SECTION – 2.08

AUXILIARY TRANSFORMER (OIL FILLED TYPE)

1.0.0 INTRODUCTION

1.1.0 This section covers the requirements of oil filled outdoor 11 kV transformer for MCR and BESS plant area shall be installed to power up the control circuit and plant auxiliaries.

1.2.0 The sizing of Transformer shall be as per Auxiliary load calculation with 10% design margin

2.0.0 SCOPE OF WORK

2.1.0 The scope of work shall include the following equipment.

2.2.0 Required rating shall be designed as per connected load. Final rating shall be as per Standard Ratings as per IS

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, IEC publications and any other standards of latest edition including amendments, except where modified and /or supplemented by this specification.

IEC 60296	Fluids for Electrotechnical applications- Mineral insulating oil for electrical equipment.
IS 12463	Inhibited mineral insulating oils
IS 2026	Specification for Power Transformers (All parts)
IS 2099	Specification For Bushings for Alternating voltages above 1000V
IS 3347	Dimension for porcelain transformer bushings
IS 3639	Specification For Fittings and accessories for Power Transformers
IS 4257	Porcelain Bushings for Transformers
IS 6600	Guide For Loading Of Oil Immersed Transformers
IS 10028	Code of practice for selection, installation, and maintenance of transformers
IS-5	Painting

IS-2705	Specification for Current Transformers.
IS 8478	Application Guide for On Load Tap changers.
IS 10561	Application Guide for Power Transformers.
IS 1271	Electrical insulation - Thermal evaluation and designation
IS 1554(PART 1)	PVC insulated (heavy duty) electric cables, Part 1 For working voltage up to and including 1100V
IEC 60529	Ingress Protection of Enclosure of Transformer
IEC 60076	Power Transformer
CBIP Manual on Transformers	
Indian Electricity Act and rules framed there-under.	
Regulations laid by the office of the Chief Electrical Inspector to Inspector to Central Electricity Authority (Draft Regulation on Technical standards for Construction of Electrical Plants and Electric Lines) Regulations, 2021/2022.	

4.0.0 DESIGN REQUIREMENTS (OIL FILLED TRANSFORMER)

4.1.0 Oil-filled Transformers shall be suitable for outdoor installation in a hot, humid and tropical climate. The transformers shall be capable of operating continuously at its rated output without exceeding the specified temperature limits.

4.2.0 The transformer HV winding and bushing insulation shall be suitable for ungrounded system voltage

4.3.0 Transformers shall be sized for the following ambient conditions as specified in the tender and in line with CEA regulations.

- Maximum daily average temperature of 40ºC
- Maximum yearly weighted average temperature of 32ºC
- Minimum ambient temperature of -5ºC

4.4.0 The transformers shall be capable of delivering the rated output at any particular tap continuously without exceeding the specified temperature limits under the following operating conditions.

- Voltage variation of ± 10% of rated voltage of that tap.
- Frequency variation of +3% -5% of rated frequency.
- Combined voltage and frequency variation of 10% (absolute sum).

4.5.0 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that under 10 per cent continuous over-voltage condition it does not exceed 1.9 Tesla.

4.6.0 Transformers shall withstand, without injurious heating 125% over fluxing for a period of one (1) minute and 140% over fluxing for a period of five (5) seconds. (Over fluxing caused by combined voltage and frequency fluctuations).

4.7.0 Transformers shall be capable of operating at 125% rated voltage for a period of one (1) minute and 140% rated voltage for a period of ten (10) seconds due to sudden load throw off.

4.8.0 The transformers shall be free from annoying hum and vibration when it is in operation, even at 110% rated voltage.

4.9.0 The transformers shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuit.

4.10.0 The transformers shall be capable of withstanding without injury, the thermal & magnetic stresses caused by faults on any of the winding /through faults with full voltage maintained on other winding for a period of 2 seconds.

4.11.0 The transformer and all its accessories including CT's (as applicable) etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 2 seconds.

4.12.0 The transformers shall be capable of being loaded in accordance with IS: 6600/IEC 60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

4.13.0 The noise level of transformer, when energized at normal voltage and frequency shall not exceed, when measured under standard conditions, the values specified in NEMA standard publication TR-1 and IEC 60076-10.

4.14.0 The temperature rise of top oil (by thermometer method) shall not exceed 50ºC over an ambient temperature specified in the tender document and Temperature rise of winding (by resistance method) shall not exceed 55ºC over an ambient temperature. Hot spot temperature based on maximum yearly weighted average temperature shall not exceed 98ºC.

4.15.0 Firefighting arrangements for Transformers shall be provided if applicable as per Tariff Advisory Committee (TAC)/CEA Regulations (latest/amended) / statutory requirements. Firewall & soak pit as applicable (as per statuary requirement/TAC/IS 10028 / IS 1646) shall be provided.

5.0.0 CONSTRUCTIONAL FEATURES - OIL IMMERSED TYPE TRANSFORMER

5.1.0 Tank

a) Tank shall be of welded construction and fabricated from tested quality low carbon steel plate of adequate thickness. After completion of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. Tank stiffeners shall be provided for general rigidity and these shall be designed

to prevent retention of water. The main tank body excluding tap changing compartments and radiators shall be capable of withstanding vacuum.

b) Each tank shall be provided with :

- Lifting lugs suitable for lifting the equipment complete with oil.
- A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks.
- Suitable haulage holes.
- Oil level site glass

c) The tank shall be designed in such a way that it can be mounted on the plinth directly.

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

e) The tank cover shall be sloped to prevent retention of rainwater and shall not distort when lifted.

f) At least two adequately sized inspection openings one at each end of the tank, shall be provided for easy access to bushings and earth connections. The inspection covers shall be bolted type and shall not weigh more than 25 kg. Handles shall be provided on the inspection cover to facilitate lifting.

g) The tank covers shall be fitted with pockets at the position of maximum oil temperature at maximum continuous rating for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.

h) Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

i) All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over-compression.

5.2.0 Core

a) The core shall be constructed from high permeability grade, non-ageing, cold rolled, super grain oriented, and silicon steel laminations.

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

c) The hot spot temperature and surface temperatures in the core shall be calculated for over voltage conditions specified in the document and it shall not exceed 125 deg C and 120 deg C respectively

d) The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 kV (rms) for 1 minute.

e) Core and winding shall be capable of withstanding the shock during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

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

g) Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

h) 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.

i) Adequate lifting lugs will be provided to enable the core and windings to be lifted.

j) The frame work and clamping arrangement shall be earthed.

5.3.0 Windings

a) The conductors shall be of electrolytic grade copper free from scales and burrs.

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

c) The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service.

d) Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.

e) The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.

f) The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalize the distribution of currents and temperature along the winding.

g) All leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury/ shock from vibration or short circuit stress. Guide tube shall be used wherever applicable.

5.4.0 Conservator & Oil Preservation System

a) Conservator shall be provided which shall be fitted with oil level gauge with low oil level potential free contacts. The oil level at 30° C shall be marked on the gauge.

b) 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 100°C.

c) The conservator shall be fitted in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell, wherever applicable. Conservator shall be positioned so as not to obstruct any electrical connection to transformer. The conservator shall be designed so that it can be completely drained by means of the drain valve provided, when mounted as in service.

d) Conservator shall be fitted with a dehydrating filter breather. The breather shall be with SS cover (e.g. Yogya 100-186 flanged Type:DTO-3 or equivalent) Passage of air shall be through Silica gel. Silica gel shall be isolated from atmosphere by an oil seal. Breather shall be mounted not more than 1200 mm above rail top level. To minimize the ingress of moisture, two breathers of identical size shall be connected in series for main tank conservator.

e) Air cell shall be provided and shall be suitable for operating continuously at 100°C**.** Contact of the oil with atmosphere is prohibited by using a flexible air cell of Nitrile rubber reinforced with Nylon cloth. Air cell of conservator shall be able to withstand the vacuum during installation/maintenance periods. Otherwise provision shall be kept to isolate the conservator from the main tank when the latter is under vacuum by providing a vacuum sealing valve or other suitable means in the pipe connecting main tank with the conservator. The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator.

5.5.0 Pressure Relief Device

a) Adequate number of pressure relief devices shall be provided at suitable locations (minimum one number). These shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment. The device shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. It shall be mounted directly on the tank. One set of electrically insulated contacts shall be provided for alarm/tripping. Discharge of pressure relief device shall be properly taken through pipes and directed away from the transformer/other equipment and this shall be prevented from spraying on the tank. Means shall be provided to prevent ingress of rain. Pressure Relief device shall be mounted on the main tank in such a position to prevent gas accumulation.

5.6.0 Buchholz Relay

a) Buchholz relay shall be provided to collect any gas evolved in the transformer. 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/stainless steel tube shall be connected from the gas collector to a valve located at 1200 mm (Maximum) above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation/ low oil level conditions and the other for tripping on sudden rise of pressure/ low oil level conditions. A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the pipe and the cross level of the relay. Adequate clearance between oil pipe work and live metal shall be provided.

5.7.0 Joints and Gaskets

a) All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber or synthetic rubber gaskets confirming IS : 4253. with leak proof design and shall be guaranteed for oil leakage for at least five years

5.8.0 Oil Temperature Indicators (OTI)

a) Transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device shall be provided in the OTI. 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. Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Accuracy class of OTI shall be 1.5% or better.

b) The OTI shall also be provided with in built variable resistor for connecting it to transducers for remote monitoring ((SAS/SCADA/EnMS etc) of the temperature. The transducers shall be provided with dual outputs of 4-20mA signal and shall be mounted in the marshaling box.

5.9.0 Winding Temperature Indicator (WTI)

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

- Temperature sensing element.
- Image coil.
- Auxiliary CTs, if required to match the image coil, shall be furnished and mounted in the cooler control cabinet.
- 150 mm dia local indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts besides that required for control of cooling equipment,. Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Accuracy class of WTI shall be 1.5% or better.
- Calibration device.

b) The WTI shall also be provided with in built variable resistor for connecting it to transducers for remote monitoring (SAS/SCADA/EnMS etc.) of the temperature . The transducers shall be provided with dual outputs of 4-20mA signal and shall be mounted in the marshalling box..

5.10.0 Off Circuit Tap Changer

a) Off circuit taps as specified shall be provided on the high voltage winding.
b) +5% to –5% in steps of 2.5%
c) The transformer shall be capable of operation at its rated kVA on any tap provided the voltage does not vary by more than 10% of the rated voltage corresponding to the tap.
d) The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between HV and LV windings at all voltage ratios.
e) The tap changing shall be possible without disturbing the transformer in any way except de-energizing.
f) Tap position status shall be integrated with SAS/SCADA/EnMS etc. for remote monitoring.
g) An indicating device shall be provided to show the tap in use.
- A warning plate (SS-304) indicating "The switch shall be operated only when the transformer has been de-energised" shall be fitted.

5.11.0 Cable Box (HV and LV)

a) A dust tight air insulated type cable box with IP: 55 protection shall be provided for terminating the cables with termination kit for HV and LV side..

b) Inspection cover for fixed portion of cable box shall be provided. Handles for lifting cable box shall be provided.

c) Gland plate for cable termination shall be of Aluminum. with predrilled holes suitable to cable OD. HV cable box shall be provided with cable support arrangement suitable cable

d) The cable box (HV and LV) shall have Pressure Relief Diaphragm (PRD).

5.12.0 Axles and Wheels

a) The transformers shall be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer. The rail track gauge shall be suitable for transformer dimensions.
b) To prevent transformer movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation. All Wheels shall be detachable and shall be made of cast iron and steel as required.

c) Wheels shall be arranged so that they can be turned through an angle of 90° when tank is jacked up clear of the rails or floor.

5.13.0 Bushings

a) Bushings of identical rating shall be interchangeable.

b) Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

c) Clamps and fittings shall be of hot dip galvanised steel. The design of connectors/clamps shall ensure corona free operation at the maximum rated voltage.

d) Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.

e) No arcing horns shall be provided on the bushings.

f) The terminal marking and their physical position shall be as per IS: 2026.

5.14.0 Earthing Terminals

a) Two (2) earthing pads (each complete with two (2) Nos. holes, Galvanized steel M10 bolts, plain and spring washers) suitable for connection to 65 x 8 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.

b) Two earthing terminals suitable for connection to 50 x 6 mm galvanised steel flat shall also be provided on marshalling box and any other equipment mounted separately.

5.15.0 Terminal Arrangements

a) The electrical and mechanical characteristics of bushings shall be in accordance with IS: 2099 and IS: 3347.

b) Bushings of identical rating shall be interchangeable.

c) Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

d) Clamps and fittings shall be of hot dip galvanized steel.

e) Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.

f) No arcing horns shall be provided on the bushings.

g) The terminal marking and their physical position shall be as per IS: 2026.

5.16.0 Neutral Earthing Arrangement

a) For solidly grounded system, The neutral bushing terminal of the Transformer shall be brought to the ground level by a tinned copper grounding bar, supported from the tank by using porcelain insulators. The end of the tinned copper bar shall be brought to the bottom

of the tank, at a convenient point, for making bolted connection to Purchaser's grounding mat.

b) For non effectively grounded system, the neutral terminal shall be brought to cable box provided with transformer.

5.17.0 Valves

a) All valves upto and including 100 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 counter clock wise when facing the hand wheel.

b) Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.

c) Each valve shall be provided with the indicator to show clearly the position of the valve.

d) All valves flanges shall have machined faces.

e) All valves in oil line shall be suitable for continuous operation with transformer oil at 100 degree C.

f) The oil sampling point for main tank shall have two identical valves to be put in series .Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling. The sampling device shall not be fitted on the filter valves.

g) 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 of approved shade distinct and different from that of main tank surface. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate followed by two coats of fully glossy finishing paint.

h) All hardware used shall be cadmium plated / electro galvanized.

5.18.0 Rating and Diagram plate

a) Rating, instruction and Diagram plate shall be fixed to the transformer tank at an average height of about 1750 mm above ground level and shall be of stainless steel (SS-304 or higher grade) material.

b) Rating plate shall have all the data specified in the appropriate clauses of IS : 2026

c) Diagram plate shall show the internal connections and also the voltage vector relationship of the several windings in accordance with IS: 2026 and in addition a plan view of the transformer giving the correct physical relationship of terminals. No load voltage shall be indicated for each tap.

d) Valve schedule (table) with diagram shall be provided on a separate plate

e) Air cell replacement instruction plate shall be provided.

5.19.0 Wiring and Terminal Blocks

a) All, marshalling boxes, junction boxes etc shall be fully wired at the factory to ensure proper functioning of the control, protection and interlock schemes. All contacts including spare contacts of switches, relays and other devices shall be wired up to the terminal block. The

inter-connection cables shall not touch transformer body to avoid heating. The device cables shall be laid in suitable perforated adequately supported SS-304 cable trays with SS cover (tray filling factor not more than 50%). Glands used at device as well as marshalling box end shall be of double compression nickle plated brass glands

b) Wiring shall be done with flexible 1.1 kV grade PVC cables with stranded copper conductor of minimum size 2.5 sq. mm. Not more than two wires shall be connected to a terminal. Wiring shall be identified at both ends with ferrules bearing wire numbers as per approved drawing. Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

c) Terminal blocks shall be of 1.1 kV grade suitable for terminating required cable size. Terminals for CT secondary shall have provision for shorting & earthing. Not more than two wires shall be connected to any terminal. 20% spare terminals shall be provided for each terminal station and for each type of TB.

d) All devices and terminals blocks within the panel shall have identification numbers as per schematic diagram.

e) The marshalling box shall have IP 55 degree of protection.. Filling factor of troughs for wiring inside marshalling box used shall not be more than 50%.

5.20.0 Insulating Oil

a) The insulating oil shall be inhibited type mineral oil, and shall conform to IS: 12463.The transformer and all associated oil filled equipment shall normally be supplied along with the first filling of oil and excess quantity of oil shall also be supplied as per annexure- B of GTS in non-returnable drums The Bidder shall furnish test certificates from the supplier against their acceptance norms as mentioned below, prior to dispatch of oil from refinery to site. Sufficient quantity of oil necessary for maintaining required oil level in tank, radiators, conservator etc till commissioning shall be supplied.

b) Insulating oil used in all the transformers and spare oil to be supplied shall be of same make and type.

5.21.0 Each Oil filled Transformer shall be supplied with the following accessories:

Sl. No.	Item	Quantity
1)	Conservator for main tank with oil filling hole and cap, isolating valves, drain valve, , vent valve, toughened glass magnetic oil level gauge with low level alarm contacts.	1 No.
2)	Pressure relief devices with alarm/trip contacts.	1 No.
3)	Air cell type Oil preservation system complete with accessories	1 No.
4)	Conservator Protection Relay.	1 No.
5)	Buchholz relay with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.	1 No.
6)	150 mm dial magnetic oil level gauge with low level alarm contact.	1 No.
7)	Thermometer pocket with mercury in glass thermometer (0-120°C)	2 Nos.
8)	150 mm dial Winding temperature indicator with alarm and trip contacts.	1 No.
9)	150 mm dial oil temperature indicator with alarm and trip contacts.	1 No.
10)	Set of drain valves with pad locking arrangement	1 Set

Sl. No.	Item	Quantity
11)	Set of Sample valves (top oil sampling valve shall be located at bottom (two valves in series) and bottom oil sampling valve (two valve in series))	1 Set
12)	Set of Filter valves (top and bottom) with pad locking arrangement at bottom valve.	1 Set
13)	Set of Silica gel breather with oil seal (two connected in series). (SS cover type breather e.g. Yogya make model 100-186 flanged type or equivalent)	1 Set
14)	SS-304 Rating plate, instruction diagram plates and terminal marking plates.	1 No.
15)	SS-304 Valve Schedule plate.	1 No.
16)	SS-304 Do's & Don'ts plate.	1 No.
17)	All cabling between transformer and marshalling box.	1 Set
18)	Set of Air relief devices	1 Set
19)	Ladder with safety device for access to the top of transformer tank and conservator.	1 No.
20)	HV bushings	1 Set
21)	LV bushings	1 Set
22)	LV Neutral bushing	1 Set
23)	Inspection covers	1 Set
24)	Cover lifting eyes, lifting lugs, jacking pads, towing holes, etc.	1 Set
25)	Protected type mercury or alcohol in glass thermometer.	2 Nos.
26)	Flanged bi-directional wheels/rollers	1 Set
27)	Radiator banks complete with valves, etc..	1 lot
28)	Drain valves/plugs for pipe work	1 Set
29)	Off circuit tap changer.	1 Set
30)	Marshalling box with louvers. Louvers shall be protected by extended canopy, dimension of canopy shall be finalized during detailed engineering as per owners requirement.	1 No.
31)	HV cable box with cable supporting arrangement	1 No.
32)	LV cable box with pre drilled holes (according to OD of cables used) Aluminum gland pate	1 No.
33)	SS-304 Rain/ Weather protection canopies/ sheds of adequate size with mounting clamps & SS hardware for all the field devices e.g. buchholz relay, PRD, MOG etc. Dimension of canopy / rain / weather sheds shall be finalized during detailed engineering as per purchasers requirement	1 No.

The fittings listed above are only indicative and other fittings which generally are required for satisfactory operation of the transformer are deemed to be included. The transformer fittings and accessories shall be of reputed make and shall be subject to approval of the Purchaser.

Protection Devices to be mounted on transformers i.e. Buchholz, PRD/ PRV, CPR and MOG shall be Plug & Socket Type, IP67 protection. All protection devices along with nickle plated brass plug & socket with threaded locking arrangement and required length of armoured cable shall be assembled at respective device manufacturer's factory i.e. assembly at site or transformer manufacturer's work will not be allowed.

6.0.0 TESTS

All tests shall be carried out using its own accessories and parts which shall be supplied along with the Transformers. Offered rating and type of transformer should have type tested. Test reports of short circuit test shall be submitted along with the offer. The charges for carrying out all routine tests shall be deemed to be included in the Bid price. The charge of carrying out each type test/ special test shall be given separately in "Schedule of Unit Rates" for price adjustment purpose, In case of waiver of any of the tests by the Purchaser at a later date.

6.1.1 Type Tests

Following type tests shall be conducted in addition to routine tests on one of each type (rating) of transformer as per IS: 2026/ IEC-60076//CBIP Manual:

- Temperature rise Test.
- Power frequency voltage withstand test
- Lightning impulse test on line terminal
- Lightning impulse test on neutral terminal (for non effectively grounded neutral)
- Degree of protection for marshalling cabinet

6.1.2 Routine Tests

Following routine tests shall be conducted on each transformer as per IS: 2026/ IEC-60076/CBIP Manual :

- Measurement of winding resistance
- Measurement of voltage ratio and check of phase displacement
- Measurement of impedance voltage / short circuit impedance (principal tapping) and load loss.
- Measurement of no load loss and current.
- Measurement of insulation resistance.
- Separate source AC withstand test
- Induced overvoltage withstand test
- Lightning impulse test on line terminal
- Lightning impulse test on neutral terminal(for non effectively grounded neutral)

6.1.3 Following additional routine tests shall also be carried out on each transformer :

- Magnetic balance test
- High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

6.1.4 **Insulating oil shall** be tested for BDV & moisture, at manufacturer's works (oil sample shall be drawn before and after heat run test) :

- BDV : 60 kV (min.)
- Moisture content : 15 ppm
- DGA at factory and before commissioning at site.

6.1.5 **Special Tests**

Following Special tests shall be conducted on each transformer as per IS: 2026/ IEC-60076 /CBIP Manual:

- Determination of capacitance windings-to-earth, and between windings.
- Measurement of insulation resistance to earth of the windings, and /or measurement of dissipation factor (tan δ) and capacitance of the insulation system at factory and before commissioning at site. Tan-Delta and capacitance parameters shall be within IEEE C57.152 standards.

6.1.6 **Tank Tests**

a) **During fabrication** the following tests shall be carried out as per CBIP Manual for Transformers:

- The tank shall be tested for leakage by being completely filled with air at a pressure corresponding to twice the normal head of oil or to normal pressure plus 35 KN/Sq.m whichever is lower. The pressure shall be maintained for a period of minimum one hour during which time no leak shall occur. The equivalent air pressure corresponding to oil pressure calculated at the base of the tank to be considered for air pressure test. Permanent deflection of flat plates shall be measured on one tank of each design, after the excess pressure has been released and shall not exceed the figures specified below:

Horizontal Length of Flat Plate (in mm)	***Permanent Deflection (in mm)***
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.0
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

- The conservator shall be tested for leakage by being completely filled with air at 35 kN/ m2. The pressure shall be maintained for a period of minimum one hour during which time no leakage shall occur.
- The radiators shall be tested for leakage by placing them horizontally in a tank filled with clean water and applying air pressure 2 kg/cm2m for at least 15 minutes during which time no leakage shall occur.

- The Pipes shall be tested for leakage by applying air pressure 4 kg/cm^{2}m for at least 15 minutes during which time no leakage shall occur.

b) During fabrication the Vacuum test shall be carried out as per CBIP Manual as follows:

Transformer tank of each design shall be subjected to vacuum as follows:

i. 250 mm of Hg for upto 1.6 MVA

ii. 500 mm of Hg for above1.6 MVA and up to 20MVA

iii. 760 mm of Hg for above 20MVA

- The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values stated in above clause.

c) Before conducting pressure test, the following shall be taken care of:

  - Pressure relief valve/relief vent shall be removed and opening shall be blanked.
  - Transformer conservator shall be disconnected.
  - Oil should be completely filled and all trapped air released.

d) During assembly stage the following test shall be carried out as routine test.

e) Oil pressure test to be conducted on tank with turret and all other accessories as assembled by filling completely with oil at a pressure corresponding to twice the normal head of oil or to normal pressure plus 35kN/m2 whichever is lower. The pressure shall be maintained for eight hours during which time no leakage shall occur. If any leakage is observed, manufacturer / supplier shall rectify the same and reoffer the Transformer for Pressure test. During the test the pressure shall now be maintained only for 4 (Four) hours during which time no leakage shall occur. This test shall be repeated till there is no leakage from any joints.\

7.0.0 DEVIATION POINT

9.1.1 Bidder shall furnish the list of deviation from the technical specification in his proposal. Unless or otherwise deviation list submitted it is understood that Bidder is fully in compliance with the Technical Specification mentioned herewith.

8.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Transformer sizing calculation
- Technical data sheet
- Dimensional General Arrangement drawing of transformer and section drawing.
- Parts list
- Component list and Bill of Quantities
- Bushing / Terminal arrangement
- Cable box details
- Busduct termination arrangement
- Catalogues/drawings for bought out items.
- Transport /Shipping dimension drawing
- Foundation Plan & loading details
- Name plate details
- Dynamic short circuit test certificate / test report of similar transformer shall be provided. In case of DSC test certificate is not available; manufacturer shall carry out the test at no cost to the owner.
- Design calculations for short circuit withstand capability.
- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

9.0.0 TECHNICAL PARAMETERS

Sl. No.	Description	Unit	Data
1.	Service		Outdoor
2.	Type		Oil Filled type, two winding
3.	No. of Phase		Three
4.	Rating	kVA	-
5.	No. of windings		Two
6.	Nominal system voltage (HV / LV)	kV	11/0.415 , 50 Hz
7.	Vector group		Dyn11
8.	Type of cooling		ONAN
9.	Impulse withstand level		
a)	HV side	kV	75
10.	One minute Power frequency withstand voltage		
a)	HV side	kV	28
b)	LV side	kV	3
11.	Connections		
a)	HV side		Delta
b)	LV side		Star
12.	Neutral Earthing		
a)	HV side		
b)	LV side		Solidly grounded
13.	Terminal arrangement		
a)	HV side		Cable Box
b)	LV side		Cable Box
a)	LV Neutral side		Ground conductor
14.	Bushings		
a)	Bushings Creepage distance		31 mm /kV
15.	Tap Changer		
a)	Type		OCTC
b)	Tap provided on		HV side
c)	Range of taps	%	+5% to –5% in steps of 2.5%
16.	Short circuit withstand duration	Sec	2
17.	LV neutral bushing CT		As per requirement
18.	Losses		
	Copper Loss		As per IS
	Iron Loss		As per IS
19.	Impedance		As required to limit fault level
20.	Winding Material		Copper