shall be fitted with a dehydrating silicagel filter breather. Connection shall be made to a point in the oil conservator not less than 50 mm above the maximum working oil level by means of a pipe with a minimum diameter of 25 mm.

10.0 PRESSURE RELIEF DEVICE

One number PRD shall be provided. It shall be mounted directly on the tank. Suitable canopy shall be provided to prevent ingress of rainwater. One set of potential free contacts shall be provided for tripping. The PRD shall comply with IEC 60076-22-1 requirement for type test and shall be suitable for 220V DC application.

11.0 BUCHHOLZ RELAY

One number Double float, reed type Buchholz relay complying to IS 3637 shall be provided in the connecting pipe between the oil conservator and the Transformer tank with minimum distance of five times pipe diameters between them. Any gas evolved in the Transformer shall be collected in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper tube shall be connected from the gas collector to a valve located about 1000 mm above ground level to facilitate sampling while the Transformer in service. Suitable canopy shall be provided to prevent ingress of rainwater. Each device shall be provided with two potential free contacts, one for alarm / trip on gas accumulation and the other for tripping on

sudden rise of pressure. The Buchholz Relay shall comply with IEC 60076-22-1 requirement for type test and shall be suitable for 220V DC application.

12.0 OIL TEMPERATURE INDICATOR (OTI) & WINDING TEMPERATURE INDICATOR (WTI)

All Transformers shall be provided with a device for measuring the top oil temperature and hot spot temperature of each winding (HV and LV) with dial type thermometer of 150 mm diameter for Oil and winding temperature indication with angular sweep of 270° and shall have adjustable potential free alarm and trip contacts. The setting of alarm and tripping contacts shall be adjustable at site. OTI/WTI shall comply with IEC 60076-22-1 requirement for type test and shall be suitable for 220V DC application.

Temperature sensing element suitably located in a pocket on top oil shall be provided. These shall be connected to the OTI and WTI instrument by means of flexible stainless-steel armoured capillary tubing. WTI shall have image coil and auxiliary CTs, if required to match the image coil, shall be mounted in the Marshalling Box / cooler control cabinet.

Temperature indicator dials shall have linear gradations to clearly read at least every 20C. Range of temperature should be 0- 150°C with accuracy of ±1.5% (or better) of full-scale deflection. Adjustable range shall be 20-90% of full-scale range. Heavy duty micro switch of 5A at 240V AC shall be used. The instruments case should be weatherproof and having epoxy coating at all sides.

OTI/WTI shall be provided with 4-20mA output which can be wired to BCU for further transfer data to SCADA through IS/IEC 61850 compliant communications.

Instruments should meet ingress protection class of IP55 as per IS 13947 /IEC60529. The instruments should be capable of withstanding line to body high voltage of 2.5kV AC rms, 50Hz for 1 minute.

13.0 TERMINAL ARRANGEMENT

13.1 The transformers shall be fitted on high voltage and low voltage sides with outdoor type bushings of appropriate voltage and current ratings. The high voltage bushings (3 Nos.) shall conform to IS 2099. The low voltage bushings (4 Nos.) shall conform to IS 7421. Low voltage side shall be made suitable for adoption of PVC/XLPE cables of suitable size. The neutral terminals of 433V winding shall be brought out on a bushing along with the 433-volt phase terminals to form a 4-wire system.

13.2 To facilitate cable connections, suitable cable boxes shall be provided and shall be air insulated. Sufficient space should be provided to accommodate Purchaser's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust & vermin proof.

14.0 OFF CIRCUIT TAP CHANGING EQUIPMENT

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

15.0 PAINT SYSTEM AND PROCEDURES

The typical painting details for transformer main tank, pipes, conservator tank, radiator, control cabinet/ marshalling box etc. shall be as given in **Annexure – C**. The proposed paint system shall generally be similar or better than this. The quality of paint should be such that its colour does not fade during drying process and shall be able to withstand temperature up to 120 deg C. The detailed painting procedure shall be finalized during award of the contract.

16.0 INSULATING OIL/ FLUID

Transformer to be filled with virgin synthetic ester insulating fluid complying with IS 16081 / IEC 61099. The contractor shall furnish test certificates from supplier for all physical, chemical & electrical properties as per IS 16081 / IEC 61099 against acceptance norms, prior to dispatch to site.

In case transformer is required with virgin high grade inhibited insulating oil conforming to IS 335 instead of synthetic ester fluid the same shall be specified in section project.

200 Liters (in one Steel drum) spare fluid for each LT transformer Unit shall be supplied & the cost shall be deemed to be included in each LT transformer Unit.

Insulating fluid used for first filling, testing and impregnation of active parts at manufacturer's works shall be of same type which shall be supplied at site and shall meet parameters as per specification. Proper handling, storage & filtration of ester fluid to be ensured at manufacturer’s work prior to first filling. There shall be no possibility for contamination with any other type of oil/ fluid during manufacturing & transportation.

17.0 MARSHALLING BOX

A metal enclosed (Stainless steel of minimum 1.5 mm thickness as per GTR), weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IS: 13947 Part-1.

Terminal blocks shall be suitable for connecting the following conductors on each side:

(i.) Current transformer circuits – minimum of two No. of 2.5 sq. mm copper wires each side
(ii.) Other circuits— minimum of one No. of 2.5 sq. mm copper wire each side

All incoming cables shall enter the marshalling box from the bottom. A removable undrilled gland plate shall be provided at the bottom of the box for accommodating glands for Employer's incoming and outgoing cables, which shall not be less than 450 mm from finished floor level.

Wiring Scheme shall be engraved in a plate and the same shall be fixed inside the Marshalling Box door. The cable between the M. Box & transformer shall be laid by the supplier through GI conduits/ pipes.

18.0 PVC CONTROL & POWER CABLES

Each Transformer unit is to be provided with Power & control cable (as required) from Transformer accessories to Marshalling box.

19.0 COOLING EQUIPMENT

The Transformer shall be designed for Oil Natural Air Natural Cooling (ONAN). Radiator shall be tank mounted. Design of cooling system shall satisfy the performance requirements. The radiator shall be of sheet steel in accordance with IS 513 and minimum thickness 1.2 mm. Radiators and its accessories shall be hot dip galvanised or corrosion resistant paint (as per Annexure-C) should be applied to external surface of it.

20.0 VALVES

All valves upto and including 50 mm shall be of gun metal or of cast steel/cast iron. 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 counterclockwise when facing the hand wheel. Suitable means shall be provided for locking the valves in the open and close positions. Each valve shall be provided with the indicator to show clearly the position of the valve. All valves' flanges shall have machined faces. All valves in oil line shall be suitable for continuous operation with oil at 115 deg C. Gland packing/gasket material shall be of "O" ring of nitrile rubber for all the valves flanges. All the flanges shall be machined.

21.0 EARTHING TERMINALS

Two (2) earthing pads (each complete with two (2) nos. holes, M16 bolts, plain and spring washers) suitable for connection to 75 x 12 mm galvanised steel grounding flat shall be provided each at position close to earth of the two (2) diagonally opposite bottom corners of the tank.

22.0 FITTINGS & ACCESSORIES

The following fittings & accessories shall be provided with each transformer covered in this specification. The fittings listed below are not exhaustive and other fittings which are required for satisfactory operation of the transformer are deemed to be included.

a) Conservator for main tank, isolating valves, drain valve, magnetic oil level gauge (with canopy) with low oil level alarm contacts and prismatic oil level gauge and Dehydrating Silicagel Filter Breather with flexible connection pipes to be used during replacement of any silicagel breather.
b) Pressure relief devices including canopy.
c) Buchholz relay double float, reed type with canopy and isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm / trip contacts (gas collecting device)
d) Air release plug
e) Bushing of each type with metal parts and gaskets to suit the termination arrangement.
f) Winding & Oil temperature indicators
g) Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.
h) Thermometer or magnetic or micro switch type dial type temperature indicator as applicable
i) Rating and diagram plates (in Hindi & English) on transformers and auxiliary apparatus
j) Marshalling box
k) Radiators
l) Terminal marking plates
m) Valves schedule plate
n) Cables for body protection equipment/relays to Marshalling Box.

23.0 INSPECTION AND TESTING

23.1 The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment. All accessories and components of transformer shall be purchased from approved soured of purchaser. All process tests, critical raw material tests and witness / inspection of these testing shall be carried out as per approved manufacturing quality plan (MQP) by purchaser.

23.2 FACTORY TESTS

The manufacturer shall be fully equipped to perform all the required type and routine tests as specified. The contractor shall carry out type & routine tests as per "**Annexure-B**". Type test shall be carried out one unit and routine test shall be performed on all units of same rating. Complete test report shall be submitted to

purchaser after proper scrutiny and signing on each page by the test engineer of the contractor.

23.3 **TANK TESTS**:

Vacuum & Pressure Test (as routine test) shall be performed on tank. Vacuum withstand: 3.33kPa absolute pressure for 1 hour without deflection beyond 5mm.

23.4 PRE COMMISSIONING TEST AT SITE

The following tests shall be carried out at site prior to energization:

i. Measurement of Winding Resistance
ii. Core assembly dielectric and earthing continuity test
iii. Measurement of insulation resistance & Polarization Index
iv. Measurement of insulation power factor and capacitance between winding to earth, and between windings
v. Measurement of Voltage ratio and check of phase displacement
vi. Oil parameters tests like BDV, Water content & Dielectric dissipation factor

The test results shall be compared with factory test results provided by OEM.

ANNEXURE-A

Technical Parameters

S. N.	Description	Unit	Parameters						
1	Rated Capacity	kVA	250	315	630	800	315	630	800
2	Rated Voltage								
a)	HV	kV	11	11	11	11	33	33	33
b)	LV	kV	0.433	0.433	0.433	0.433	0.433	0.433	0.433
3	Standard		IS 1180 & IS 2026						
4	Type of Winding		Two Winding						
5	Service		Outdoor						
6	No of Phases	No.	Three						
7	Frequency	Hz	50						
8	Type of Cooling		ONAN	ONAN	ONAN	ONAN	ONAN	ONAN	ONAN
9	Impedance at 75 Deg C	%	4.5	4.5	4.5	5	5	5	5
10	Tolerance on Impedance	%	±10	±10	±10	±10	±10	±10	±10
11	Duty		Continuous						
12	Overload		IS 2026						
13	Max. Temp. Rise over an ambient of 50 Deg C								
a)	Oil (Temperature rise measurement by thermometer)	O C	40						
b)	Winding Temperature rise measurement by resistance method)	O C	45						
14	Windings								
a)	System Apparent Short circuit level (kA)		As per IS 2026-Part 1						
b)	Winding Connection								
(i)	HV		Delta	Delta	Delta	Delta	Delta	Delta	Delta
(ii)	LV		Star	Star	Star	Star	Star	Star	Star
15	Vector Group		Dyn1						

16	Insulation		Uniform						
17	Insulation Level	kVrms							
a)	Power Frequency Test Level								
(i)	HV	kVrms	28	28	28	28	95	95	95
(ii)	LV	kVrms	2						
18	Basic Impulse Level								
(i)	HV	kVp	75	75	75	75	250	250	250
(ii)	LV	kVp	-	-	-	-	-	-	-
19	Highest voltage (kV) for each winding	kV	12	12	12	12	52	52	52
20	Method of earthing		Solidly earthed						
21	Tap changer								
a)	(i) Tap Change		+5% to -10% in step of 2.5% on HV side						
b)	(ii) Tap control		Off Circuit Tap Change Switch						
22	HV Bushing								
a)	Rated Voltage	kV	12	12	12	12	52	52	52
b)	Rated current	A	100	100	100	100	100	100	100
c)	Basic Impulse Level (kVp)	kVp	75	75	75	75	250	250	250
d)	Wet & Dry Power frequency Withstand Voltage	kVrms	28	28	28	28	95	95	95
e)	Min. Total Creepage Distance	mm	300	300	300	300	1300	1300	1300
f)	Mounting		Tank / Transformer Body						
23	LV & Neutral Bushing								
a)	Rated Voltage	kV	1	1	1	1	1	1	1
b)	Rated current	A	630	630	1000	2000	630	1000	2000
c)	Wet & Dry Power frequency Withstand Voltage	kVrms	5	5	5	5	5	5	5
d)	Mounting		Tank / Transformer Body						

24	Terminal Details			
a)	HV		Suitable for 11kV Cable or Over Head Conductor	Suitable for 33kV Cable or Over Head Conductor
b)	LV & Neutral		Cable Box	
25	Min. Clearance in Air and cable box			
a)	Ph-Ph (HV/LV)	mm	As per IS: 1180 & IS 2026-3	
b)	Ph-Earth (HV/LV)	mm	As per IS: 1180 & IS 2026-3	
26	Rated Short Circuit Current	kA	25 kA for 3 second	
27	Guaranteed Losses	**kW**	The total losses (no-load + load losses at 75°C) at 50 percent of rated load and total losses at 100 percent of rated load shall not exceed the maximum total loss values given in IS 1180. Energy Efficiency Level 2	

ANNEXURE-B

TEST PLAN

Sr. No.	Test Description	11kV	33kV
1	Measurement of Winding Resistance	Routine	Routine
2	Core assembly dielectric and earthing continuity test	Routine	Routine
3	Measurement of insulation resistance & Polarization Index	Routine	Routine
4	Measurement of insulation power factor and capacitance between winding to earth, and between windings	Routine	Routine
5	Measurement of Voltage ratio and check of phase displacement	Routine	Routine
6	Measurement of Load Loss and short circuit impedance (Normal & Extreme taps)	Routine	Routine
7	Measurement of No-Load loss and current	Routine	Routine
8	Chopped wave lightning impulse test for the line terminals (LIC)	-	Type
9	Full wave lightning impulse test for the line terminals	Type	-
10	Applied voltage test (AV)	Routine	Routine
11	Induced voltage withstand test (IVW)	Routine	Routine
12	Pressure Test on Tank	Routine	Routine
13	Vacuum Test on Tank	Routine	Routine
14	Oil leakage test on transformer tank	Routine	Routine
15	High voltage with stand test on auxiliary equipment and wiring after assembly	Routine	Routine
16	Appearance, construction, and dimension check	Routine	Routine
17	Temperature rise test	Type	Type
18	Dynamic Short circuit test (If specified in BPS)	Type	Type

ANNEXURE – C

PAINTING PROCEDURE

Painting	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	Total dry film thick-ness (DFT)	Colour shade
Main tank, pipes, conservator tank, etc. (external surfaces)	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40µm)	Epoxy high build Micaceous iron oxide (HB MIO) (75µm)	Aliphatic polyurethane (PU) (Minimum 50µm)	Minimum 155µm	RAL 7035
Main tank, pipes (above 80 NB), conservator tank, etc. (Internal surfaces)	Shot Blast cleaning Sa 2 ½*	Hot oil proof, low viscosity varnish or Hot oil resistant, non-corrosive Paint	--	--	Minimum 30µm	Glossy white for paint
Radiator (external surfaces)	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40µm)	Epoxy base Zinc primer (30-40µm)	PU paint (Minimum 50µm)	Minimum 100µm	Matching shade of tank/ different shade aesthetically matching to tank
	Contractor may also offer Radiators with hot dip galvanised in place of painting with minimum thickness of 40µm (min)					
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish or Hot oil resistant, non-corrosive Paint	--	--	--	--
Control cabinet / Marshalling Box - No painting is required.						

Note: (*) indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1.

For coastal area transformer (external surface) painting shall be of **C5 type** as per ISO 12944-5 with total DFT 320 µm (minimum).