



SECTION – 2.26

SCOPE OF WORK FOR THE EXISTING 70 MVA TRANSFORMERS

1. INTENT OF SPECIFICATION

Scope work for the existing 70 MVA, 132 kV transformer, is envisaged under this project. The broad scope outlined herein is conceptual in nature and intended to provide an overall understanding of the work involved.

The Bidder shall review the available data, site conditions, and existing system configuration, and shall accordingly carry out the required work. All activities shall be aligned with applicable standards, OEM recommendations, and best industry practices, ensuring safe, reliable, and efficient operation of the transformer integration with the proposed BESS.

2. DETAILS OF POWER TRANSFORMER

Sl. No.	Description	Unit	Data
1)	Make		BHEL
2)	Serial. No		6005602
3)	Rated Capacity		
	HV	MVA	70
	LV	MVA	70
4)	No. of windings		Two
5)	Winding Material	Lot	Electrolytic Copper
6)	Voltage Ratio (HV / LV)	KV	132/11
7)	Vector group		Ynd1
8)	Service		Outdoor
9)	Seismic Zone	Zone	V
10)	Corrosion Zone	Zone	C5-M as per ISO-12944
11)	Type of cooling		ONAN/ONAF
12)	ONAN Rating	MVA	50
13)	ONAF Rating	MVA	70
14)	Bi-directional power flow	Yes / No	Yes
15)	Temp. rise above 50 °C ambient Temp.		
	In oil by thermometer measurement	°C	50
	In winding by resistance method	°C	55
16)	HV system Voltage level		132kV, ± 10 %
17)	Highest HV system Voltage		145 kV
18)	LV system Voltage level		11 kV, ± 10%



Sl. No.	Description	Unit	Data
19)	Frequency & Variation		50 Hz, +3%, -5%
20)	No. of phases/frequency		3 / 50 Hz
21)	Lightning Impulse withstand level		
	HV side	KV _p	650
	LV side	KV _p	75
	HV Neutral	KV _p	95
22)	One minute Power frequency withstand voltage		
	HV side	KV _{rms}	275
	LV side	KV _{rms}	28
23)	Connections		
	HV side		Star
	LV side		Delta
24)	System earthing		
	HV side		Solidly grounded
	LV side		Resistive grounded
25)	Terminal arrangement		
	HV side		Overhead line
	LV		Cable Box
	LV Neutral side		Earthing Transformer with NGR
	HV Neutral side		Ground conductor
26)	Bushings creepage distance		31 mm/kV
27)	Tap Changer (OLTC)		
	Make		BHEL
	Type		M
	Type of Motor Drive Unit		MA7
	Tap provided on		HV side
	Range of taps	%	+16% to -16% in steps of 2%
	Mode of operation		Local Manual, Local Electrical, Remote Electrical, Auto Mode
28)	Auxiliary supply at Cooler Control cabinet		415 V, 3 phase 4 wire 50 Hz.
29)	% Impedance		14%
30)	Zero seq. Impedance		11%
31)	Transformer Losses		
32)	No load losses at rated voltage and frequency	KW	50



Sl. No.	Description	Unit	Data
33)	Load Losses at rated current and 75 degree centigrade	KW	222
34)	Auxiliary Losses at rated output and ambient temperate	KW	8

The following drawings, details, and documents are included in the tender for general reference only. These may not necessarily represent the latest "as-built" or updated status.

The Bidder shall be solely responsible for verifying the actual site conditions, type, and quantum of work prior to submission of the bid.

No additional cost or claim shall be admissible on account of any discrepancies, deviations, or inaccuracies in the drawings, documents, or information provided herein.

All available details and documents have been provided in this tender. For any additional information, the bidder shall carry out necessary site assessment.

The Bidder is advised to visit the site to familiarize themselves with the site conditions. Site visits may be arranged with prior intimation and on a mutually convenient date and time.

1. Transformer Name Plate
2. Technical Schedule
3. Transformer Layout (Refer for 70 MVA)
4. Transformer Earthing Layout (Refer for 70 MVA)
5. Instruction Manual OLTC type M
6. Schematic Diagram of Cooler Control Gear / Panel
7. Schematic Diagram of RTCC Panel (Independent T.C. Control)
8. Transformer Oil Testing Report Dated 01-10-2025
 - BDV, PPM, Acidity, Dielectric, Resistivity, Sludge , Interfacial Tension, and Flush Point
 - Furan
 - DGA
9. Isolated Phase Bus Duct Drawings
 - Layout of 11 kV , 5000 Amp Power Gear Make IPBD
 - Erection Key Diagram
 - Termination Details at Transformer
 - Termination Details at Wall
 - Cross Section
 - Expansion Joint, Disconnecting Link (Tap Off) & support insulators



- Support Structure with steel details.

10. Hydrant Network.

The following document shall be provided to the Bidder prior to commencement of work or as and when required:

- a) Instruction Manual Transformer (Will be provided to the bidder before commencement of work or as and when required)
 - Volume-I : Description and Operation of the equipment
 - Volume-II : Installation, Commissioning and O&M
- Transformer shutdown and isolation will be made available immediately once contractor team is mobilized at site with required tools, tackles, spare and material.
- Maintenance work shall be carried out strictly under controlled dry atmospheric conditions, ensuring no ingress of moisture during the activity. Before first-time charging after overhauling, the NIFPS system shall be mandatorily available and in serviceable condition.
- Any items, activities, or requirements not explicitly stated but necessary for the completeness, safety, reliability, and intended performance of the transformer system shall be deemed to be included within the Bidder's scope.

3. SCOPE OF WORK (Dismantling the existing & Replacement by brand new)

Supply, Design, Engineering, manufacturing, assembly, procurement, transportation (including transit insurance), loading, unloading, internal handling erection, installation, testing and commissioning etc. of following equipment for Power Transformer.

a. NIFPS System.

- i. Installation of NIFPS system requires complete dismantling of existing HVWS system. same is in scope of bidder.
- ii. Removal and Blanking of the existing HVWS system shall be carried out properly to ensure continuity of the remaining system.
- iii. All dismantled materials shall be handed over to the Owner.
- iv. Bidder shall refer to the scope of NIFPS defined in this specification.

b. Cooling Control Gear / Cabinet / Panel

- i. WTI



- ii. OTI
- iii. Fan Controls and protection.
- iv. SAS integration.
- v. Dismantling of existing CCC and handed over to the owner.

c. New LV side Cable Box

- i. Suitable for termination of 14R x 1C x 630 Sq. mm, 11 kV (UE) AL, XLPE Cables. Mentioned cable size & runs in SLD shall be finalized during detail engineering.
- ii. Suitable for termination of 11 kV (UE) AL, XLPE Cables for Neutral Grounding System.
- iii. Installation of New Cable Box requires, dismantling of existing bus ducts (IPBD) up to UAT tap off or as per project requirement. However, reuse of existing busbars of busduct may be permitted only after detailed inspection, testing, and certification confirming their suitability, safety, and compliance with project requirements. The decision of the owner in this regard shall be final and binding.

d. RTCC Panel

- i. Transformer unit shall be provided with separate Digital RTCC panel.

3.1 Nitrogen Injection Fire Protection system (NIFPS)

Bidder shall refer Vol. II Section 2.29 for DTS of NIFPS system.

3.2 Cooling Control Cabinet/Gear (CCC or CCG)

The Contractor shall supply, install, test, and commission a new Cooling Control Cabinet (CCC) suitable for integration with the existing 70 MVA, 132/11kV transformer. The CCC shall be designed to provide complete monitoring, control, protection, annunciation, and interfacing functions associated with the transformer cooling system. The detailed requirements are as follows: However, the Bidder shall ensure that the minimum functionality is maintained as per the existing system.

a) Functional Requirements



The CCC shall house all equipment required for the automatic, manual, and remote control of the transformer cooling system, including monitoring of oil and winding temperatures. The cabinet shall include devices for fan control, fan protection, current sensing, thermal overload protection, and annunciation of cooling-related faults. Hunting prevention logic shall be incorporated to avoid frequent start/stop cycles of fans. complete SAS/SCADA integration shall be provided using hardwired signals or IEC-61850, as specified.

b) Constructional Requirements

CCC shall be new, factory-fabricated, dust-proof, vermin-proof, outdoor type with minimum IP-55. Material shall be CRCA sheet of minimum thickness of 2.5mm. All external surfaces shall be painted considering C4-M corrosion zone, using high-durability epoxy/polyurethane system. The cabinet shall be equipped with:

- i. Pad-lockable doors
- ii. hinges
- iii. EPDM/neoprene gaskets

A sloping canopy to prevent entry of rainwater, internal lighting, control wiring harness, cable supports, terminal blocks, and glands shall be provided.

Following LED lamp indications shall be provided in cooler control cabinet as a minimum.

- i. Control supply failure
- ii. Power supply failure
- iii. Power supply changeover
- iv. Fan failure.
- v. Standby fan "ON"
- vi. Cooler control on 'Manual/Auto/Remote manual'.
- vii. Thermal overload trip for each fan
- viii. Any other indication as required.



Two set of potential free initiating contacts for all the following conditions shall be wired independently to the terminal blocks of cooler control cabinet, for connecting to Relay Panel and SAS/SCADA system:

- i. Control Supply failure.
- ii. Power Supply failure.
- iii. Fan failure.
- iv. Cooler control on 'Manual/Auto/Remote manual'.
- v. Thermal overload trip for fans
- vi. Buchholz relay Alarm/Trip
- vii. Winding Temperature Indicator Alarm/Trip
- viii. Oil Temperature Indicator Alarm/Trip
- ix. Pressure Relief Valve-1 Operated (Trip).
- x. Pressure Relief Valve-2 Operated (Trip).
- xi. Main tank Oil level low Alarm
- xii. Any other contacts as required.
- xiii. OLTC tank Oil level low Alarm
- xiv. Oil surge relay Alarm/Trip

c) Cooling Fan Control & Protection

CCC shall include the following for each cooling fan:

- i. MPCB / MCCB for short-circuit protection
- ii. Contactor for fan switching
- iii. Thermal overload relay (TOR)
- iv. Single-phase protection relays (if applicable)
- v. Indication lamps for ON/Trip/Failure

d) Fans shall be controlled based on:

- i. WTI contact outputs
- ii. Auto/Manual/Remote selector switches
- iii. Manual mode shall allow individual fan operation from CCC.



e) Temperature Monitoring System Integration

Accurate sensing via capillary bulbs or RTD sensors (PT-100) shall be provided. Temperature transducers shall output 4-20mA signals to RTCC/SAS. All WTI/OTI alarm and trip contacts shall be wired to dedicated terminals. Provision for future expansion (minimum 20% free terminals) shall be included.

f) Internal Components and Arrangement

The CCC shall include the following as a minimum:

- i. MCBs for both control and power circuits
- ii. Space heater with thermostat
- iii. Cubicle illumination lamp with door switch
- iv. Cable glands (Double compression, nickel-plated brass)
- v. Earthing studs and earth bus

All components shall be neatly arranged, labelled, and wired as per approved drawings.

g) Replacement of Existing CCC

The Contractor shall dismantle and remove the existing Cooling Control Cabinet safely without damaging connected components or wiring. All dismantled materials shall be handed over to the Owner at designated area of GIPCL premises. Re-routing or re-termination of existing cables, if required, shall be included in the Contractor's scope.

3.3 LV Cable Box

The LV Cable Box to be provided under this scope shall be a new, air-insulated, dust-tight enclosure designed for terminating the 11kV outgoing cables from the transformer and neutral grounding system. The cable box shall be constructed to a minimum degree of protection of IP-55, enabling reliable outdoor operation in the high-temperature, high-humidity and corrosive environment prevalent at the project location. The enclosure shall



be robust, mechanically rigid and fabricated from corrosion-resistant material suitable for C4-M category environments as per ISO-12944. The LV Cable Box shall be dimensioned and configured to suit the number of LV cable runs finalized during detailed engineering and shall permit termination using approved cable termination kits in a safe and accessible arrangement.

Minimum current rating shall be 4000 amps at 48 Degree centigrade or as per CEA guidelines whichever is higher.

The cable box shall be provided with a removable inspection cover and associated hardware to facilitate access to the fixed portion of the termination chamber. The inspection cover and top cover shall be designed to ensure ease of removal for maintenance while maintaining full weatherproof sealing during operation. Handles or lifting provisions shall be incorporated into the design to permit safe handling and maintenance activities.

The gland plate of the LV Cable Box shall be manufactured from high-grade aluminium and supplied with pre-drilled holes accurately matched to the outer diameter of the approved 11 kV cable types. The gland plate shall provide sufficient mechanical strength to support the weight and bending forces associated with multiple 630sqmm cable runs. Suitable internal cable support and clamping arrangements shall be included to prevent mechanical stress on terminations, ensuring proper strain relief and long-term reliability of the cable entry system.

A pressure-relief diaphragm shall be provided on the LV Cable Box to safely relieve pressure in the unlikely event of internal fault or abnormal pressure buildup within the termination compartment. The LV Cable Box shall be of phase-segregated construction, using solid insulating barriers or partitions to segregate each phase to prevent phase-to-phase faults and to ensure safe working conditions. A fully air-insulated disconnecting chamber shall be incorporated on the LV side to facilitate safe isolation during maintenance.

All supporting structural elements, including the base support frame, shall be fabricated from hot-dip-galvanized iron or a corrosion-protected equivalent to ensure mechanical stability and long-term protection against environmental degradation. The installation height and orientation of the LV cable box shall be finalized during detailed engineering to provide adequate working clearance, bending radius and accessibility.

The LV Cable Box shall be provided with sufficient internal depth and length to accommodate the minimum required 11 kV cable termination length. The final length and configuration shall



be determined during detailed engineering based on the approved cable size and termination type. The enclosure shall include a fully removable top cover to facilitate easy access for installation, inspection and maintenance of cable terminations.

The design, fabrication, supply and installation of the LV Cable Box including its sealing arrangement, internal hardware, earthing provisions, insulating barriers, gland plate assembly, cable supports and access covers shall be in full accordance with relevant IS/IEC standards, OEM requirements and the Owner's specification.

3.4 Remote Tap Changer Control Panel (RTCC)

The Numerical Tap Changer-cum Transformer Monitoring Unit (NTCMU) shall be housed in the RTCC panel. The panel shall comprise of the following as a minimum requirement: However, the Bidder shall ensure that the minimum functionality is maintained as per the existing system

- a) Raise / off / lower push buttons.
- b) Tap position indicator (On LCD or, better display)
- c) Remote transformer winding temperature indication (On LCD or, better display)
- d) Remote transformer oil temperature indication (On LCD or, better display)
- e) Voltage sensing relay
- f) Voltage regulation relay (AVR) for Auto operation
- g) Auto/Manual Selection
- h) Necessary auxiliary relays.
- i) Necessary analog/binary inputs
- j) LED indications for :
 - Tap change in progress
 - OLTC Mechanism stuck
 - AC supply fail
 - Oil surge relay Alarm/Trip
 - Control supply healthy
 - Lower limit reached
 - Upper limit reached
 - Any other feature/control/annunciation as required during detail engineering.



RTCC relay shall be microprocessor based adopting the latest state of the art design & technology with in-built large LCD (or better) display for ease of programming and viewing.

It shall be possible to communicate/integrate all digital RTCC relays may be of different make located at different locations in the Pooling Substation-1, by IEC 61850 communication protocol.

The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select these set points from SAS/SCADA.

In Manual Mode: In this mode, commands shall be executed manually by raise/lower push buttons. During Manual Mode, power system automatic voltage control shall be blocked.

In Auto Mode: In Auto mode, digital RTCC relay shall automatically control OLTC taps based on power system voltage and voltage set points from SAS. An interlock shall be provided to cut off electrical control automatically, on recourse being taken to the manual control in emergency.

Raise/Lower control: The remote OLTC scheme offered shall have provision to raise or lower taps for the Transformers remotely.

RTCC panels shall be installed in the Control & Relay (C&R) Room of the Main Control Room (MCR) building. The constructional features, design, and specifications of the RTCC panels shall be identical to those of the C&R panels (refer the relevant section of this tender for detailed specifications). The height of the RTCC panels shall match that of the C&R panels to maintain uniformity.

3.5 Constructional features of Cooler Control Cabinet/ Marshalling Box/ Junction Box / Digital RTCC Panel

The cooler control cabinet, marshalling box, Junction box and all other outdoor cubicles and OLTC Drive Mechanism box shall be made of CRCA sheet of minimum thickness of 2.5mm.



Digital RTCC panel shall be made of CRCA sheet of minimum thickness of 2.5mm and shall be painted considering C4-M corrosion zone as per ISO 12944 for high saline zone.

The degree of protection shall be IP: 55 for outdoor and IP: 43 for indoor in accordance with IS 13947/IEC: 60947.

Viewing windows in all the panels shall be of toughened glass (Acrylic, polycarbonate etc. are not permitted).

All doors, removable covers and plates shall be gasketed all around with suitably profiled. All gasketed surfaces shall be smooth straight and reinforced if necessary, to minimize distortion to make a tight seal. For Control cubicle / Marshalling Boxes etc. which are outdoor type, all the sealing gaskets shall be of EPDM rubber or any better approved quality, whereas for all indoor control cabinets / Digital RTCC panel, the sealing gaskets shall be of neoprene rubber or any better approved quality. The gaskets shall be tested in accordance with approved quality plan, IS: 1149 and IS: 3400.

Ventilating Louvers, if provided, shall have screen and filters. All the louvers shall be covered by canopy (extended as per owners requirement) to avoid ingress of moisture. The screen shall be fine wire mesh of brass. All the control cabinets shall be provided with suitable lifting arrangement. Thermostat controlled space heater, 15A Switch & socket and cubicle lighting with ON-OFF switch. All the canopies for the panel protection against rain shall be CRCA or better material with lifting lugs.

An extended canopy shall be provided to serve as a rain guard. The design details shall be finalized during the engineering stage, since no such arrangement currently exists

All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof for outdoor application.

The cabinet shall be equipped with:

- Pad-lockable doors
- hinges
- EPDM/neoprene gaskets



A sloping canopy to prevent entry of rainwater, internal lighting, control wiring harness, cable supports, terminal blocks, and glands shall be provided.

a) Wiring and Terminal Blocks

The control cabinets 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.

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.

All other cables shall be armored type (cable properly dressed) and shall be routed through fully covered good quality Galvanized Iron (GI) cable tray with adequate support/clamp/anchoring (GI) arrangement on Tank body and the cable tray shall be fixed at Transformer OEMs' factory (Site fixing / assembling / arrangement is not allowed). Filling factor of the trays used shall not be more than 50%.

All cable accessories such as double compression nickel plated brass glands at both device as well as panel end, lugs, cable tags/ numbers etc. as required shall be considered included in the scope of supply.

Terminal blocks shall be of 1.1 kV grade suitable for terminating required cable size and shall be of stud type (screw driver operated) with ring type lugs. Terminals for CT secondary shall have provision for shorting & earthing and shall be disconnecting type. Not more than two wires shall be connected to any terminal. 20% spare terminals shall be provided.

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



The enclosure shall have IP 55 degree of protection.

4. SCOPE OF WORK (Transformer & its accessories)

4.1 Codes & Standards

All overhaul, refurbishment and restoration activities covered under this specification shall be carried out in accordance with the latest applicable Indian Standards, IEC publications and other relevant standards, to the extent that they are applicable to repair, servicing, testing and refurbishment of existing transformers, except where specifically modified or supplemented by this specification.

- a) IS 12463 : Inhibited mineral insulating oil
- b) IS 2026 : Specification for Power Transformers (All parts)
- c) IS 2099 : Specification For Bushings for Alternating voltages above 1000V
- d) IS 3639 : Specification For Fittings and accessories for Power Transformers
- e) IS 6600 : Guide For Loading Of Oil Immersed Transformers
- f) IS 10028 : Code of practice for selection, installation and maintenance of transformers.
- g) IS-2705 : Specification for Current Transformers
- h) IS 8478 : Application Guide for On Load Tap changes.
- i) IS 10561 : Application Guide for Power Transformers.
- j) IS 1893 : Criteria for earthquake resistant design of structures.
- k) IS 5 : Painting
- l) IEC 60076 : Power Transformers (All parts)
- m) CBIP Manual on Transformers
- n) Indian Electricity Act and rules framed there-under.
- o) Regulations laid by the office of the Chief Electrical Inspector to Government.
- p) "Standard Specifications and technical Parameters for Transformers and Reactors (66 kV & above voltage class)" by CEA in April, 2021.
- q) CIGRE TB 529: Guidelines for conducting design reviews for power transformers

4.2 Overhauling of Transformer

The scope of work for the existing 70 MVA, 132/11 kV Power Transformer shall include but shall not be limited to the following activities. The intent is to restore the transformer to optimal operating condition through systematic refurbishment, replacement of worn-out



parts, diagnostic testing, and functional verification. All work shall be executed strictly as per OEM recommendations, relevant IS/IEC standards, and good utility engineering practices.

4.3 Documentation & Pre-Work Activities

4.3.1. Drawings:

The Contractor shall prepare complete drawings before commencement of work. This shall include nameplate details, wiring schematics, physical layout, OLTC configuration, control wiring, protection interfaces, auxiliary equipment arrangement, and any deviations from original drawings.

4.3.2. As-Built Drawings:

Upon completion, updated As-Built drawings reflecting all modifications, replacements, and changes in wiring or equipment locations shall be provided.

4.3.3. Comprehensive Overhaul Report:

A detailed report shall be submitted including:

- Pre-overhaul condition assessment
- Photographic record of dismantling
- All measurements, recorded values, and observations
- List of replaced parts
- Post-overhaul test results
- OEM conformity statements

Any other documents required for statutory compliance, Owner audit, or quality assurance shall be submitted.

4.4 Painting of Transformer & Accessories

The Contractor shall carry out complete repainting of the transformer and its associated components as follows:



- a. Main Transformer Tank
- b. Radiator Banks
- c. Conservator Tank
- d. Mounting Structures and Platforms
- e. All Valves and Associated Piping
- f. Cable Trays
- g. All External Accessories
- h. Final Paint Shade: RAL 7035 (Light Grey)
- i. Painting System: As per corrosion category of Baroda GIPCL site (C4-M, ISO-12944)

Surface cleaning, de-rusting, primer, intermediate and finishing coats shall match OEM-quality.

Painting shall be carried out as per 'CBIP Manual on Transformers'. Painting process shall be approved by the Owner.

The final thickness of paint film on steel shall not be less than 125 microns at any point. Sufficient quantity of touch-up paint shall be furnished for application at site.

Any damage to paint work incurred during handling shall be made good by the Bidder by thoroughly cleaning the damage portion and applying the full number of coats of paint that had been applied before the damage was caused. One coat of additional paint shall be given at site over all external surfaces, including hardware, after erection. Bidder shall supply the requisite quantity of paint.

The painting of all structures & equipment shall be done considering C4-M corrosion zone as per "ISO-12944" for high saline zone.

4.5 Replacement of Accessories

The following devices shall be replaced with new units of approved make:

4.5.1. Air Cell (COPSV)

The Air Cell shall be new, of approved make, and compatible with the existing BHEL 70MVA transformer design.



The Air Cell (COPSV) to be supplied and installed as part of the transformer overhauling works shall be a new, oil-resistant, and fully compatible bladder-type oil preservation element designed for installation inside the existing conservator tank of the 70 MVA power transformer. The air cell shall be constructed from high-quality elastomer such as reinforced nitrile rubber (NBR) or an equivalent synthetic compound approved by the Owner, and it shall be specifically formulated to withstand continuous exposure to hot transformer mineral oil at temperatures up to 100°C without degradation, swelling, cracking, or loss of elasticity. The air cell shall effectively prevent direct contact between transformer oil and atmospheric air, thereby eliminating oxidation, moisture ingress, and sludge formation in the oil.

The air cell shall be fabricated as a seamless or vulcanized component with uniform wall thickness, smooth internal and external surfaces, and reinforced fabric layers to provide the required mechanical strength and flexibility. The material shall be impermeable to atmospheric gases and moisture and shall retain its dimensional stability under repeated cycles of expansion and contraction throughout the expected service life of the transformer. The air cell shall be capable of operating reliably under varying internal pressures and shall withstand full vacuum conditions encountered during transformer oil filtration and hot oil circulation processes. It shall also tolerate differential pressure variations associated with transformer loading cycles without developing folds, stress points, or mechanical fatigue.

The air cell shall be supplied complete with a corrosion-resistant mounting flange made of stainless steel (SS-304/316) or hot-dip galvanised steel, fitted with oil-resistant gaskets to ensure leak-proof sealing to the conservator tank. The air inlet connection shall be provided with the required threaded or flanged fitting suitable for integrating with the existing dehydrating breather system. Provision for venting or draining may be incorporated where required by the existing transformer design. The interface dimensions, mounting hole patterns, port locations, and connection geometry shall match the existing BHEL conservator configuration, ensuring that no modification to the conservator tank is required during installation.

The air cell shall undergo factory testing, including a minimum 1 bar pneumatic leak test held for not less than 30 minutes without pressure drop, verification of seam integrity, mechanical strength testing of the fabric reinforcement, and material compatibility testing in accordance with IS 12463 and IEC 60296 oil-immersion requirements. The air cell shall be capable of



withstanding full vacuum (-760 mmHg) without deformation or structural failure. Only air cells supported by manufacturer's routine test certificates shall be accepted at site.

During installation, the Contractor shall remove the existing air cell, clean the internal surface of the conservator tank, remove rust and oil sludge, and apply a suitable coat of oil-resistant epoxy paint wherever required. The new air cell shall be installed without creases or stresses and shall be properly secured to avoid twisting during operation. After installation, the Contractor shall fill transformer oil into the main tank and conservator in a controlled manner to ensure uniform expansion of the air cell. All associated air lines and breather connections shall be reassembled and tested for air-tightness.

Upon completion, the Contractor shall provide the Owner with manufacturer's product data sheets, routine test certificates, installation instructions, warranty documents, and any other relevant technical literature. The Air Cell (COPSV) shall carry a minimum warranty of twelve months from the date of commissioning or twelve months from the date of supply, whichever is later.

4.5.2. Magnetic Oil Gauge (MOG)

The Magnetic Oil Gauge (MOG) to be supplied under the transformer overhauling work shall be a new, factory-calibrated, float-type magnetic level indicator designed for continuous monitoring of the transformer conservator oil level. The MOG shall be suitable for outdoor installation in an EHV substation environment and shall provide reliable indication of oil level under all operating conditions of the transformer. The device shall operate on the principle of magnetic coupling between an internal float assembly and an external dial indicator, ensuring leak-proof operation without the need for any physical shaft passing through the conservator wall. The MOG shall be compatible with mineral insulating oil conforming to IS12463 / IEC60296 and shall be capable of functioning at oil temperatures ranging from -10°C to $+100^{\circ}\text{C}$ without loss of accuracy or mechanical degradation.

The MOG shall consist of a corrosion-resistant float housed inside the conservator connected to a magnet assembly that transmits float movement to the dial indicator mounted externally on the conservator tank. The dial indicator shall have a clear, UV-resistant, glass or polycarbonate window with a legible oil level scale showing "LOW", "NORMAL", and "HIGH" markings. The indicator shall be readable from ground level or designated working platform.



The construction of the float and lever mechanism shall ensure friction-free movement, long-term stability, and resistance to sludge or contaminants in aged transformer oil.

The MOG shall be equipped with at least two potential-free contacts independently adjustable for low-oil alarm and low-oil trip functions. These contacts shall be of the sealed, moisture-protected type suitable for integration with the marshalling box and SCADA/SAS systems. Contact operation shall remain accurate over the entire temperature and oil-level range of the conservator. The contact rating shall be adequate for supervisory and relay interface circuits normally used in EHV substations.

The mounting flange, gasket, and associated hardware shall match the existing conservator tank opening so that installation can be completed without modification of the tank. The MOG body shall be fabricated from galvanized steel, aluminium alloy, or stainless steel (SS-304/316), and shall be finished with a corrosion-resistant coating for environment corresponding to C4-M category as per ISO 12944. All mechanical seals shall be oil-resistant and designed to prevent ingress of moisture or dust into the indicator housing.

The MOG shall be supplied complete with all accessories required for installation, including gaskets, bolts, washers, and terminal connectors. Upon completion of installation, the Contractor shall ensure proper calibration by comparing the indicated level with physical oil level inside the conservator. The operation of alarm and trip contacts shall be functionally tested from minimum to maximum level conditions. All wiring from the MOG contacts to the marshalling box shall be carried out using tinned-copper control cables with proper ferruling and tagging.

The MOG shall be provided with the manufacturer's routine test certificate confirming mechanical integrity, float travel accuracy, contact operation, leakage test, and marking as per relevant IS/IEC standards. A minimum warranty period of twelve months from the date of commissioning shall apply. The installation, commissioning, and functional testing of the MOG shall be fully included in the Contractor's scope.

An extended canopy shall be provided to serve as a rain guard. The design details shall be finalized during the engineering stage, since no such arrangement currently exists

4.5.3. Buchholz Relay



The Buchholz Relay to be installed as part of the transformer overhauling works shall be a new, double-float, oil-operated gas and sudden-pressure relay suitable for mounting in the pipeline between the main tank and the conservator. The relay shall be designed to detect slow gas accumulation as well as rapid oil movement caused by internal faults. It shall be fully compatible with mineral insulating oil in accordance with IS12463 or IEC60296 and shall operate reliably within the temperature range and vibration levels present in EHV transformers. The relay shall incorporate a gas collection chamber, a test petcock for gas sampling, and two independent potential-free electrical contacts for alarm and trip functions. The contacts shall operate through sealed reed switches actuated magnetically and shall not require external mechanical linkage. The enclosure of the relay shall be weather-proof and corrosion-resistant for outdoor service. The float mechanism shall be designed for smooth, friction-free movement, insensitive to oil sloshing or transient surges during normal operation. After installation, the relay shall be checked for proper orientation, oil tightness, contact operation, and gas-sampling functionality. The Contractor shall route all trip and alarm wiring to the marshalling box using approved FRLS control cables and perform a complete functional test before energization.

An extended canopy shall be provided to serve as a rain guard. The design details shall be finalized during the engineering stage, since no such arrangement currently exists

Gas sampling system shall be provided, as the same is not presently installed

4.5.4. Pressure Relief Valve (PRV-1 & 2)

The Pressure Relief Valve (PRV/PRD) shall be a new, fast-acting device designed to provide instantaneous release of excess internal pressure generated within the transformer under abnormal or fault conditions. The PRV shall open rapidly at a preset pressure below the tank's mechanical withstand capability and reseal automatically after discharge. The unit shall be constructed from corrosion-resistant materials suitable for outdoor EHV service, with an oil-tight body, spring-loaded diaphragm or disc mechanism, and protective canopy to prevent ingress of rainwater. The PRV shall include one set of electrically independent, potential-free contacts that change state upon operation and are suitable for integration with alarm and trip circuits. The PRV shall be capable of withstanding full vacuum during oil filtration and shall remain leak-proof across the normal operating pressure range of the transformer. All mounting dimensions, bolt patterns, and connection interfaces shall match the existing BHEL tank openings to allow direct replacement without modification. The Contractor shall test the



operation of the PRV contacts and ensure correct routing to the marshalling box prior to commissioning.

An extended canopy shall be provided to serve as a rain guard. The design details shall be finalized during the engineering stage, since no such arrangement currently exists

4.5.5. Oil Surge Relay (OSR)

The Oil Surge Relay for the OLTC compartment shall be a new, high-sensitivity device designed to detect sudden surges in OLTC oil flow that may result from internal arcing or mechanical malfunction within the tap changer. The OSR shall operate by sensing the oil velocity in the OLTC piping and actuating a hermetically sealed contact mechanism. It shall provide one alarm and one trip contact, each electrically independent and suitable for incorporation into the OLTC protection scheme. The OSR housing shall be made of corrosion-resistant material and fitted with isolation valves at both inlet and outlet to facilitate maintenance without draining the tap changer oil. The relay shall be compatible with OLTC insulating oil and shall retain accuracy across the specified temperature range. The Contractor shall carry out complete functional checks including mechanical operation, contact movement, wiring verification, and simulation of surge conditions where permissible.

All replaced equipment shall include required fittings, valves, gaskets, and electrical contacts wired to marshalling box.

An extended canopy shall be provided to serve as a rain guard. The design details shall be finalized during the engineering stage, since no such arrangement currently exists

4.6 Replacement of All Gaskets & O-Rings

All gaskets and O-rings shall be replaced for:

- i. Main Tank
- ii. All Valves
- iii. Radiators and Cooler Banks
- iv. Conservator and Associated Piping



All gasketed joints and O-ring seals associated with the transformer shall be replaced as part of the overhauling activity. This replacement shall cover but not limited to the main tank, all valve interfaces, radiator banks and cooling system connections, the conservator tank and its associated piping network, and every other location where gasket or O-ring sealing is employed in the transformer assembly. The intent of this requirement is to eliminate any risk of oil leakage, ingress of moisture or air, and long-term deterioration of the sealing system after the transformer is returned to service.

The gaskets and O-rings supplied for replacement shall be entirely new, manufactured within six months from the date of installation, and shall comply with the approved elastomeric classes specified for transformer applications. Unless otherwise stipulated, all gaskets shall be of RC-80C grade, made from oil-resistant nitrile rubber or an equivalent elastomer that retains sealing properties under continuous exposure to transformer oil at elevated temperatures. All gasket materials shall be compatible with hot mineral insulating oil conforming to IS12463 / IEC60296 and shall demonstrate resistance to compression set, hardening, swelling, and chemical degradation.

The Contractor shall ensure that each gasketed joint is cleaned, levelled, and prepared prior to installation of the new gasket or O-ring. The sealing surfaces shall be inspected for flatness, corrosion, pitting or burrs, and any deficiencies shall be rectified to ensure uniform sealing pressure. The installation shall be carried out using proper alignment and torque-controlled tightening of bolts to prevent over-compression or non-uniform stress on the sealing material. Only original-quality gasket profiles and cross-sections matching the existing joint design shall be used; substitute or fabricated gaskets that deviate from OEM geometry shall not be permitted without explicit Owner approval.

Upon completion of installation, each joint shall be visually inspected and subsequently monitored during oil filling, vacuuming, heating and circulation operations to verify leak-free performance. Any joint exhibiting sweating, seepage, or pressure-related leakage shall be immediately rectified by the Contractor at no cost to the Owner. All replaced gaskets and O-rings shall be documented in the overhaul report along with material grade, manufacturer details, batch number, and installation location.

4.7 Replacement of LV Cable System (Power, Control & Communication)

All low-voltage power, control, and communication cables associated with the transformer and its auxiliary systems shall be replaced in full as part of the overhaul work. The Contractor shall



examine the existing cable trench, trays, and routing paths and may reuse these only after a detailed physical inspection confirms their structural integrity, corrosion-free condition, and suitability for continued service; any damaged or inadequate sections shall be replaced or strengthened to meet current installation standards. The new cables shall be laid, dressed, clamped, and terminated strictly in accordance with relevant IS/IEC practices and OEM guidelines, ensuring mechanical protection, clear segregation of power and control circuits, and proper bending radius.

Only double-compression, nickel-plated brass glands shall be used for termination at all equipment and panel interfaces, providing weather-proof, dust-proof and vibration-resistant gland sealing. For all LV power circuits, the terminations shall be made using heavy-duty, long-barrel tinned-copper lugs, crimped using calibrated hydraulic crimping tools to ensure low contact resistance and long-term mechanical reliability. For control and communication wiring, only ring-type tinned-copper lugs shall be used, and the Contractor shall ensure that no fork-type or open-type lugs are installed anywhere in the system.

Every cable installed under this work shall be clearly identified with durable, machine-printed cable tags made of UV-resistant, fire-retardant material. These tags shall be provided at both ends of each cable, at intermediate locations near supports, and at entry/exit points of equipment or enclosures. Each core within a multicore cable shall be individually identified using machine-printed ferrules with permanent marking, installed in such a manner that the identification remains legible throughout the cable's service life. The Contractor shall ensure that ferrules correspond exactly to the approved wiring diagrams and shall update all drawings if deviations or renumbering occur during execution.

The replaced LV cabling system shall be fully tested for continuity, insulation resistance, polarity, phase sequence (where applicable) and correct termination. All deviations observed during cable laying or testing shall be rectified by the Contractor at no additional cost. The entire LV cable replacement work shall be carried out with due regard to safety, workmanship, and neat installation standards, ensuring long-term reliability of the transformer's auxiliary electrical systems.

4.8 Transformer Oil (New + Existing)



The existing transformer oil presently contained in the main tank shall be recovered, filtered, dried, degassed and vacuum-treated for reuse in the transformer during the overhauling process. The Contractor shall carry out this treatment using a suitably rated high-vacuum oil filtration plant, ensuring that the processed oil meets the dielectric, moisture and purity requirements specified for EHV-grade insulating oil in accordance with IS 12463 and IEC 60296. The Contractor shall include in his scope the complete procedure, filtration methodology, acceptance criteria, and test limits for the reused oil, and shall ensure that these details are submitted during engineering review for Owner approval.

In addition to refurbishing the existing oil, the Contractor shall supply new, unused mineral insulating oil required for topping-up the main tank, filling the OLTC compartment, and supporting all overhaul activities such as flushing, circulation, and oil loss recovery. The new oil shall be of the same make and grade as the oil currently in service; the Owner's designated make is **Savita**, and the oil shall conform to the applicable clauses of IS 12463 / IEC 60296. The Contractor shall provide the complete specification sheet and manufacturer's test certificate for each batch of new oil delivered to site, confirming compliance with permissible limits for BDV, moisture content, acidity, interfacial tension, sludge, particle count and dissolved gas levels.

The storage, handling, and preservation of both existing and new oil shall be entirely within the Contractor's scope. All oil shall be stored in clean, moisture-free, sealed steel tanks or drums, protected from dust, rain and direct sunlight, and shall be handled in a manner that prevents contamination at every stage of overhauling. The Contractor shall ensure that no oil is left exposed to the atmosphere, that nitrogen-blanketed containers are used where required, and that all hoses, pumps, filters and fittings remain free of moisture and foreign particles before use.

After completion of the overhauling work, any unused quantity of new insulating oil supplied by the Contractor shall be handed over to the Owner in properly sealed and labelled containers along with identification of batch numbers and relevant test certificates. All activities related to oil filtration, conditioning, filling, restoration of oil levels, and post-filling testing shall be carried out under the Contractor's responsibility, following strict adherence to the approved method statement and quality assurance plan.



4.9 Dismantling & Reinstallation

4.9.1. General Requirements

The dismantling and reinstallation of all peripheral structures, electrical equipment, mechanical assemblies and associated systems necessary for executing the transformer overhauling work shall form an integral part of the Contractor's scope. These activities shall be carried out in a planned, controlled and sequential manner, ensuring that no damage, deformation or misalignment is caused to any component during dismantling, shifting or reassembly. All work shall be executed under strict supervision by qualified personnel, using appropriate lifting tools, cranes, rigging devices and handling equipment in accordance with approved safety procedures applicable to EHV substation environments.

4.9.2. Scope of Dismantling Activities

The Contractor shall dismantle or temporarily remove all equipment and structures that obstruct access to the transformer, its radiators, bushings, conservator system, or any other part requiring intervention during overhauling. This may include removal of the 132 kV surge arresters, 132 kV post insulators, portions of the gantry tower or gantry steelwork connected to the transformer bay, the fencing sections, support structures, and the transformer yard gate or barriers required to create a safe working zone. The dismantling shall be undertaken with utmost care to avoid mechanical stresses on the porcelain insulators, galvanized structures and steel members, and all components shall be protected from impact, dust or moisture during the period of removal.

4.9.3. Handling, Storage and Protection During Dismantled Condition

All dismantled equipment shall be labelled, documented and stored within the Owner's premises. Storage shall be on cushioned supports or wooden pallets to prevent chipping, cracking or surface damage. Sensitive equipment such as surge arresters, post insulators, clamps, connectors and hardware shall be covered with weather-resistant protective material, ensuring that neither moisture nor dust enters any part of the equipment. The Contractor shall provide all temporary covers, protective wrapping, pallets, and storage arrangements needed to maintain the integrity of dismantled items throughout the overhaul period.

4.9.4. Reinstallation Requirements

Upon completion of overhauling work, all dismantled equipment and structures shall be reinstalled to their original positions with correct orientation, alignment, torque tightening and



electrical clearances restored to their pre-dismantling condition. The reinstallation shall be carried out strictly in accordance with original installation drawings, approved erection procedures and applicable IS/IEC standards. The Contractor shall ensure that the gantry components, surge arresters, post insulators and structural supports are reinstated with proper verticality, phasing, creepage distances and integrity of mechanical connections. All fasteners shall be cleaned and replaced if corroded, and joints shall be made using appropriate galvanised hardware.

4.9.5. Verification and Functional Checks After Reinstallation

Following reinstallation, the Contractor shall carry out comprehensive visual inspection and functional checks to verify that all equipment and structures are correctly installed, secure and ready for energization. This shall include verification of insulator alignment, surge arrester earth lead connections, gantry electrical clearances, integrity of fence grounding, and mechanical stability of all reassembled components. Any discrepancies observed during inspection shall be rectified immediately at the Contractor's cost. No equipment shall be energised unless written clearance is issued by the Owner/Engineer-in-Charge based on satisfactory inspection results.

4.9.6. Responsibility and Cost Implications

The Contractor shall bear full responsibility for safe dismantling, preservation, storage, reassembly and restoration of all affected equipment. Any damage, breakage or loss arising during handling or reinstallation shall be rectified or replaced by the Contractor at no cost to the Owner. The scope shall be deemed inclusive and complete, and no claim shall be entertained for dismantling or reinstallation activities necessary for facilitating transformer overhaul work.

4.9.7. Testing (Before & After Overhaul)

a) General Requirements

All testing before commencement of overhauling and after completion of all refurbishment activities shall be carried out by the Contractor using calibrated, NABL-certified equipment. The purpose of these tests is to establish the baseline condition of the transformer, verify the integrity of all components during the overhaul process and confirm the readiness of the



transformer for re-energisation. All tests shall adhere to the procedures and acceptance criteria in relevant IS/IEC standards and shall be witnessed by the Owner or its authorised representative whenever required.

b) Pre-Overhaul Testing

Prior to dismantling or opening any part of the transformer, the Contractor shall carry out the complete set of diagnostic and electrical tests to record the existing health condition of the transformer, including insulation strength, magnetic symmetry, winding electrical characteristics and overall dielectric state. These results shall be treated as reference data for comparison with post-overhaul measurements.

c) Voltage Ratio and Vector Group Verification

The Voltage Ratio Test shall be performed at all tap positions to confirm that the winding ratio corresponds with nameplate values and that the OLTC positions correspond to their designated tap numbers. The Vector Group Test shall verify phase displacement, polarity and winding interconnections to ensure that there has been no internal change or misalignment. These tests shall be carried out in accordance with IEC 60076.

d) Magnetic Balance and Magnetizing Current Measurements

The Magnetic Balance Test shall be conducted on the HV windings to detect any displacement, partial shorting or distortion in the magnetic circuit. Magnetizing Current Measurement shall follow, performed at rated or specified reduced voltage, and the current shall be compared phase-wise to determine core condition, presence of inter-turn faults, or abnormal magnetic losses. Deviation from established patterns shall be analysed and rectified prior to continuing with overhaul.

e) Winding Resistance Measurement

Winding resistance shall be measured for all taps of the HV and LV windings using a precision micro-ohm meter. The Contractor shall correct measured values for temperature and compare them with OEM-provided reference values or historical data. Any abnormal resistance



gradients, imbalance between phases or slow stabilisation behaviour shall be addressed before proceeding with further activities.

f) Insulation Resistance and Polarisation Index Measurements

The Contractor shall perform Insulation Resistance (IR) and Polarisation Index (PI) testing of all windings using a 5 kV or higher insulation tester. The tests shall include winding-to-winding, winding-to-earth, and core-to-earth insulation measurements. Additional insulation checks shall be carried out between the core, frame, tank and metallic structures to establish correct earthing and insulation isolation. All IR and PI results shall be compared with threshold values recommended in IS 2026 and with pre-overhaul data.

g) Tan Delta (Dissipation Factor) Measurements

The Contractor shall conduct Tan Delta measurements for HV and LV windings as well as for bushings wherever access permits. This test shall establish the dielectric health, moisture ingress level and ageing of the insulation system. Tan Delta shall be measured phase-wise, and any abnormal values shall be analysed and corrective actions initiated before filling oil or re-assembling the transformer.

h) Sweep Frequency Response Analysis (SFRA)

A full SFRA test shall be conducted prior to opening the transformer and after all overhauling activities are complete. SFRA shall be carried out as per international guidelines to detect core movement, winding displacement, deformation, electrical asymmetry or any mechanical disturbance during the overhaul process. Pre- and post-overhaul signatures shall be compared, and any deviation shall be investigated thoroughly.

i) Oil Quality Testing

Comprehensive insulating oil testing shall be performed at an NABL-accredited laboratory such as ERDA. The test scope shall match the latest GIPCL oil test report and include BDV, moisture content, acidity, dissipation factor, IFT, DGA (Dissolved Gas Analysis), particle count and any additional tests required to determine the health of the insulation system. Oil samples



shall be collected before oil draining and after final filling and filtration, and their results shall be compared for conformity.

j) Degree of Polymerisation (DPv) Testing

A DPv test of the transformer's cellulose insulation shall be carried out at ERDA or another Owner-approved NABL laboratory. This test shall provide an assessment of the ageing condition of the solid insulation and shall be used to determine residual life and expected loading capability of the transformer. The Contractor shall ensure proper sampling and sealing procedures to avoid contamination.

k) Current Transformer (CT) Testing

Neutral CT-1 and CT-2 shall undergo polarity testing, ratio verification, excitation characteristic evaluation and secondary winding insulation checks. Any deviation in ratio, knee point or magnetisation pattern shall be analysed and corrected. Wiring and terminations from CTs to the marshalling box shall also be verified during this stage.

l) Post-Overhaul Testing

After reassembly, refilling, filtration and final tightening of all components, the Contractor shall repeat the entire spectrum of tests described above. The post-overhaul results shall be matched against pre-overhaul data. Any deterioration, mismatch or abnormal variation shall be rectified immediately by the Contractor at no extra cost to the Owner.

m) Documentation and Certification

All test results shall be recorded systematically and compiled into a comprehensive report. The Contractor shall submit certified test reports, calibration certificates, comparison charts and analysis sheets to the Owner. No energisation of the transformer shall be permitted until all tests are completed satisfactorily and formally accepted by the Owner.

All test instruments shall have NABL Calibration Certificates.



4.10 OLTC Overhaul (Complete, Condition-Based)

4.10.1. General Requirements

The On-Load Tap Changer (OLTC) shall be completely as part of the transformer scope, including the full refurbishment of the diverter switch, selector switch, associated internal mechanisms and the external drive mechanism box. All overhaul activities shall be executed strictly in accordance with OEM recommendations, using approved tools and methods, and under the direct supervision of experienced and competent personnel familiar with OLTC maintenance procedures for EHV power transformers. The entire scope of work shall be executed in accordance with the relevant OEM manuals and guidelines.

4.10.2. Opening and Dismantling

The Contractor shall begin the overhaul process by carefully opening the OLTC diverter switch and selector switch compartments, ensuring that no foreign particles enter the chamber. The diverter switch assembly, selector switch components and all mechanical linkages shall then be systematically dismantled in a controlled manner, documenting the condition of parts and preserving reusable components. The dismantling operation shall ensure that the alignment, orientation and integrity of components are preserved for proper reassembly.

4.10.3. Inspection of Internal Components

Once dismantled, all OLTC components shall undergo detailed inspection. This includes a thorough examination of the main contacts, arcing contacts and transition resistors to determine wear, pitting or erosion. Springs, shafts, bearings and all mechanical linkages shall be assessed for fatigue, corrosion or deformation. Insulating parts such as barriers, cylinders and support structures shall be examined for cracks, carbon tracking or thermal ageing. The Contractor shall also inspect the chamber for carbon deposits, burnt residue, metallic debris and any signs of overheating, arcing or misalignment.

4.10.4. Cleaning and Servicing



All inspected components that are deemed fit for reuse shall be thoroughly cleaned using approved solvents, lint-free materials and OEM-recommended cleaning procedures. Carbon deposits, oil degradation products and contact residue shall be removed without altering surface profiles or mechanical tolerances. Moving parts shall be lubricated with OEM-specified lubricants to restore smooth operation. Insulating surfaces shall be cleaned to remove deposited contaminants that could compromise dielectric strength.

4.10.5. Replacement of Worn Components

The Contractor shall replace all worn-out contacts, both fixed and moving, where erosion or pitting exceeds OEM limits. Arcing contacts and transition resistors shall be replaced if inspection reveals thermal damage or degradation. All gaskets, O-rings and seals shall be replaced irrespective of condition to ensure perfect oil tightness. Bearings, springs, pins, and other mechanical hardware exhibiting wear or reduced elasticity shall also be replaced. Only OEM-approved spares or Owner-approved equivalents shall be used.

4.10.6. Reuse of Cleaned Components

Reusable components that meet inspection criteria shall be reinstalled after ensuring that their mechanical and electrical surfaces are restored to acceptable condition. No component shall be reused unless it has been fully cleaned, inspected and approved by the supervising engineer.

4.10.7. Drive Mechanism Overhaul

The external OLTC Drive Mechanism Box shall be completely overhauled. This shall include the inspection and servicing of the motor drive unit, gear trains, shafts, couplings and intermediate linkages. The Contractor shall verify lubrication of all moving parts and replenish lubricants where necessary. All limit switches, tap position indication devices, and mechanical interlocks shall be inspected, calibrated and adjusted to OEM-specified tolerances. Manual and electrical operating mechanisms shall be functionally tested to confirm correct sequencing and interlock integrity.



4.10.8. Reassembly of OLTC System

Upon completion of inspection, cleaning and component replacement, the Contractor shall reassemble the diverter switch, selector switch and drive mechanism strictly in accordance with OEM instructions. All alignments, tolerances and torque settings shall be adhered to during reassembly to ensure correct operation. New gaskets and sealing elements shall be installed to prevent oil leakage and maintain internal dielectric strength.

4.10.9. Oil Filling and Filtration

Following reassembly, the OLTC compartment shall be filled with new insulating oil supplied by the Contractor. The oil shall comply with IS 12463 / IEC 60296 or equivalent standards. The OLTC oil shall be thoroughly filtered and dehydrated to meet required BDV, moisture and purity parameters. The Contractor shall ensure that the OLTC chamber, selector chamber and drive box compartments are air-free and perfectly sealed during filling and circulation.

4.10.10. Testing and Functional Checks

After oil filling, the Contractor shall conduct a full mechanical operation test of the OLTC across its entire tap range in both local and remote operating modes. Contact timing and tap-change sequencing shall be verified for correctness. Insulation resistance measurements and winding resistance checks shall be performed for each tap position to confirm electrical continuity and stability. All protections, annunciators, interlocks and tap-position indication circuits shall be tested for proper operation at both the OLTC box and the control room.

4.10.11. Final Verification and Commissioning

Prior to commissioning, the OLTC shall be inspected for smooth and noiseless operation, absence of mechanical binding, and correct functioning of the drive mechanism. The Contractor shall check for oil leakage, abnormal heating, mechanical vibration or irregularities in tap-change movement. Upon satisfactory completion of all tests, all electrical and mechanical connections shall be restored, and the OLTC shall be placed on trial operation under no-load and then under load as approved by the Owner.



4.10.12. Exclusions

The overhaul scope excludes major OEM-level repairs such as replacement of complete diverter switch assemblies, full selector switch units or any work requiring factory-based refurbishment. Such major repairs, if required, shall be proposed separately as additional scope subject to Owner approval.

4.11 Internal Inspection & Cleaning

4.11.1. General Requirements

The Contractor shall perform a comprehensive internal inspection and cleaning of the transformer as part of the overhauling work. These activities shall be carried out after the transformer is safely isolated, drained, and made accessible, and shall be executed under strict supervision using approved tools, safety procedures, and OEM-compliant methods. The objective of this stage is to assess the internal condition of the transformer, remove all contaminants, restore insulation integrity, and ensure that no foreign particles or degraded materials remain within the tank before refilling with processed oil.

4.11.2. Internal Inspection of Active Parts

Once the transformer tank is opened and internal access is obtained, the Contractor shall carry out a detailed inspection of the core, windings, insulation structures, leads, clamping arrangements, and all internal hardware. Particular attention shall be paid to signs of overheating, deformation, insulation ageing, carbonisation, metallic debris, discolouration, varnish deterioration, mechanical looseness, or any abnormalities affecting the windings or core assembly. The inspection shall also include verification of proper tightness of winding clamps, integrity of spacers and wedges, alignment of winding columns, and the physical condition of supports and tie-plates.

4.11.3. Cleaning of Core and Windings



Following inspection, the Contractor shall thoroughly clean the transformer core, windings, and insulation surfaces using a controlled hot-oil jet process. The hot oil circulation shall be carried out in accordance with OEM practice to dislodge sludge, varnish flakes, oxidation deposits, and residual contaminants from copper, insulation paper, and structural components. Care shall be taken to avoid mechanical stress or thermal shock to the windings during cleaning. All waste oil and sludge removed during the process shall be collected and disposed of as per applicable environmental standards.

4.11.4. Re-Taping and Insulation Restoration

Wherever inspection reveals deteriorated, loosened, or damaged insulation on leads, tap connections, winding risers, or terminal joints, the Contractor shall perform re-taping or insulation reinforcement using approved materials compatible with transformer insulating oil. The restored insulation shall be applied uniformly, securely and in layers conforming to OEM practice to ensure long-term dielectric strength and mechanical stability. All tap leads, main leads, and cross-connections shall be examined and tightened where necessary.

4.11.5. Cleaning of Tank, Turrets and Structural Surfaces

The Contractor shall clean the interior tank walls, turret chambers, bracing structures, and all internal metallic components using hot-oil wash or other approved cleaning methods. Any sludge, sediment, carbon deposits, flaked paint, rust particles or accumulated contaminants at the bottom of the tank shall be completely removed. Internal surfaces shall be inspected for corrosion, pitting or flaking, and any such defects shall be addressed to ensure a clean and stable surface before refilling with oil.

4.11.6. Cleaning of Bushings and Associated Interfaces

All bushings—HV, LV, and Neutral—shall be externally cleaned and internally inspected wherever accessible. Contaminants, dust, carbon tracks and oil film deposits on bushing porcelain or composite surfaces shall be removed using suitable solvents and lint-free materials. The bushing turrets, gasket surfaces, clamping hardware and metallic interfaces shall



be cleaned and checked for smoothness, alignment and integrity before reassembly. Any abnormalities shall be recorded and rectified as required.

4.11.7. Final Inspection Before Closure

Upon completion of all cleaning and insulation restoration activities, the Contractor shall perform a final comprehensive inspection of the core, windings, internal insulation, tank bottom, and all structural components. The transformer interior shall be confirmed to be free from loose objects, debris, lint, rags, metallic fragments, tools, or any foreign materials. Only after this confirmation and Owner verification shall the tank be prepared for vacuum processing and subsequent oil filling.

4.12 SOP for Drying-Out (Vacuum + Hot Oil Cycle)

4.12.1. General Objective

The drying-out process shall be carried out to remove moisture from the transformer active part, insulation system, and internal structures after internal inspection, cleaning, and overhaul activities. The procedure shall ensure that the cellulose insulation, windings, core assembly, and structural components attain the required dryness level before oil filling. The Contractor shall strictly follow OEM recommendations, industry-approved practices, and quality-assured time-temperature-vacuum protocols to achieve the required dielectric condition.

4.12.2. Initial Hot Oil Filling and Conditioning

After completing internal inspection and ensuring that no foreign material remains inside the tank, the Contractor shall introduce hot, filtered transformer oil into the main tank up to the core-top level. The oil used for this purpose shall have a minimum BDV of 60kV before introduction. This hot-oil fill shall assist in loosening residual moisture from insulation materials and internal metallic surfaces. Once the oil reaches the core-top level, hot-oil circulation shall commence through a high-vacuum filtration machine, and the oil shall be continuously filtered, heated, and circulated for a minimum duration of twelve hours or as required to achieve uniform temperature and preliminary dehydration throughout the active part.



4.12.3. Oil Draining and Nitrogen Purging

Upon completion of the initial hot-oil circulation process, the Contractor shall drain the oil from the transformer tank while simultaneously purging the tank with dry nitrogen gas. This nitrogen purging during drainage shall prevent atmospheric moisture ingress into the insulation and shall maintain a controlled environment inside the tank. The process shall continue until all internal surfaces are exposed and the tank is ready for the vacuum cycles.

4.12.4. First Dry-Out Cycle

The tank shall be evacuated using a high-capacity vacuum system until the vacuum pressure reaches below 1 torr. Once this vacuum level is achieved, the tank shall be held under vacuum for a continuous period of seventy-two hours, thereby enabling deep moisture extraction from the insulation system. After the vacuum-holding period, the tank shall be slowly brought back to atmospheric conditions by introducing ultra-high-purity (UHP) nitrogen gas with a minimum dew point of -50°C , until a stable internal pressure of 0.30 kg/cm^2 is attained. The tank shall remain under nitrogen pressure for a minimum of twenty-four hours to aid in moisture desorption and to stabilize the insulation.

4.12.5. Second Dry-Out Cycle

The Contractor shall initiate the second cycle by again pulling a vacuum below 1 torr. The vacuum shall be maintained for a continuous period of forty-eight hours. After the hold period, nitrogen gas with a dew point of -50°C shall be introduced to break the vacuum and raise the internal pressure to 0.30 kg/cm^2 . The tank shall then be kept under nitrogen pressure for a minimum of twenty-four hours. The Contractor shall monitor dew point, vacuum stability, and temperature gradients during this stage to ensure uniform drying.

4.12.6. Third and Fourth Dry-Out Cycles

Depending on the moisture level observed in the insulation, the Contractor shall perform one or two additional dry-out cycles. Each cycle shall include drawing the vacuum down to below 1 torr, holding the transformer in vacuum for a minimum of forty-eight hours, and breaking



the vacuum with UHP nitrogen to 0.30 kg/cm² followed by twenty-four hours of nitrogen holding. These cycles shall continue until the insulation dew point of the main tank reaches acceptable limits as determined by OEM guidelines and Owner criteria.

4.12.7. Post-Drying Hot Oil Filling and Circulation

Upon completion of the final dry-out cycle, the Contractor shall fill the transformer with hot, filtered transformer oil up to approximately half the level of the conservator tank. After filling, continuous hot-oil circulation and filtration shall be carried out for a minimum period of thirty-six hours. This circulation shall ensure uniform heating, moisture removal, and impurity elimination within the insulation and metallic surfaces.

4.12.8. Radiator Bank Oil Filling and Conditioning

Following the main tank circulation, the Contractor shall separately fill both radiator banks using the filtration machine and perform hot-oil circulation and filtration in each radiator bank for a minimum period of five hours. This shall ensure that the radiators are free of moisture, air pockets, and contaminants.

4.12.9. Final Integrated Oil Circulation

After conditioning each radiator bank, the Contractor shall connect the radiator banks to the main tank and initiate combined hot-oil circulation for a further period of approximately eighteen hours. This integrated circulation shall equalize the temperature and oil quality across the entire oil circuit and remove any remaining traces of moisture.

4.12.10. Final Oil Level Adjustment and Documentation

Upon completion of all filtration and circulation processes, the Contractor shall top up the oil to the required operational level in the main tank and conservator. The final oil level shall be adjusted after temperature stabilization. The Contractor shall record all vacuum values, hold times, nitrogen pressures, dew points, oil BDV results, moisture readings, and circulation parameters in a detailed drying-out logbook, which shall be submitted as part of the final overhaul documentation.



4.13 Cleaning of Existing Oil Pit

Complete removal of sludge, sediment, oil residues and disposal as per environmental norms.

The Contractor shall carry out thorough cleaning of the existing transformer oil pit as part of the overhauling works. This activity shall ensure that the oil containment system is fully restored to its intended operational condition and capable of safely accommodating any drained or spilled insulation during filtration, drying, circulation, or emergency handling procedures associated with the transformer. The cleaning operations shall be performed only after the pit has been fully isolated, made safe for entry, and inspected for structural integrity.

The Contractor shall remove all accumulated sludge, degraded oil residues, moisture deposits, dirt, sand, metallic particles, and any foreign matter that may have settled in the pit over time. All sludge and oil-contaminated material shall be manually or mechanically extracted using appropriate tools such as scrapers, absorbent pads, pumps, and vacuum units. Care shall be taken to ensure that no residue remains adhered to the pit floor or walls, particularly in corners, recesses or areas adjacent to drain pipes. After removal of contaminants, the pit shall be washed and flushed using an approved cleaning agent or degreasing compound compatible with oil-handling areas. The surface shall then be rinsed with clean water, dried thoroughly, and inspected to verify complete removal of oil traces and deposits.

All removed sludge, contaminated water, and cleaning materials shall be collected, stored, transported, and disposed of strictly in accordance with applicable environmental standards and statutory waste-handling regulations. Under no circumstances shall the Contractor permit oil or sludge to enter soil, stormwater drains, or open ground. The Contractor shall ensure the oil pit surface, drainage arrangement, and soak pit interface (if applicable) are left clean, dry, and free from blockage. Any damage, corrosion, cracks, or wear observed during cleaning shall be reported to the Owner and rectified with approved repair measures to restore proper containment functionality.

After completion of cleaning, the pit shall be inspected jointly with the Owner or their representative. The pit shall be accepted only after confirming that it is clean, dry, free of contaminants, and suitable for reuse during transformer oil handling operations.



4.14 Valves

All valves associated with the transformer including those on the main tank, radiators, cooler piping, OLTC piping, conservator system, sampling lines, drain points and filter-connection points shall be thoroughly serviced as part of the overhauling work. The Contractor shall inspect each valve for external and internal leakage, passage of oil when closed, deformation of moving parts, corrosion on hardware, stiffness of operation, deterioration of gland packing and integrity of valve seating surfaces. The servicing shall include dismantling of valve handles, removal of gland packing, cleaning of the valve chamber, inspection of the valve seat, lubrication of moving components and reinstallation or replacement of gaskets as necessary.

Valves found to be passing oil when fully closed, valves exhibiting degraded sealing surfaces, and valves with cracked bodies, worn spindles or corroded discs shall be attended immediately for repair. The Contractor shall perform any rectification required to restore proper sealing and operation, except where valve condition is assessed as beyond repair. In such cases, the Contractor shall inform the Owner, and replacement valves being in the Owner's supply scope shall be provided by the Owner, while the Contractor shall carry out the installation, alignment, tightening and leak-testing of all replacement valves under this contract.

After servicing or replacement, each valve shall be functionally checked for full-open and full-close operation, smooth movement without abnormal force, absence of leakage under static oil pressure and correct sealing upon closure. All connections disturbed during valve servicing shall be restored using new gaskets and proper torque settings. Final acceptance shall be based on joint inspection by the Owner and Contractor.

4.15 Cooling Fans

All cooling fans shall be overhauled; motor bearings replaced; fan impellers cleaned; electrical protections tested.

All cooling fans associated with the radiator banks of the transformer shall be fully taken care as part of the current activity. The Contractor shall perform a detailed inspection of each fan assembly to determine the mechanical and electrical condition of the fan motor, bearings, impeller, guard structure, mounting brackets and power/control wiring. The fan motor shall be dismantled where required, and the bearings shall be mandatorily replaced with new bearings



of equal or superior specification to ensure long-term reliability and smooth operation. The fan blades or impeller shall be cleaned thoroughly, checked for cracks, imbalance, deformation or erosion caused by prolonged service, and rebalanced if necessary to avoid vibration during operation.

The Contractor shall inspect the fan housings, support frames and mounting structures for corrosion, cracks or mechanical instability. All loose fasteners shall be tightened, and any damaged hardware shall be replaced. The electrical motor windings shall be tested for insulation resistance, continuity and proper earthing. Terminal boxes shall be cleaned, wiring connections shall be re-terminated if necessary, and the condition of grommets and cable entries shall be restored to ensure weather protection. Space heaters, if provided, shall be verified for functionality.

Once reassembled, each fan shall be run individually to confirm noiseless operation, vibration-free rotation and proper airflow. The Contractor shall ensure correct phasing, proper rotation direction, and stable motor current within specified limits. The fans shall also be tested in automatic mode through the cooler control system to verify that they start and stop based on winding or oil temperature settings and that thermal overload relays and protection devices associated with fan operation work as intended.

4.16 Tools, Tackles & Consumables

4.16.1. General Requirements

The Contractor shall provide, mobilize and maintain at site all tools, tackles, lifting–shifting equipment, consumables and sundry items necessary for the execution of transformer overhauling works. These resources shall be adequate in capacity, appropriate for EHV substation use, and maintained in good working condition throughout the overhaul period. No additional claims shall be entertained on account of non-availability or inadequacy of tools or equipment, as the Contractor is responsible for ensuring the complete availability of all materials required to execute the work safely, efficiently and within the stipulated timeframe.

4.16.2. Lifting and Handling Equipment



The Contractor shall arrange cranes, hydra units, jacking systems and other lifting equipment of suitable capacity for handling transformer components, radiators, OLTC parts, bushings, cooling equipment and any associated heavy elements. These shall be operated only by certified and experienced operators, and all lifting activities shall follow approved lifting plans and safety procedures. Jacking systems used for minor lifting operations shall be compatible with the weight of the transformer's active part and tank components and shall be deployed in accordance with OEM-recommended points to avoid structural stress.

4.16.3. Oil Handling and Filtration Equipment

The Contractor shall provide an oil storage facility, clean storage tanks or drums, and a high-vacuum oil filtration plant with a minimum capacity of 6 kL per hour, complete with heaters, degassing modules and moisture removal elements. All hoses, couplings, valves and accessories associated with oil handling shall be clean, leak-free and suitable for use with transformer-grade mineral insulating oil. Consumables such as filter cartridges, gaskets and sampling bottles shall be provided as required for the duration of the overhaul.

4.16.4. General Tools, Consumables and Protective Materials

The Contractor shall supply nuts, bolts, washers (both plain and spring type), tools for dismantling and servicing valves, gasket cutting tools, torque wrenches, spanners, hydraulic crimping tools, cable preparation tools and all other hand tools required for overhaul. Tarpaulins and protective coverings of adequate size shall be provided to protect the transformer and its parts from dust, rain and UV exposure during internal work. Adequate quantities of nitrogen cylinders shall be arranged for purging, vacuum-breaking and maintaining positive pressure inside the tank during the drying-out procedure.

4.16.5. Diagnostic and Measurement Instruments

The Contractor shall provide calibrated diagnostic instruments including dew-point meters, McLeod vacuum gauges, digital thermometers, insulation testers, micro-ohm meters and other necessary measurement devices. All instruments used for testing, vacuum measurement, moisture analysis and oil filtration shall carry valid NABL-accredited calibration certificates.



Dummy plates, blanking covers and sealing components necessary to isolate transformer openings during the overhaul process shall also be provided by the Contractor.

4.16.6. Responsibility for Tools and Equipment

All tools, lifting devices, filtration systems and equipment brought to site shall remain under the Contractor's custody. The Contractor shall ensure secure storage, periodic maintenance, and safe handling of these resources. Any damage caused to tools, equipment or transformer parts due to mishandling shall be rectified entirely at the Contractor's cost.

4.17 Power & Control Supply

4.17.1. General Requirement for Temporary Power Supply

The Contractor shall make complete arrangements for the temporary power and control supply required for all overhaul, testing, commissioning and illumination activities at site. The responsibility includes providing distribution boards, cables, connectors, protective devices and all auxiliary items necessary to ensure uninterrupted power during critical stages such as oil filtration, vacuum drying, OLTC testing, cooling fan trials, marshalling box wiring checks and NIFPS integration tests.

4.17.2. Electrical Safety and Protection

The temporary power supply system shall incorporate proper overcurrent protection, earth-leakage circuit breakers (ELCB), residual current devices (RCD), miniature circuit breakers (MCB), and surge-protective devices wherever required. All temporary cables used for construction power shall be unbroken lengths without joints, shall be of adequate cross-section and shall be routed through safe, mechanically protected paths. The Contractor shall ensure the system is adequately earthed at all locations where power is drawn or distributed.

4.17.3. Control Supply for Testing and Commissioning

The Contractor shall arrange suitable DC control supply for energization of control circuits, OLTC drive mechanism testing, wiring verification, annunciation testing, and auxiliary system checks. The control supply shall be stable, free from noise or surges, and shall be sourced through proper isolators and protective devices. Where 110V DC is required for the



transformer's protection and control circuits, the Contractor shall ensure compatibility with the station DCDB and shall provide any interposing equipment if needed.

4.17.4. Illumination and Site Working Conditions

Adequate lighting shall be provided inside and around the transformer overhaul work area, particularly during night operations or during internal inspection of the tank. Temporary illumination shall be arranged ensuring mechanical protection of lamps and cables, with IP-rated housings suitable for working in and around transformer oil, moisture and metallic structures.

4.17.5. Responsibility and Compliance

All temporary electrical installations shall comply with IS/IEC electrical safety standards and substation working norms. The Contractor shall be fully responsible for the safety, reliability and uninterrupted availability of the temporary power and control supply system during overhaul and shall promptly attend to any breakdowns or faults at no extra cost to the Owner.