synchronization between the bus bar and transmission line through breaker, at 33 kV. Details layout shown in the tender drawings

- The supplier shall ensure that the current transformers shall have adequate VA output for the type of protection & metering offered. The supplier shall also ensure that the current transformers quoted by him have adequate output for prescribed accuracy class and accuracy limit factor for the type of relays and instruments connected in their circuits. PS class CTs shall have low secondary resistance and high knee point voltage so as to avoid any possibility of CT saturation under through fault conditions.
- Three single phase voltage transformers shall be suitable for connecting in a bank of three phase voltage transformers for protection and measurement purpose for each incomer and outgoing feeders. Separate and dedicated voltage transformers shall be provided for synchronization.
- The lightning arrester & voltage transformer (LAVT) cubicles for 33 kV shall comprise of lightning arresters and capacitors (for surge protection) and voltage transformers. The LAVT & VT cubicles shall be dust tight, vermin-proof.
- Each cubicle shall be equipped with space heaters, thermostats, illumination lamps & 240 V AC, 5A receptacle.
- Suitable single compression type, heavy duty brass cable glands with check nuts, rubber sealing ring and brass washers mounted on a removable gland plate shall be supplied with the switchgear to support all power and control cables entering the switchgear.
- Cables for each equipment must be tagged with permanent metal tag of impregnated cable number as per drawings at MCC/switchgear end and equipment terminal end as well as in the mid portion of the cables at certain distances as instructed by the owner or his authorized representative.
- The relay for the switchgear units shall have all the features as specified under Cl. no. 5.13.11 of, Sec-V of the Technical Specification.
- The switchgear units shall have the remotely controlled.
- The accuracy class of indicating instruments shall be 1 or better as per IS. The accuracy class of meters for commercial metering shall be 0.2. All instruments shall have means for calibration, testing and adjustment at site.
- Three phase watt hour meters conforming to latest issue of relevant Indian standard shall be provided with test link for CTs & PTs. Meters shall be compensated for temperature errors and factory calibrated to directly read the primary quantities.

- Following equipment at 33 kV switchgear shall be monitored and control from OWS of SCADA/DCS:

  1) Circuit breaker - On/Off status & Control, Test, service, spring charged, Trip Circuit unhealthy, Lock out operated etc.

  2) Transformer - Winding temperature & Oil temperature, Bucchhlz etc Alarm status

  Through hardwire. IPR shall be placed at switchgear end.

  3) Energy meters through RS 485 network.

  4) Numerical Relays through RS 485 network.

  5) Voltmeters- from transducer as analogue signal.

  6) Ammeters- from transducer as analogue signal.

- The switchgear shall be capable of addition another two outgoing and two incoming feeder and separate line PT provision for future extension. Necessary space provision should be envisaged during control room design.

5.13.6.5 APPROVAL

The Detailed Design Report submitted by the contractor to WBPDCL must contain but not limited to the following details of the Ring Main Unit/Switchgear:

- Detailed specification of all the items.
- Necessary Drawings
- All necessary test certificates and approvals etc.

The successful bidder required to produce all necessary test certificates and approvals of the product as per relevant standard with the Detailed Design Report.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Electrical diagrams
- Safety precautions
- Detailed schematics of all power instrumentation and control equipment and subsystems along with their interconnection diagrams. Schematics shall indicate wiring diagrams, their numbers and quantities, type and ratings of all components and subsystems etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCL.

5.13.7 33kV OUTDOOR SWITCHYARD

5.13.7.1 OIL FILLED POWER TRANSFORMERS

5.13.7.1.1 SCOPE OF SUPPLY

This specification covers design, engineering, manufacture & assembly of 3-Phase, 132/36 KV 12.5 MVA, Power Transformer complete with all fittings and accessories required for efficient and trouble free operations of the transformer, testing at manufacturer's works and customer's premises, supply, loading at factory, delivery at site, unloading, handling, dragging for proper storage at site on the plinth of transformer after the same is ready at respective site, erection, site testing. Commissioning, charging etc. as per direction of customer. The MANUFACTURER / Bidder shall arrange for the services of their Supervisor/Engineer from the manufacturer during erection, testing and commissioning of the equipment at sites at free of cost as many time as required by WBPDCL.

Following transformers as stated below:
12.5 MVA, 132KV/ 36 KV 3 Phase, Auxiliary Transformer: One (01) no.

- MVA rating of the transformers, as indicated above, shall be considered as the minimum requirement for the project. Transformer offered by the bidder shall be sized according to the maximum demand at most stringent condition plus minimum 10 % margin.

- Each transformer shall be furnished complete with:

a) Fittings and accessories.
b) Auxiliary equipment.
c) First filling of oil including 10% extra.

- One set of special tools and tackles.
- Mandatory Spare parts.
- Recommended spare parts for three (3) years operation in addition to mandatory spares.
- All relevant drawings, data and instruction manuals.

The scope also include that this new 12.5 MVA 132/33 kV transformer shall have to be installed over existing Transformer foundation. Existing old 132/33 kV transformer shall have to be dismantled after removing all the existing connection. Necessary rectification, modification, strengthening of the existing transformer foundation is under bidder's scope. If it is found during detail engineering that the existing transformer foundation is not sufficiently strong or not matching with the proposed new transformer, the contractor has to install new transformer foundation in the available space of existing foundation. In this case, dismantle and cleaning of the existing space is also bidder's scope.

If, any of the existing structure is damaged or required to be dismantled for convenience of the erection, the same has to mend good as per the original. Existing drainage system must have to be maintained. If, any cable crossing is required to cross over the existing toe drain of the reservoir, the same has to be properly rectified & to be restored to the original.

5.13.7.1.2 CODES AND STANDARDS

- All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS), IEC and CBIP Specifications except where modified and/or supplemented by this specification.
- Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

The Power Transformer covered under this specification shall comply with the requirements of the latest edition of following minimum Standards:

i) IS:2026 (Part I to IV) - Specification for Power Transformer
ii) IS:2099 & IS:3347 - Bushing for alternating voltage above 1000 volt
iii) IS : 6600 - Guide for loading of oil immersed transformer
iv) IS : 335 - Specification for transformer oil
v) CBIP - Manual on transformer.
vi) IEC-60076 - Power Transformer
vii) IEC-60214 - On Load Tap changer.

viii) IEC-354 - Loading Guide for Oil immersed Transformer
ix) IEC-551 - Tr. Sound Level.

5.13.7.1.3 DESIGN CRITERIA

- The transformer will be used to supply power for STPS Switchyard.
- The transformer will be installed in hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- The transformer shall be capable of continuous operation at rated output under the following condition:

a)	Voltage variation	:	± 10%
b)	Frequency variation	:	± 5%
c)	Combined voltage and frequency variation	:	10% absolute sum)

- The transformer shall be so designed that it is capable of operation at 125% rated voltage for a period of one minute and 140% rated voltage for a period of five seconds due to sudden load throw off.
- The transformer shall be capable of withstanding the short circuit stresses due to a terminal fault on one winding with full voltage maintained on the other winding for minimum period of two (2) seconds.
- The transformer shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.
- The noise level shall be limited to the value specified by NEMA Standard Publication No. TR-1-1993 when measured in accordance with conditions outlines in ANSI/IEEE C57.12.90-1999/IS13964/CBIP publication.
- The Transformer and accessories shall be designed to facilitate easy inspection, cleaning and repairs. All fittings and accessories shall be designed to ensure satisfactory operation under worst conditions of load and voltage as may be met under working conditions in the system.
- All materials used shall be of best quality and of the class most suitable for working under the conditions specified. It shall withstand the variations of temperature and atmospheric conditions without undue stressing etc. i.e.

not affecting the workability/durability of the various parts of the transformer.

- All outdoor fittings and accessories, including bushings insulators with their mounting, shall be so designed as to avoid pockets in which water can collect. All electrical connections shall be of ample cross sections for carrying the specified currents continuously without undue heating. All fixing bolts and screws shall be reliable under worst conditions of operations.
- Transformers shall be suitable for continuous operation with a frequency of 50 Hz and variation of ± 5% without exceeding specified temperature rise.
- Clearances of line terminals in Air:

  The clearance of HV, IV & LV terminal shall be maintained as specified below :

Highest System voltage of equipment (KV rms)	Phase to Phase clearance (mm)	Phase to earth clearance (mm)
145	1220	1050
36	350	320

- Transformer with its winding and all its accessories including Bushing CTs etc. shall be design to withstand without injury, the mechanical and thermal effects and any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 Sec. The short circuit level of HV & IV system to which the subject transformer will be connected is 31.5 KA (Sym., rms, 3 Ph. fault on 132KV).

Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

- For parallel operation with other transformers, necessary provision is to be kept in transformer RTCC panel for tap changing operation in any of Master/Follower/ Independent mode.
- THE LOADING GUIDELINE :

  Over loading of transformer shall be guided by latest IS-6600.

5.13.7.1.4 SPECIFIC REQUIREMENTS

a) Tanks

- Tanks shall be of all welded construction and fabricated from tested quality commercial grade low carbon steel of adequate thickness. All seams shall be double welded. All welding shall be stress relieved.

  The tank wall shall be reinforced by stiffener to ensure rigidity so that it can withstand without any deformation (a) mechanical shock during transportation and (b) oil filling by vacuum.

- The tank wall shall be reinforced by stiffener to ensure rigidity so that it can withstand without any deformation (a) mechanical shock during transportation, (b) oil filling by vacuum, (c) Short circuit forces and (d) continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.

- All removable covers shall be provided with weatherproof, hot oil resistant, resilient gaskets. The design shall be such as to prevent any ingress of water into or oil from the tank.

- The tank shall be provided with one set of bi-directional flanged wheels for rolling the transformer parallel to either canter line over 1676 mm rail gauge. In case more than two rails are required to be provided the rail gauge of 1676 mm shall be maintained between two adjacent rails

- Jacking pads, lifting eyes and pulling lugs shall be provided to facilitate movement of the transformer. All heavy removal parts shall be provided with eyebolt for ease of handling.

- Manholes/hand-holes of sufficient size shall be provided for access to leads, windings, bottom terminals of bushings and taps.

- Suitable guide shall be provided in the tank for positioning the core and coil assembly.

- The transformer tank shall be equipped with the following valves and plugs with standard screw connection for piping:

  1) Drain valve at the bottom

  2) Filter valve at top

  3) Filter valve at bottom

  4) Sampling valve at top

  5) Sampling valve at bottom

  6) Radiator shut off valve at top and bottom

  7) Buchholz relay shut off valve at both ends of the relay

8) Air release plugs on tank.

9) One no. oil inlet valve

Any other valves & plugs other than those mentioned above, are also to be provided as per requirement.

- For this two winding Transformer 4 no. thermometer pocket should be provided for WTI & 2 no. for OTI. Amongst 4 no. pocket for WTI, Two (2) will be used for direct connection with the WTI in MK of Transformer. Balance Two (2) shall be provided with PT 100 sensor and Current Converter Unit (CCU) at MK for WTI repeater at the RTCC panel to be installed in Control Room. Similarly amongst Two (2) no. pocket for OTI, one (1) will be used for direct connection with OTI in MK of Transformer. Balance one no. (1) shall be provided with PT 100 sensor and Current Converter Unit (CCU) at MK for OTI repeater at the RTCC panel to be installed in Control Room.
- Design shall be such that Tank cover can be lifted independently without lifting active part of core, winding etc.

b) Core & Coils

- The core shall be built up with high grade, non-aging, low loss, high permeability, grain oriented, cold-rolled silicon alloy of HI -B or its equivalent grade steel especially suitable for core material.

  The insulation of lamination shall be coated with oxide/silicate/phosphate coating or any coating inert to the action of hot transformer oil. The core should be bottom mounted.
- The coils shall be manufactured from electrolytic copper conductor and fully insulated for rated voltage. Insulation shall be of Class A.
- Insulating material shall be of proven design. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum.
- Coil assembly shall be suitably supported between adjacent sections by insulating spacers and barriers. Bracing and other insulation used in assembly of the winding shall be arranged to ensure a free circulation of the oil and to reduce the hot spot of the winding.
- All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used where practicable.

- The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses.

  The design of 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 lamination which may cause local heating.

  The insulation for the core to bolts and core to clamps shall be such as to withstand a test voltage of 2 (two) KV rms at 50 Hz for one minute.

  The maximum flux density in any part of the core and yoke at the rated MVA, voltage & frequency shall be such that less than 10% continuous over voltage condition does not exceed 1.9 Tesla.

  For consideration of over fluxing, the transformer shall be suitable for continuous operation for values of over fluxing at (i) 110% (ii) one minute for 125% and (iii) 5 seconds for 140% of rated voltage.

- The prime core materials are only to be used. Bidder's should furnish following document as applicable as a proof towards use of prime Core material to be submitted before the stage inspection:

  (a) Invoice of supplier

  (b) Mill's test certificate

  (c) Packing List

  (d) Bill of lading

  (e) Bill of entry certificate by Custom.

  (f) Description of material, electrical analysis, physical inspection, certificate for surface defects, thickness and width of the materials.

  (g) Place of cutting of core materials

c) Tapping

- On load tap changer (OLTC) as specified in the annexure shall be provided on the high voltage winding.

- The transformer shall be capable of operation at its rated MVA on any tap provided the voltage does not vary by more than ±10% of the rated voltage corresponding to the tap.

- The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between HV and LV windings at all voltage ratios.

d) WINDINGS

- The Material of winding conductor should be of electrolytic grade copper of minimum 99.90% purity and free from scales, spills, splits and other defects. The windings shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repair is possible. The coils shall be supported between adjacent sections by insulating spacers, and the barriers. Bracing and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings. The stacks of windings shall receive adequate shrinkage treatment before final assembly and the same shall be assembled in dust controlled chamber.

  The insulation of the coils shall be such as to withstand the full electrical strength of the windings. All materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or otherwise be adversely affected under the operating conditions. The dielectric strength of winding insulation shall confirm to values given in IS: 2026, as amended up to date, or as per specific Technical Parameters.

  All threaded connections shall be provided with locking facilities.

- All leads from the windings to the terminal board and bushings shall be rigidity supported to prevent injury from vibration. Guide tubes shall be used where practicable.
- The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core and windings shall be vacuum dried and suitably impregnated with insulating oil. The copper conductors used in the coil assembly shall be best suited to the requirements and all permanent current carrying joints in the windings and the leads shall be welded or brazed. Oil ducts shall be such as will not impede the free circulation of oil through windings assembly.

- 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.

e) On-Load Tap Changer (OLTC)

- The OLTC switch contacts shall be located in a separate oil-filled chamber complete with its own oil preservation system, Oil Surge relay, shut-off valves, oil level gauge, gas vent etc.
- OLTC mechanism and associated controls shall be housed in an outdoor weatherproof cabinet. Internal illumination lamp and thermostat controlled space heater shall be provided in the cabinet.
- The tap change equipment shall be so designed that if the mechanism is stuck in an intermediate position, the transformer shall be capable of delivering full load without any injury.
- The OLTC gear shall be suitable for local and remote electrical control and local manual control. Further, there shall be provision of automatic operation through voltage sensing relay wherever specified.
- The hand cranking arrangement shall be such that it can be operated at standing height from ground level. Further the mechanism shall be provided with a tap position indicator and an operation counter.
- Interlock shall be provided to ensure the following :-

  a) Positive completion of tap changing step once initiated.

  b) Blocking of reverse tap change command during a forward tap change already in progress until the mechanism rests and vice-versa.

  c) Cutting out of electrical circuit during manual operation.
- The tap changing gear shall have local selector switches with RTCC-Local-Test-Central positions. Provisions of various modes of operation of the tap changers of transformers, like individual operation, remote/local operation; operation from voltage regulating relays (where specified), etc. and for various interlocks shall be kept in the Remote Tap Changer Cubicle (RTCC) as well as local OLTC cabinet. Necessary equipment switches, relays, etc., shall be provided in these panels. The following minimum components shall be provided in the RTCC panel. Any other feature desired for proper and safe operation of equipment shall be provided. All indicating lamps shall be LED type.

  a) Voltage regulating relay for auto operation where specified.

  b) Auto-manual selector switch where auto operation specified.

  c) Selector switch for master follower solo operation.

d) Raise-Lower control switch

e) Necessary relays and accessories.

f) Tap position indicator

g) Indication lamps for "Tap change in Progress" and "Control supply healthy".

h) Red lamp to indicate master position

i) Winding & Oil temperature (0° –150°C) repeaters to be connected to winding and oil Temperature meter housed in the main Transformer Marshalling Box at outdoor. In addition to above necessary arrangements are to be made in RTCC panel for Hot spot temperature indication and alarm by optical sensor method.

j) Annunciations for:

k) Tap position in progress

l) Mechanism stuck

m) Control supply failure

n) Tap changer A.C. supply failure

o) Oil surge relay operated

- Provisions shall be kept in the RTCC for serial link communication with the plant SAS/SCADA.
- The construction and other details of the RTCC shall be similar to those described elsewhere in this specification. Remote Tap Changer Panel shall also be provided to be installed at our Control Room.
- An under voltage relay shall be incorporated to monitor the 2200 Volt DC control circuit voltage of tap changer. Audible Alarm and annunciation shall be provided for failure of control circuit supply, failure of 400 V AC supply to the motor. All the relays requisite for remote tap change operation shall be provided in RTCC panel. The OLTC should have been Type Tested.

f) Insulating oil

- The transformer shall be filled with mineral insulating oil suitably inhibited to prevent sludging.

- First filling of oil along with 10% excess shall be furnished for each transformer. Oil shall be supplied in non-returnable containers suitable for outdoor storage.
- Oil preservation shall be by means of bellows/ diaphragm sealed conservator tank with silica gel breather to avoid direct connection between atmosphere and transformer oil. It shall be complete with level gauges, pipes, drain valve, buchholz relay with shut-off valves at both sides etc. The level gauges shall be so placed that same can be readable standing from ground. Necessary device shall be kept to provide annunciation in the event of rupturing of bellow.
- The oil shall comply in all respect with the provisions of the latest edition IS:335 (as amended up-to-date) of specification for New Insulation oils for transformers and switchgears. Particular attention shall be taken to deliver the oil free from moisture having uniform quality throughout in non-returnable steel drums. The quantity of oil for first filling of each transformer shall be stated in the offer.

The oil should have the following characteristics:

SL. NO.	CHARACTERISTICS	REQUIREMENT
1.	Interfacial tension at 27°C (min)	0.04 N/m
2.	Electrical strength (Breakdown voltage)	60 KV (rms) after treatment
3.	Resistivity at 90°C /27°C	35x1012 /1500x1012 Ohm-cm
4.	Dielectric dissipation factor (tan delta at 90°C max.)	0.002

- After site processing through filtration and before commissioning, the moisture content shall be as follows :

Sl. No.	Parameters	Before filling in main tank & tested for	Prior to energization for following properties & acceptance norms:
i)	BDV	60 kV (min)	60 kV (min)
ii)	Moisture content	10 ppm (max.)	10 ppm (max.)

g) Bushing

- Bushing shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushing and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size and shall be suitable for bimetallic connection, if necessary. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the high voltage winding.

  All main windings, tertiary windings and neural leads shall be brought out to outdoor through bushings which shall be so located that the full flashover strength will be utilised and phase to phase and phase to earth clearance shall be more than minimum value specified below. Location and arrangement of bushing shall follow Indian Standards. Each bushing shall be so coordinated with the transformer insulation that flashovers will occur outside the tank. Bushing rated above 52KV voltage class shall be oil communicating type.

- Bushings shall be provided with terminal connectors of approved type and size. All porcelain used in the bushings shall be made of the wet process, be homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burns, and other defects. Upper portion of Bushing made of Porcelain & lower portion made of Epoxy/porcelain is also acceptable.

  Bushings for 145 KV & 52 KV voltage class shall be Oil Filled Condenser type and shall be hermetically sealed. All OIP bushing shall have provision of measurement of capacitance and tan-delta without dismantling of the bushing. Rating plate of bushing shall be provided near each type of bushing with terminal marking and physical position as per IS:2026. Bushing for 36KV shall be Solid porcelain or oil communicating type.

  The electrical and mechanical characteristic of bushings shall conform to IS:2099 and IS:3347. The characteristic of the oil used in the bushing shall be the same as that of the oil in the transformer.

- The spacing between the bushings must be adequate to prevent flashover between phases under all conditions of operation. All bushings shall be

suitable for heavily polluted atmosphere and minimum creepage distance shall be taken as 25 mm per KV.

h) Bushing Current Transformer:

i) Current transformer shall comply with IS:2705/IEC-185.

ii) It shall be possible to remove the turret mounted current transformers from the Tr. Tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret.

iii) Current transformer secondary leads shall be brought out to a weather proof terminal box near each bushing. These terminals shall be wired out to cooler control cabinet/marshalling box using separate cables for each core.

iv) The voltage and current rating of the bushings shall be as follows :

Highest System Voltage (KVrms)	Current Rating (Amps.)
132(HV)	800
36 (LV)	1250
36 (Neutral)	1250

- 36 kV side of Transformer will be fitted with cable end box suitable for cable termination as per required size of cable. Cable box arrangement shall be with suitable type of bushing and dry type termination of suitable size & run for LV side of Transformer. The cable box entry shall be of suitable type and shall be designed such that it shall be able to withstand without any deformity the electrical, thermal and mechanical stresses & forces developed due to rated short circuit current during any terminal fault inside the cable box. The flange joints of cable boxes shall be secured with suitable & proper sized and nos. of stainless steel HTS nuts and bolts.

i) Terminal Arrangements

- The physical position of the terminals and the markings shall be as per relevant IS/IEC unless otherwise shown in the enclosed drawing. Each terminal (including the neutral) shall be distinctly marked on both the primary and secondary side in accordance with the diagram of connection supplied with the transformers.
- Vertical/horizontal/universal type bi-metallic, rigid connector for bushing stud shall be provided. Minimum thickness of Bimetal in bimetallic connection shall be 2mm.

- High voltage terminals shall be brought out thru' top cover mounted bushings with matching flanges around each bushing for connection to isolated phase bus. The Contractor shall furnish all necessary details in this connection for co-ordination with the bus duct and shall guarantee the matching dimensions within close tolerance.
- Low voltage terminals shall be brought out thru' sidewall mounted bushings. For bus duct connection, bushings shall have matching flange around. For cable connection, a detachable type cable end-box with disconnect links shall be furnished.
- Low voltage winding neutral shall be brought out thru' sidewall mounted bushing to a detachable cable end-box with disconnect link.
- The cable end-box shall be self-supporting, weather-proof, air filled type, complete with all hardware such as gland plate, brass glands, tinned copper lugs, armour clamps etc.
- In general, the arrangement shall be such as to permit removal of transformer without dismantling the bus duct/cable connection.

j) Cooling System

- The cooling system shall comprise of 2 x 50% cooling units each complete with its radiator banks, AC 3 phase Motor driven fans and other accessories. The cooler system should be such that any fan in a bank can be used as standby.
- The design shall be such that rated transformer output under ONAF Condition can be maintained :

  a) For at least twenty (20) minutes in case of failure of fans associated with one cooler unit without the calculated winding hot spot temperature exceeding 140°C.

  b) For at least ten (10) minutes in case of failure of the complete cooling system without the calculated winding hot spot temperature exceeding 140°C.

  The radiators shall be detachable type with top and bottom isolation valves to permit the removal of the same without drainage of oil from the tank. Radiators shall be provided with drain and air release plug.
- The fans shall operate without any abnormal noise. They shall be fitted with guards of close mesh-wire-netting for safety. The terminal connections and

the greasing caps of the fan motors shall be accessible without the need of removing any fan guard.

- Convenient means shall be provided to remove or replace any fan with the transformer in service. Fan shall be so located so that they are readily accessible for inspection and repair.
- Complete control for fan inclusive of all switches, fuses, starters, relays and wiring shall be furnished. Each motor circuit shall have over load, single phasing and short-circuit protection.
- Fan motor controls will be actuated automatically from winding temperature indicator contacts. Provision shall however be kept for manual control from and indication in both local and remote. Control selection switches shall be provided in the cooler control with arrangement for remote control and indications of all operations.
- Cooling fans shall not be directly mounted on radiator bank to avoid undue vibration on the same. These shall be located in such a manner as to prevent ingress of rain water. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.
- Each cooling unit shall be provided with a number of fans such that in the event of outage of one fan, rated output can be maintained within the specified temperature limit.

k) VALVES

(i) Two Nos. oil inlet valves located in suitable locations

(ii) One oil drain valve each suitably located at top and bottom

(iii) One filter valve suitably located near the top of the tank

(iv) One filter valve suitably located near the bottom of the tank

(v) One valve each for oil sampling suitably located at bottom and top

vi) Radiator shut off valve at top and bottom.

vii) Buchholz relay and oil surge relay shut-off valves at both ends of the relays

viii) Main Conservator – filter, drain, sample valve, air release valve, air release plug.

ix) OLTC Conservator – Oil filling valve, Drain valve, Suction valve

x) One drain valve for OLTC

xi) One oil inlet valve

xii) One no. Bleed valve with pet cock for Buchholz relay.

xiii) Any other valves other than those mentioned above for improvement of operation and maintenance facility if required & pointed during drawing approval stage shall also be within the scope of supply of manufacturer.

l) Remote Tap Changing Control Panel and Cooler Control panel

- The transformer cooler control panel shall be used for control, interlocking, metering and indication of cooler control system of transformer and shall be installed outdoor near the transformer coolers.
- Remote Tap Changing Control Panel (RTCC) shall be installed indoor.
- Control panels shall be of CRCA sheet steel construction with protection class of IP-52 for indoor and IP-55 for outdoor installation.
- The frames and load bearing panels shall be fabricated of not less than 2 mm thick sheet steel. The doors and covers shall not be less than 1.6mm thick. All access doors shall be provided with channel rubber/ neoprene gaskets all round.
- The operating height shall be limited from 750mm to 1800mm. The total height of the panel and its depth shall be matched with adjacent panel.
- The operating handle shall have locking arrangement. The panels shall be complete with floor channel sills, vibration damping pads and stainless steel kick plates.
- All instrument, relays, switches, etc. mounted on the front face of the panel shall be flush or semi flush type. Switch contacts shall be silver faced and rated at least 10 Amp at operating voltage. Push buttons shall have required number of contacts.
- Panel shall be provided with internal illumination lamp with door switch, space heater with thermostat one 5A, 3 pin receptacles with plug.
- The annunciation system shall be solid-state type with optical isolation for input signals. It shall be complete with its own power supply, audible alarms, acknowledge, reset, and test buttons and other necessary accessories.
- The control panels shall be fully wired up at factory. All spare contacts of relays and switches shall be wires up to the terminal blocks.

- The panel shall have provision of cable entry from bottom. Bottom gland plate shall be 3mm thick.
- 50 x 6 mm copper ground bus shall be provided on the panel extending along the entire length of the assembly. The ground bus shall have two-bolt drilling with GI bolts and nuts at each end to receive ground connection of 75x10 mm G.I. flat.
- Remote Tap Changing Control Panel and Cooler Control panel shall have (I/O) connection with Plant SAS/SCADA with necessary Control, Indication and annunciation.

m) Marshalling Box

A sheet steel, weatherproof, IPW55, marshalling box shall be provided for the transformer. The box shall contain all auxiliary devices except those, which must be located directly on the transformer.

All terminal blocks for cable connection shall be located in this box.

The marshalling box shall be provided with cubicle lamp with door switch, space heater with thermostat and removable cable gland plate.

n) Wiring

All control, alarm and indication devices provided with the transformer shall be wired upto the terminal blocks.

- Wiring shall be done with flexible, 650V/1100V grade PVC wires in conduit or PVC armored cable. Minimum wire size shall be 2.5-mm2 copper. Not more than two wires shall be connected to a terminal. 20% spare terminals shall be provided.
- Multi-way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5 mm2 stranded copper conductor and provided with acrylic insulating cover. Terminals for C.T. secondary leads shall have provision for shorting and grounding.
- All devices and terminal blocks shall be identified by symbols corresponding to those used in applicable schematic or wiring diagram. Each wire shall be identified, at both ends, with interlocking type permanent markers bearing

wire numbers as per Contractor's Wiring Diagrams. AC / DC wiring shall have separate color-coding.

- Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

o) Grounding

- The grounding pads, located on the opposite sides of the tank, shall be provided for connection to station ground mat.
- Grounding pad shall have clean buffed surface with two tapped holes, M10 G.I. bolts and spring washers for connection to 75x10 mm G.I. flat.
- Ground terminals shall be also provided on marshalling box to ensure its effective earthing.
- For continuity of earth connection, all gasketted joints shall be provided with braided copper wire jumpers. Bidder shall extend and connect the Transformer earthing mat (Minimum two connection at different location) with the existing station earth grid.

p) Auxiliary Supply

- A.C. supply will be made available to each transformer by two separate feeders one normal and the other standby.
- Isolating switch fuse unit shall be provided for each of the incoming supply along with automatic changeover scheme to switch on to the standby source in case of failure of the normal supply.

q) Auxiliary Equipment

Neutral bushing current transformers shall be furnished when specified in the annexure.

The arrangement shall be such that the C.T. can be removed from the transformer without removing the tank cover.

CT secondary leads shall be wired upto the terminal blocks.

r) Painting

- All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents as required, to produce a smooth surface free of scales, grease and rust.

- The internal surfaces in contact with insulating oil shall be painted with heat resistant insulating varnish which shall not react with and be soluble in the insulating liquid used.
- The external surfaces, after cleaning, shall be given a coat of high quality red oxide or yellow chromate primer followed by filler coats.
- The transformer shall be finished with two coats of battle ship grey (IS Shade # 632) synthetic enamel paint unless otherwise specified.
- The paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
- Sufficient quantity of touch up paint shall be furnished for application after installation at site.
- If it is considered necessary, the transformer may be given a further coating at site by the Owner/Purchaser. The Bidder shall therefore indicate the type and quality of the paint with full specification for this purpose.
- All supporting structures and hardware shall be hot dip galvanized.

s) Transportation

- Transformer tank shall be dispatched filled with oil or pure dry inert Nitrogen gas depending upon the transport weight limitations. A positive pressure of 2 to 2.5 Psi at temperature of 36°C approximate shall be kept. In case the tank is filled with oil, sufficient space is left above the oil to take care of the expansion of the oil. The space is filled with pure dry air or inert gas under atmospheric pressure.
- The temperature and pressure at the time of gas filling shall be marked on a tag. A graph showing pressure vs. temperature shall be attached for reading pressures at different temperatures. Necessary valves, two-stage pressure regulators, filled up Nitrogen cylinder etc. along with other accessories required shall be provided with the tank for intermittent replenishment during transportation.
- Impact Recorder

  Impact recorder/indicator shall be provided to monitor the impact experienced by the transformer during transport.

5.13.7.1.6 TESTS

i) Routine Tests

- During manufacture and on completion, all transformers shall be subjected to the routine tests in accordance with latest IEC 60076 and its different parts.
- In addition, the following tests shall be performed on each transformer :

a) Transformer tank with coolers shall be tested for leaks with normal head of oil plus 35 KN/m2 for a period of 8 hours. If any leak occurs, the test shall be conducted again after all leaks have been repaired.

b) During fabrication stage, the tank shall be pressure tested with air at a pressure corresponding to twice the normal head of oil or normal pressure plus 35KN/m2 whichever is lower for a period of one hour. Also the tank designed for full vacuum shall be tested for maximum internal pressure of 3.33KN/m2 for one hour. The permanent deflection of flat plates shall not exceed CBIP specified figures on release of excess pressure of pressure test and on release of vacuum.

c) After assembly, each core shall be pressure tested for one minute at 2KV (r.m.s.) A.C. between all bolts, side plates, structural steel works and the core.

d) The wiring for auxiliary power and control circuitry shall be subjected to withstand one minute power frequency test with 2.0KV (r.m.s.) to earth.

e) Dielectric special tests as per IEC60076-3.

f) Determination of capacitances windings-to-earth and between windings.

g) Frequency Response Analysis test (This test shall also be undertaken by the manufacturer at site after transformer is installed.)

h) Measurement of acoustic sound level.

i) Measurement of power consumption of fans.

j) Measurement of zero sequence impedance(s) on three-phase unit.

k) Measurement of dissipation factor (tan delta) of insulation system capacitances.

ii) **Type Tests**

Following type tests shall be performed on one transformer in accordance with relevant standard:

a) Dielectric type test (IEC60076-3).

b) Temperature rise test.

c) Impulse test.

Cost of such tests, shall be included in the tender.

- Miscellaneous

All component parts and auxiliary equipment such as oil, bushings, C.Ts etc. shall be routine tested as per relevant Indian Standards.

- Test Witness

Tests shall be performed in presence of Owner/Purchaser's representative if so desired by the Owner/Purchaser. The Contractor shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

- Test Certificates

Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner/Purchaser.

The equipment shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.

Type test certificates on any part of the equipment, if so desired by the Owner/Purchaser, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

5.13.7.1.7 SPECIAL TOOLS & TACKLES

- A set of special tools & tackle which are necessary or convenient for erection, commissioning, maintenance and overhauling of the transformer and its accessories shall be supplied.

- The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

5.13.7.1.8 DRAWINGS, DATA & MANUALS

Drawings, Data and Manuals shall be submitted after the bid and for approval and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.

After placement of LOA, six copies of following drawings, manuals and literatures shall be submitted.

To be submitted for Approval and Distribution

(A) : Approval Category; ®: Reference Category

Drawing for Controls:

i) Schematic diagram of transformer cooler control (A)

ii) Schematic diagram and location of WTI and OTI. (A)

iii) General arrangement of ground mounted Marshalling Box for transformer. (R)

iv) Schematic diagram of manual and push button control of on load tap changer. (A)

v) Abbreviation table for OLTC and RTCC (R).

vi) Explanatory note for RTCC (R)

vii) General Arrangement & scheme drawing for RTCC (A)

viii) Explanatory note for transformer cooler (A)

ix) Wiring diagram of ground mounted Marshalling Box for each type of Transformer(A)

x) Wiring diagram of RTCC panel. (A)

xi) Cable Interconnection Diagram and Cable schedule (R).

xii) Drawings other than there mentioned above if required as per provision of Technical Specification for Erection & Maintenance are also to be submitted.

Drawings of Transformer:

(i) Data sheet of Transformer.(A) General outline drawing showing front, side elevation, plan of the transformer and accessories with detailed dimensions and detailed legend. (R)

(ii) Detailed foundation plan. (A)

(iii) Drawing of each type of bushings, lifting dimensions, clearance between Terminals of different voltage level and ground, quantity of insulation oil, name plate, details etc (R).

Flow diagram of the cooling system showing the number of cooling banks, Pumps, fans etc (A).

(iv) Operation and maintenance guide for transformer and ON LOAD TAP CHANGER. (R)

(v) Transport Outline Drawing (R)

(vi) Valve Schedule Plate(A)

(vii) Measured Loss Plate (A)

(viii) Clamp & connectors (R)

(ix) Rating Plate diagram (A)

(x) Oil filling instruction plate (R)

(xi) Roller locking arrangement (R)

(xii) Foundation Plan drawing. (A)

Xiii) Terminal Arrangement both HT and LT side.

xiv) Drawings of major components like bushing, CTs etc (A).

xv) Quality Assurance Plan (A/Approval by owner).

xvi) Test certificates of transformer and auxiliary equipment (A).

xvii) Instruction manuals on transformer and its various fittings (R).

The manual shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment.

(xviii) Drawings other than those- mentioned above if required as per provision of Technical Specification for Erection & Maintenance is also to be submitted.

- Four (04) copies of approved drawings and literatures for each transformer along with soft copy shall be submitted for our record and distribution to site.
- Instruction Manuals:

Six (06) copies of operation, maintenance and erection manuals in English language shall be supplied for each transformer against each LOA. The manuals shall be bound volumes and shall contain the drawings and information required for erection, operation and maintenance of the power transformer. The manuals shall include amongst other, the following particulars.

a) Marked erection prints identifying the components parts of the power transformers as dispatched, with assembly drawings.

b) Detailed dimensional drawings, assembly and descriptions of all the components.

- The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary

write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.

- The drawings and documents marked with (A) above are of 'Approval' category and are subject to review by Owner. Those marked (R) are for 'reference' category.

- The Owner /Purchaser may review the documents marked (R) if thought necessary. The Contractor shall note that the approval of drawings & documents by the Owner does not relieve him of his contractual obligation.

- All drawings shall be prepared by using AutoCAD and documents shall be generated using Electronic version. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in AutoCAD 2013 and M.S. Office format as applicable for Owner's future reference

To be submitted with the Bid

- Typical general arrangement drawings showing disposition of cooler banks, fittings, terminal arrangement etc.
- Transport/shipping dimensions and weights, space required for handling parts for maintenance.
- Technical leaflets on major components and fittings.
- Write-ups on OLTC if specified, oil preservation and cooling system.
- Type test certificates including short circuit test report of a similar transformer (as per the guidance for identification of a similar transformer as defined in Annexure-A of IEC 60076-5). The type test certificates shall not be more than 5 years old.

ANNEXURE -A

RATINGS AND REQUIREMENTS

AUXILIARY TRANSFORMERS

1.0 Application : 132/36 kV Power Transformer

2.0	Service	:	Outdoor, step up
2.1	Number of Transformer	:	1 No. 12.5 MVA (3Ph.)
2.2	Environment	:	Hot, Humid, Tropical and heavily polluted atmosphere
3.0	Type	:	Out Door Oil immersed Inter connection Power transformer Running in parallel
3.1	Number of Windings per phase	:	Two winding
4.0	Reference standard	:	IS 2026 & IEC60076
5.0	Rated voltage(line to line)	:	132 33
6.0	Rated power (MVA)	:	12.5 12.5
6.1	Maximum System Voltage (kV)	:	145 kV 36 kV
7.0	Number of phases of each unit	:	3 (1-Ph or 3-PH unit)
8.0	No. of phases	:	3
9.0	Rated frequency	:	50 Hz
10.0	Cooling system		
10.1	Type of Cooling & respective power Value % of rated power ONAN/ONAF)	:	ONAN/ONAF 80% / 100%
10.2	Nos. of cooling units & each capacity	:	2 x 50%
11.0	Temperature rise		
11.1	Design ambient temperature	:	50 °C

11.2 Temperature rise above design ambient temperature.		
a) in oil by thermometer	:	50 °C
b) in winding by resistance	:	55 °C
12.0 Insulation level (LI : Lightning Impulse Voltage, AC : Short duration induced & separate source AC withstand Voltage)		
HV-(LI/AC)	:	650/275 KV (peak/rms)
LV- (LI/AC)	:	250 KVp/ 95KVrms
HV Neutral – (LI/AC)	:	75 KVp/ 28KVrms
12.1 Insulation		
i) H.V. winding	:	Graded insulation
ii) I.V. winding	:	Graded insulation
iii) L.V. winding	:	Full insulation
13.0 Vector group	:	Dyn1
14.0 Short-circuit impedance at 75°C at principal tap	:	10% on 12.5 MVA base
15.0 Parallel operation of transformer	:	Yes continuously with existing
16.0 Type of taps provided	:	On-load, Full capacity suitable for bi-directional flow of rated power.
16.1 Type of Remote Tap Change Controller	:	Microprocessor based numerical type

16.2	Taps provided on	:	H.V. winding
16.3	Range of taps	:	± 10% (±8 x 1.25%)
16.4	Method of Tap charge control-		
a)	Manual local	:	Yes
b)	Electrical local	:	Yes
c)	Electrical Remote	:	Yes
d)	Automatic	:	Yes
e)	Group and Solo	:	Yes
16.5	Percentage impedance at principal	:	tapping at 75 Deg.C
17.0	a) Transformer Tank to be Designed, Manufactured and Tested	:	For Full Vacuum as per Relevant IEC/IS and CBIP
	b) Bell Type Tank Construction	:	Yes
18.0	Type of Oil preservation system	:	Diaphragm or constant Pressure system with silica gel breather.
18.1	Insulating Oil for Transformer	:	EHV grade as per IS:335 or equivalent
19.0	System earthing -		
	H.V.	:	Unearthed
	L.V.	:	33 kV System is earthed through Grounding Transformer
20.0	Terminal arrangement -		
	H.V.	:	Top cover mounted Bushing suitable for termination of OH

			ACSR MOOSE conductor / AL Bus	
	L.V.	:	36 KV Grade cable	
	L.V. Neutral	:	36 kV Grade cable for Transformer grounding.	
21.0	Transformer bushing	:	HV	LV HV-N
21.1	Voltage class KV(r.m.s.)	:	145	36 36
21.2	Material	:	Solid porcelain.	
21.3	Creepage distance bushing mm	:	132 kV 3625	36 kV 1300
21.4	Type communicating	:	Oil filled condenser / solid /Oil	
21.5	Continuous current rating	:	100	400
21.6	Minimum clearances (mm) Clearance			
	i) Phase to Phase	:	1550	350
	ii) Phase to ground	:	1300	320
22.0	System fault Level			
	HV Side (132 kV)	:	31.5 KA (r.m.s.) for 3 second	
	LV Side (33 kV)	:	31.5 KA (r.m.s.) for 3 second	
23.0	Max. Flux density in any part of core & Yoke at 110% rated voltage	:	1.9 Tesla	
24.0	Max. Noise level in accordance with Conditions specified in NEMA Std. TR-1	:	As per NEMA std. TR-1	

25.0	Auxiliary supply	:	415V± 10%, 3 ph. 50 Hz ± 5%
		:	220V +10%, -15% 2 wire DC

ANNEXURE B

FITTINGS AND ACCESSORIES

The transformer shall be equipped with fittings and accessories as listed below :

1. Rating and diagram plate.
2. Rubber back type oil conservator with filler cap, drain plug and prismatic/plain oil level gauge for both main tank and OLTC.
3. Oil preservation system complete with accessories.
4. Air release plugs and valves.
5. Required number of pressure relief device capable of resealing after release of pressure.
6. 150mm dial magnetic oil level gauge with low level alarm contacts for main and OLTC conservator.
7. 150mm dial oil temperature indicator with maximum reading pointer and electrically separate contacts for trip and alarm and embedded temperature detectors (PT-100)with suitable output for remote indication.
8. 150 mm dial winding temperature indicators for each winding with maximum reading pointer and electrically separate sets of contacts for trip, alarm and cooler control and embedded temperature detectors (PT-100) with suitable output for remote indication (data logging).
9. Remote Oil and winding temperature indicator for mounting on RTCC panel with separate measuring system for each winding.
10. Thermometer pockets in tank, OLTC chamber, top and bottom radiator header.
11. Double float Buchholz relay with gas release cock, shut-off valve on either side and separate sets of contacts for trip and alarm.

    Gas collection box and gas check valve at ground level. Copper tube interconnection between gas collection box and relay shall also be provided.
12. Filter valve with threaded adopter (top and bottom).
13. Drain valve with threaded adopter.
14. Sampling valve (Top, Intermediate & Bottom).
15. Necessary valves for detachable cooler units.
16. Jacking pads, handling and lifting lugs.

17. Cover lifting eyes.
18. Bi-directional flanged wheel and skids.
19. Clamping device with bolts & nuts.
20. Handhole of sufficient size for access to interior of the tank.
21. Two-grounding pads on tank and each frame.
22. Ladder with safety device for access to the top of transformer tank. A lockable hinged plate shall be provided to prevent unauthorised climbing upto 1500mm from bottom.
23. Weather-proof marshalling box for housing control equipment and terminal connections.
24. H.V., L.V. and neutral bushing terminal connectors.
25. Steel Rating and terminal marking plates.
26. Cooler units complete with valves, fans, pumps, oil flow indicators, supporting structure with caution plate, fixing and foundation bolts etc as required and Cooler Control panel.
27. Sudden Pressure Relay.
28. Oil surge relay with shut off valves on both sides with trip contacts for tap changer compartment.
29. On-line dissolved hydrogen and water monitor (having communicable ports for both local and remote communication), with sensors.
30. OLTC chamber, Drive mechanism bus coupler with all accessories.
31. Transformer control panel (RTCC) for OLTC & Cooler control for mounting in Electrical control room.
32. Copper busbar, mounting insulators (same kV as neutral bushing) and hardware for Neutral
33. Inspection cover for Bushing, OLTC, Tank
34. Bushing current transformers.
35. CT terminal box.
36. Nitrogen Injection Fire Protection System
37. Thermosyphon filter assembly.
38. Valve position indicating plate.

39. Any other fittings & accessories as may be required for successful installation, operation & maintenance shall be provided.

Note : All indication, alarm, trip contacts provided shall be rated for 5 A at 220 V D.C. and 10 A at 230V A.C.

ANNEXURE- C

Definitions of a similar transformer

[As per IEC 60076-5]

Transformers similar to a reference transformer can be identified by comparison using the following non-exclusive list of critical features:

1. Same type of operation, for example generator step-up unit, distribution, interconnection transformer as the reference unit;

2. Same arrangement of main windings and geometrical sequence as the reference unit:

3. Same type of main windings for example, helical, disc, layer, pancake, as the reference unit.

4. Absorbed power at short-circuit (rated power per unit short-circuit impedance) between 30% and 130 % of that of the reference unit;

5. Axial forces and relative winding stresses (ratio of actual stress to critical stress) at short-circuit not exceeding 110% of those in the reference unit;

6. Same type of winding conductors, for example, aluminum, aluminum alloy, annealed or hardened copper, metal foil, wire, flat conductor, continuously transposed conductors and epoxy bonding, if used, as the reference unit;

7. Same manufacturing processes as the reference unit;

8. Same clamping and supporting arrangement.

9. Same conceptual design, for example dry-type, oil-immersed type, core type with concentric windings, sandwich type, shell type, circular coils, non-circular coils as the reference unit.

ANNEXURE -D

TRANSFORMER LOSSES, EVALUATION OF BID & ACCEPTANCE

Rating of Transformer	Guaranteed Maximum No Load Loss on principal tap at Rated Voltage and frequency, in KW	Guaranteed Maximum Load Losses (Copper + stray loss)at rated current on principal tap at 75 oC in HV-IV combination for Auto Transformer & HV-LV combination for Two winding Transformer, in KW	Guaranteed Maximum Auxiliary/Cooler Loss in KW
12.5 MVA 132/36 KV	17	130	-

a) The Transformer is to be designed with maximum permissible losses as indicated above.

b) The bidder must clearly specify that the offered losses are "Maximum"(including IS/IEC tolerance) and no further positive tolerance as per IS/IEC shall be applicable on the offered values during evaluation as well as during testing of transformer.

c) Bids offering with losses beyond the maximum limits mentioned above shall be treated as non-responsive and rejected.

d) NIL

e) However once a bidder becomes successful on the basis of loss capitalization with certain declared loss value, they have to strictly achieve the same loss value during the course of testing of transformers, offered for supply. No tolerance as per IS/IEC will be applicable.

f) If they fail to do so, the offered transformer will be rejected and only replaced transformer with declared loss value will be accepted.

g) In this process, the delay so occurred will be on the vendor's account.

h) If the vendor fails to achieve the declared loss during second time, the contract will be terminated at the vendor's risk and cost.

ANNEXURE - E

AUXILIARY EQUIPMENT

AUXILIARY EQUIPMENT

Transformer shall be provided with minimum following quantity of phase and neutral bushing current transformers as specified and indicated below:-

Sl. No.	Description		Quantity	Application	Current Ratio	Output Burden (VA)	ISF (Max)	Accuracy class	Min Knee point Voltage (V)	Maximum Excitation Current Ie (mA) at Knee point voltage	Maximum Secondary Resistance Rct (Ohm) at higher ratio
1	**132 KV phase side CT**	BC	3	Metering	150/1 A	40	*	CL.0.2	*	*	*
		BC	3	Protection	150/1 A	30	*	CL.5P20/ PS Class	*	*	*
		BC	1 (on Y ph)	For WTI	*	30	*		*	*	*
2	**33 kV LV side CT**	BC	3	Metering	1000/1 A	40	*	CL.0.2	*	*	*
		BC	3	Protection	1000/1 A	30	*	CL.5P20/ PS Class	*	*	*
		BC	3	Protection	1000/1 A	30	*	CL.5P20/ PS Class	*	*	*
3	**Neutral side CT (after neutral formation)**	BC	1	Protection	1000/1 A	30	*	CL.5P20/ PS Class	*	*	*
		BC	1	Protection	1000/1 A	30	*	CL.5P20/ PS Class	*	*	*

(*) - To be decided by the Bidder, The CT ratio, class and burden are tentative only. Shall be decided during detail engineering.

ANNEXURE - F

ON-LINE DISSOLVED HYDROGEN AND WATER MONITOR

1.0 ON-LINE CONDITION MONITORING

Each phase of generator transformer shall be fitted with online DGA equipment. The terminals shall be wired up to the Common marshalling box to enable remote alarm/trip and status information and possible connection to a LAN system. The On line DGA monitoring equipment shall be able to monitor H2, CO, C2H4 and C2H2.

1.1 TECHNICAL PARAMETERS

The system shall meet the following technical parameters:

a)	Detection & measurement of gases	H2, CO, C2H2, C2H4 with 100% sensitivity to H2 & C2H2
b)	Accuracy (maximum)	H2: ±10% or ± 5 ppm (whichever is greater) CO: ±10% or ± 10 ppm (whichever is greater) C2H4: ±10% or ± 3 ppm (whichever is greater) C2H2: ±10% or ± 1 ppm (whichever is greater) Moisture: ± 2% RH
c)	Oil temperature range of sensor	10°C to 100°C
d)	Sensor attachment degree of protection	Minimum IP55
e)	Minimum detection sensitivity to C2H2	2 ppm

1.2 GENERAL TECHNICAL REQUIREMENTS OF DGA

The system offered shall be suitable for online monitoring of dissolved gases in oil filled power transformer. It shall at least measure dissolved gases such as H2, CO, C2H4 & C2H2 with 100% sensitivity to H2 & C2H2 and moisture.

A) The system shall be suitably be fitted to transformer in accessible location to be decided by bidder with owner's approval. Bidder shall provide necessary adopter /fittings for this purpose. The attachment shall be provided with an oil sampling port to facilitate oil collection for manual offline DGA by owner. All software/hardware/cables/PC for monitoring from control room shall be in the scope of the bidder. The supplier shall also provide a suitable calibrating arrangement for each online DGA. The software for remote monitoring in owner's control room shall facilitate real time data logging & also historical data/trend display.

B) The system shall have microprocessor, watchdog and clock system complete with LCD display unit and keypad. The function is to show Gas level, hourly/daily trend

C) The equipment shall have MODBUS TCP/IP protocol. For remote indications on Control Room, analogue output of 4-20 mA, serial output RS 232 /RS 485 shall be made available

D) Potential free alarm contacts for high gas concentration (user programmable) of each gas shall be wired up to transformer Marshalling Box. These will be used by owner for alarm in RTCC and in SAS. Also real time data of each gas shall be provided at owner's control room. All required cable, software, hardware & cable laying for the above communication shall be in the scope of bidder.

5.13.7.2 ELECTRICAL CONTROL AND RELAY BOARDS

5.13.7.2.1 SCOPE OF SUPPLY

- Electrical Control and Relay Boards as listed below, in accordance with this specification.

Control and Relay Board	Type	Quantity in Sets	Location
A. Control panels			

Control and Relay Board		Type	Quantity in Sets	Location
A. Control panels				
i)	Transformer (12.5 MVA, 132 kV/ 33 kV) Transformers cooler & OLTC backup control panel.	Simplex vertical	One(1) (Already supplied, bidder has to supply lay, terminate & test all the Power and control cables from the field. Testing and commissioning and customization of this panel is required during detail engineering)	Existing Control room
ii)	33 kV Incoming feeder from 5 MW Floating Solar Panel	Simplex vertical	One(1)	New Control room
B. Relay Panel				
i)	33 kV Incoming feeder from 5 MW Floating Solar Panel	Simplex vertical	One(1)	New Control room

N.B.: EXISTING RELAY AND CONTROL PANELS FOR TRANSFORMER WILL BE USED UNDER SAS PERVIEW ONLY. HOWEVER, NEW

- Supply, mounting and wiring of all equipment, devices and accessories.
- Floor channel sills, vibration damping pads and kick plates for control boards complete with holding down bolts and nuts.
- Mandatory spares.

5.13.7.2.2 SYSTEM CONCEPT

- New 12.5 MVA Transformer will be controlled from existing SAS. The existing SAS along the BCU **(DUAL PARALLEL REDUNDANT)** panel shall be utilized to perform control, indication, metering and annunciation of the above equipment including 132 KV and 33KV side bay equipment i.e. all circuit breakers and isolators of the above transformer and 33 kV Bays. For control from existing SAS, bidder have to do necessary modification in control and protection scheme for successful commissioning of the new transformer including Operation, Control, Protection, indication, annunciation etc. through existing Bus-tie breaker is scope of this package vendor.
- The 33KV switchyard is now being controlled from new SAS on IEC61850 protocal.
- Bidder shall install new CR panels for new 33 kV Bay for evacuation of Floating Solar Power.
- Bidder shall envisage the space at the existing BCU room adjacent to the 132/33 kV Transformer Yard for the installation all the required panels and other accessories. If the space is not sufficient considering the layout requirement as per NIT, Bidder has to install new Control room for installation of the new CR panel. This New 33KV switchyard control room for CR panel and other required panels are under bidder scope. The new CR Panel shall be utilized to perform control, indication, metering and annunciation of all the 33KV switchyard equipment.
- For coolers, Pumps & fans and tap changer (OLTC) of new transformer One (1) no. control panel will be provided in the New control room. The control & indication for cooler, OLTC can be done from this panel only.
- Existing BCUs' are GE make model: supplied system should be 1:1 compatible with existing system.
- **CONTROL AND RELAY PANEL FOR TRANSFORMER NOT REQUIRED. EXISTING WILL BE USED. However necessary supply, laying, termination of power and control cable, testing, commissioning of these panel along with all necessary control and protection is under bidder's scope.**

5.13.7.2.3 SPECIFIC REQUIREMENTS

a. **Construction**

- The Control and Relay Boards/panels shall be totally enclosed, floor mounted, free-standing, dead-front assemblies conforming to IP-4X degree of protection.
- Design, material selection, and workmanship shall be such as to present a neat appearance outside and inside with no welds, rivets, screws or bolt heads apparent from the exterior surface of the Boards. The boards shall have a smooth and uniform matt finish, free from scratches, dents, and other imperfections.
- The panels shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.
- Each board may consist of a number of panels mounted side-by-side, in which case, these shall be bolted together to form a compact unit. Where two panels meet, the joints shall be smooth, close-fitting and unobtrusive.
- The control boards shall be of folded sheet steel construction, assembled on channel/angle base plates with anti-vibration mountings.
- The boards shall be fabricated of minimum 2 mm thick sheet steel, free from all surface defects. The boards shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.
- All doors and removable covers shall be provided with neoprene gaskets all around and latches sufficiently strong to hold them in alignment when closed. The door operating handle shall have locking arrangement.
- All control panels shall have rear door with concealed type hinges and pad-locking arrangement. Doors shall be grounded by flexible copper braid.

- The boards shall be complete with vibration damping pads, stainless steel kick plates, floor channel sills, anchor bolts, and other necessary hardware for mounting.

b. **Equipment Mounting**

- All instruments, relays, switches, etc. mounted on the front face of the panels shall be flush or semi-flush type.
- No equipment shall be mounted on panel door.
- All equipment shall be so mounted that removal and replacement may be accomplished individually without interruption of service to others.
- All equipment inside the panels shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.
- In case cut-outs are provided on any panel for future mounting of equipment, the same shall be properly blanked off.

c. **Name Plate**

- Nameplates shall be provided on each panel and on each instrument or device mounted in the panel. Each panel shall also have circuit/ feeder designation name plate.
- The material of the nameplates shall be lamicoid or approved equal, 3 mm thick, with white letters on black background.
- The nameplates shall be held by self-tapping screws. The size of nameplate shall be approx. 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.
- Nameplates for panels shall be provided both on the front and the rear.
- Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.
- Instrument and devices mounted on the face of the control boards shall also be identified on the rear with the instrument or

device number. The number may be painted on or adjacent to the instrument or device case.

d. **Illumination, Space Heating and Receptacles**

- Each panel shall be provided with interior fluorescent tube with door switch, space heater with thermostat and switch, and 5A, 3 pin receptacle with plug. Third pin of the socket shall be effectively grounded through the metallic structure.

- Tube, heater and receptacle circuits shall be suitable for available A.C. supply and furnished with individual ON-OFF switch.

- The tube shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

e. **AC/DC Power Supply**

- Necessary A.C and D.C supplies to each control board, as required for control and service, shall be arranged provided by WBPDCL. Following feeders shall be shown to successful Bidder during execution stage, however necessary supply of cable and its raceway, cable laying, termination with respective new small ACDB and small DCDB is under bidder scope:

  a) Two A.C. feeders with rating of 63 A each.
  b) Two DC feeders with a rating of 16 A each.

- Bidder shall consider one ACDB and one DCDB panel for distribution of these AC and DC network inside CR Panel room. Panels shall have Two incomers and one bus-coupler with castle key interlocks. Bidder shall provide MCCB / SFU considering short circuit rating for the incomers and bus-couplers of these ACDB and DCDB.

- Alarm relays with reverse flag shall be provided to annunciate failure of main incoming A.C and D.C supplies and annunciation D.C supply in each panel.

- Lamp indications shall be provided individually for main D.C supply-1 fail, main D.C supply-2 fail, and panel annunciation D.C supply fail. A common A.C electric bell shall be provided to give an audible alarm in case of failure of D.C supply-1/D.C supply-2/annunciation D.C. supply in any panel. A common push-button shall also be provided for cancellation of lamp indication and audible alarm.
- Isolating MCCB / SFU shall be provided for the incoming AC/DC power supplies. Bus wires shall be run for power distribution to different panels. Power supply isolation switches shall be 4-pole, single throw, for A.C. (considering double feeder) and 2-pole, double throw with OFF, for D.C.
- Fuse and link shall be provided for individual circuits for protection & metering including voltage circuits and also for isolation from bus wire without disturbing other circuits. Suitable fuse failure relays shall be provided to give an alarm for voltage circuits of protection/metering. Voltage selection scheme based on relays shall be provided for meters wherever possible.
- The fuse requirements in each panel shall be grouped in easily accessible fuse blocks or distribution panel. The groupings shall be done in a neat and orderly fashion.
- Bus coupler shall be provided in the control bus such that while one bus section of HT/LT is under shut down then control bus section of that particular HT/LT bus section shall remain under dead condition.
- DC should be 100% redundant type. With the fail of one source other must come in place automatically.

f. **Wiring**

- The boards shall be fully wired at the factory to ensure proper functioning of control, protection, and metering schemes. When panels are arranged to be located side-by-side, all inter-panel wiring shall be carried out by longitudinal troughs extending the full length of the board.

- All spare contacts of relays and switches shall be wired upto terminal blocks. All interconnections between the panels of the control board shall be furnished.
- Wiring shall be done with flexible, heat resistant, 1100V grade, PVC insulated, switch board wires with stranded copper conductor. The minimum size of the wires shall be 4 Sq. mm. for current circuits and 2.5 Sq. mm. for control and voltage circuits.
- Each wire shall be ferrulled by plastic tube with indelliable ink print at both end having terminal block no. terminal no. as per approved wiring diagram.
- All wire terminations shall be made with insulated sleeve, solderless type tinned copper lugs. Wire shall not be tapped or spliced between terminals.
- Wiring shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on the termination.

g. **Terminal Block**

- Terminals shall be box-clamp and clip-on type, suitable for terminating upto two wires of 2.5 sq. mm. cross section and provided with marking strips. Terminals for CT secondary leads shall have built-in disconnecting links with facility for shorting. Terminals for CT leads should have adequate cross section for terminating associated CT leads.
- Not more than two wires shall be connected to one terminal. If necessary, a number of terminals shall be jumpered together to provide wiring points.
- Each terminal shall be identified with designation as per approved schematic. At least 20% of the total number of active terminals shall be furnished as spare in each panel.
- The wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

- The terminal blocks shall be located to allow easy access and also to suit floor openings for cable entry.
- Terminal blocks shall generally be mounted vertically with adequate spacing (not less than 100 mm) between adjacent rows.
- The bottom of the terminal blocks shall be at least 200 mm above the incoming cable gland plate.

h. **Cable Entry**

- The panels shall have provision of cable entry from the bottom. Bottom plate shall be provided to make entry dust-tight.
- The panels shall have provisions inside for fixing the multi-core (armoured) cable glands. Cable glands shall be made of brass & double compression type. Cable gland support plate shall be 4 mm thick and mounted not less than 200 mm above floor level.

i. **Grounding**

- 50 x 6 mm TINNED COPPER ground bus shall be provided in each panel, extending along the entire length of the assembly.
- The ground bus shall have two-bolt drilling with GI bolts and nuts at each end and shall be suitable for connection to 50 x 6 mm G.S. flat.
- The ground bus shall be bolted to the panel structure and effectively ground the entire assembly. The cases of meters, relays and switching devices shall be grounded through the steel structure.
- Whenever a circuit is grounded, a single wire from the circuit shall be run independently to the ground bus and connected to it.
- Potential and current transformer neutrals shall be grounded only at the terminal blocks where they enter the control boards from the transformers.

j. **Painting**

- The inside of all boards shall be painted white. The outside surface shall be finished with two coats of synthetic enamel paint, the shade of which shall be subject to approval by the Purchaser. Base frames shall be painted black.

k. **Switches**

- Switches shall be dust protected, heavy duty, switchboard type, complete with escutcheon plate. Contacts shall be silver surfaced and rated minimum 10A at operating voltage. Bidder shall provide soft means for EHV Breaker Control Switch, EHV Isolator, EHV Breaker Maintenance Transfer Switch.
- The switch details and type of handle shall be as given below :

Sl. No.	Application	Switch Type
i)	Breaker	120 deg., 3-position (TRIP/NORMAL/ CLOSE), spring return to normal with lost motion device, non-lockable, sequence device, large pistol grip handle.
ii)	On-Off Switch/	90 Deg., 2-position (ON/OFF OR LOCAL/ Local-remote REMOTE) stay put type, non-lockable, spade Selector Switch handle.
iii)	Transformer Cooler Control Switch	180 Deg., 3-position (AUTO/OFF/ON), stay-Put type, non-lockable, small pistol grip Handle
iv)	Meter Selector	4-position (OFF/R/Y/B for ammeter selector Switches switch and OFF/RY/YB/RB for voltmeter selector switch), maintained contact, stayput type, knob handle. Ammeter selector switches shall have make- before-break contacts.