SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

20 MVA, 110KV/11 kV THREE PHASE TRANSFORMERS

APPLICABLE TO KSEBL	**Rev#0**	DOC. NO.: **SCM-SPEC/XT/ 20MVA Power Transformer**
		EFF. DATE: **29/07/2021**

Number of Pages: 91

Technical Specification and Evaluation Committee for Transmission Material

(i) Document Approval & Control Status

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Date	06/08/2021	06/08/2021	09/08/2021
Signature	**Sd/-**	**Sd/-**	**Sd/-**

(ii) Amendments and History

Sec. #	*Rev. #*	*Date*	*History of Change*

1. PURPOSE:

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **20 MVA, 110kV/11 kV Three Phase Transformers** in a professional manner

2. SCOPE:

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL. Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **20 MVA, 110kV/11 kV Three Phase Transformers** used in field by KSEBL

3. RESPONSIBILITY:

The Executive Engineer (T), Office of Chief Engineer, Supply Chain Management shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions

4. PROCEDURE FOR REVISION:

Modifications if any, in the technical specification will be incorporated as **Revisions.** Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev. No.0.1, 0.2 etc.**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev. No.1.0, 2.0 etc.**

All the details of regarding the revisions (both minor and major) will be incorporated in **"(ii)-Amendments and history"** above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer (SCM).** Those who notice any discrepancy or have any suggestion regarding revision, may bring the matter to the attention of Chief Engineer (SCM) in writing or through e-mail id:**cescm@kseb.in**

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TECHNICAL SPECIFICATION FOR 20 MVA, 110KV/11 kV THREE PHASE TRANSFORMERS

1.0. SCOPE:-

1.1 This specification covers the design, manufacture, shop testing, supply, delivery, supervision of erection, testing and commissioning of 20MVA, 110/11kV three phase two winding transformer at various substations. **The transformers shall be delivered at the transformer plinth if the plinth is ready at the time of delivery or at any desired site, anywhere in the state of Kerala as mentioned by the Board.**

1.2 All drawings, schedules and annexure appended to this specification shall form part of the specification and supplement the requirements specified. The equipment/ materials offered by the Bidder shall be complete in all respects and, whether called for specifically or not, all accessories, hardware and services required for normal satisfactory operation of the system shall be deemed to be included in unit rates quoted. Design and manufacture shall also be such that equipment/ accessories of the same type and rating would be interchangeable.

Specific reference in this specification and documents to any material by trade name, make or catalogue number shall be construed as establishing standard of quality and performance and not as limiting competition. All equipment/ accessories offered shall also be of proven design and manufacture. The make of all accessories and hardware shall be subject to purchaser's approval.

1.3 It is not the intent to specify completely herein all details of the design and construction of equipments. However, the equipment shall conform in all respects to standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the supplier's guarantee in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgement, is not in accordance therewith. The equipments offered shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supplier's supply, irrespective of whether those are specifically brought out in this specification and/or the commercial order or not.

2.0. QUALITY ASSURANCE:-

The supplier shall include a quality assurance programme (QAP) that will be used to ensure that the transformer design, materials, workmanship, test, service capability,maintenance and documentation, will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include

relevant parts to fulfill the requirements of ISO-9001.The supplier shall also furnish and get approved Inspeciton Test Plan and Procedure sufficiently in advance before inspection call.

The supplier shall have Minimum five years of experience as manufacturer of Power transformers of similar capacity and shall have all in-house facility in respect of qualifying to supply the item.

The quality plan shall describe:

i. List of activities involved in design, procurement of raw materials and components, manufacture, stage inspection and final testing, preparation for despatch, delivery, installation and commissioning.

ii. The identification reference of all documentation, standards, procedures, works instructions, drawing, test methods, acceptance criteria etc.

3.0. CODES & STANDARDS:

The transformer shall be manufactured and tested according to the latest revisions of IEC 60076 and IS 2026.

The Material, equipment and methods used in the manufacture of power transformer shall conform to the latest edition of following.

Standard Name / No	Standard's Description
IEC Standards	
IEC:34	Rotating Electrical Machines. (E.g. For Cooler Fan, Motors.)
IEC 38	Standard Voltages.
IEC:71	Co-ordination of Insulation.
IEC:76	Power transformers
IEC:156	Method for Determination of the Electric Strength for Insulating Oils.
IEC:185	Current Transformers.
IEC:214	On-Load Tap- Changers
IEC:242	Standard Frequencies for Centralized Network Control Installations.
IEC:296	Specification for Unused Mineral Insulating Oils for Transformer and switchgear.

IEC:354	Loading Guide for Oil-Immersed Power Transformers.
IEC:445	Identification of Equipment Terminals and of Terminations of Certain Designated Conductors, Including General Rules for an Alphanumeric System.
IEC:529	Degrees of Protection Provided by Enclosures (IP Code)
IEC:542	Application Guide for On-Load Tap- changers.
IEC:551	Determination of Transformer and Reactor Sound Levels.
IEC:606	Application Guide for Power Transformer.
IEC:616	Terminal and Tapping Markings for Power Transformers.
IEC:947	Low- Voltage Switchgear and Control gear.
British Standards	
BS:148	Unused Mineral Insulation Oils for Transformers and Switchgear.
BS:223	Bushings for alternating Voltages above 1000 V.
BS:2562	Cable Boxes for Transformers and Reactors.
BS:6435	Unfilled enclosures for the Dry Termination of HV Cables for Transformers and Reactors.
Indian Standard	
IS:335	Insulating oil
IS:1271	Thermal evaluation and classification of electrical insulation
IS:2099	Bushing for Alternating voltage above 1000V
IS:2705	Current Transformers
IS:3347	Dimensions for porcelain Transformer bushing
IS:3637	Gas operated relays
IS:3639	Fitting & Accessories for power transformers
IS:4201	Application guide for CT's
IS:6600	Guide for loading of oil immersed transformers
IS:8478	Application guide for On-load tap changer
IS:8468	On-load tap changer

IS:10028	Code of practice for selection, installation & maintenance of transformers
IS:13947	LV switchgear and control gear part-1
IS:2026	Power transformers
IS:6272	Industrial Cooling Fans
IS:5	Colours for ready mix paints
IS:5561	Electrical power connectors
	Indian electricity act
	CBIP manual on transformers- Publication 295

In the event of direct conflict between various order documents, the precedence of authority of documents shall be as follows:

1) Guaranteed Technical Particulars (GTP)
2) This Specification
3) Referred Standards
4) Approved Vendor Drawings
5) Other documents.

4.0. MAJOR DESIGN CRITERIA & PARAMETERS OF THE TRANSFORMER:-

4.1	**Major design criteria**	
4.1.1	Location of equipment	OUTDOOR
4.1.2	Reference design temperature	-5 to 40°C
4.1.3	Type	Oil immersed, Core type, Step down
4.1.4	Type of cooling	ONAN/ONAF
4.1.5	Polarity	Subtractive
4.1.6	Voltage variation on supply side	+ / - 10%
4.1.7	Frequency variation on supply side	+ / - 5%
4.1.8	Transient condition	- 20% or + 10% combined variation of voltage and frequency
4.1.9	Climatic conditions	Maximum temperature of air in shade: 40degC Minimum temperature of air in shade:15degC Maximum humidity : 100%

		Average number of thunderstorm days per annum : 50 Average number of dust storm days per annum : 5 Average number of rainy days per annum: 90 Average annual rainfal : 3000 mm Number of months during which tropical monsoon Conditions prevail : 5 Altitude above M.S.L : 0-1000 m	
4.1.10	Reference Standard	IEC 60076 and IS 2026	
4.1.11	No. of windings per phases	2	
4.1.12	No. of phases	3	
4.1.13	Rated voltage ratio	110/11kV	
4.1.14	Rated voltage of HV winding, kV	110	
4.1.15	Rated voltage of LV winding, kV	11	
4.1.16	Phase connection		
4.1.16.1	HV	STAR with Neutral solidly grounded	
4.1.16.2	LV	STAR with Neutral solidly grounded	
4.1.17	Rated frequency	50 Hz	
4.1.18	System Earthing		
4.1.18.1	HV side	Solidly grounded	
4.1.18.2	LV side	Solidly grounded	
4.1.19	Insulation level	**HV**	**LV**
4.1.19.1	Highest System voltage, kV	123	12
4.1.19.2	Lightning Impulse withstand voltage, kV peak	550	75
4.1.20	Power frequency withstand voltage, kV rms	230	28
4.1.21	Design Clearances, mm	Phase to Phase	Phase to Earth
4.1.21.1	For nominal system voltage of 11kV	350	140

4.1.21.2	For nominal system voltage of 110kV	1220	1050
4.1.22	Short circuit withstand level	Shall withstand 1) 3 phase short circuit at secondary terminal with rated voltage maintained on the other side for 3 seconds and 2) Single phase short circuit at secondary terminal with rated voltage maintained on the other side for 3 seconds.	
4.1.23	Overload capability	As per IS 6600 & IEC 354	
4.1.24	Noise level	Shall not exceed limits as per NEMA TR1 with all accessories running, measured as per IEC 551/NEMA standard.	
4.1.25	Radio influence voltage	Maximum 250 µV.	
4.1.26	Harmonic currents	Transformer to be designed for suppression of 3rd, 5th, 7th harmonic voltages and high frequency disturbances	
4.1.27	Partial discharge	Transformer to be free from PD up to 120% of rated voltage as the voltage is reduced from 150% of rated voltage ie. there shall be no significant rise above background level.	
4.1.28	Parallel operation	Shall be designed to operate in parallel with similar transformer.	
4.2	**Major parameters**		
4.2.1	Rating	16/ 20 MVA (ONAN/ONAF)	
4.2.2	Vector group	YNyn0	
4.2.3	Impedance	% impedance at principal tap at rated voltage, frequency at 20MVA Base shall be 10%, with a tolerance of +10%. No negative tolerance is allowed.	
4.2.4	Losses		
4.2.4.1	No load loss	Maximum no load loss at rated condition allowed without any positive tolerance shall be 12 kW	
4.2.4.2	Load losses at principal tap	Maximum load loss at rated condition(20MVA) @ 75°C and principal tap allowed without any positive	

		tolerance shall be 102 kW
4.2.5	Loss capitalization formulae	As per CBIP manual
4.2.5.1	No load loss capitalization figure	Rs.4,72,003/-per kW
4.2.5.2	Load loss capitalization figure	Rs.2,51,106/-per kW
4.2.5.3	Cooler loss capitalization figure	Rs.1,88,801per kW
4.2.6	Temperature rise	For the purpose of maximum temperature rises of oil & winding the following ambient temperature considering the transformer to be operating at extreme tap position incurring extra copper losses a) Maximum ambient temperature :50°C b) Maximum ambient daily temperature:35°C c) Maximum yearly weighed ambient temp.:32°C
4.2.6.1	Temperature rise top oil by thermometer	45°C
4.2.6.2	Temperature rise winding by thermometer	55°C
4.2.7	Flux density	Maximum flux density allowed in the core at rated voltage, rated frequency shall not exceed 1.70 Tesla
4.2.8	Current density	Maximum current density on any portion of the winding (HV/LV) shall not exceed 2.80 Amp/Sq.mm
4.2.9	Tappings on HV winding	On load units with steps of +2.5% to –10% to be provided on the HV winding in steps of 1.25% for rated voltage on the LV side.
5. CONSTRUCTION & DESIGN		
5.1	**Type**	ONAN/ ONAF,Copper wound, Core type, three phase, oil immersed with on load tap changer
5.1.1	Essential provision for ONAF cooling	1) The transformers will be evaluated against no load and load losses guaranteed by the bidders with capitalization of losses as per CBIP guidelines for loss capitalization. The corresponding capitalization figures for no load, load losses and cooler aux. loads shall be as per Cl.4.2.5.1, 4.2.5.2 & 4.2.5.3 above. In the event of measured loss figures during testing

		exceeding the guaranteed loss figures of the successful bidder penalty shall be levied at a rate of 1.25 times the figures mentioned above for no load, load loss and cooler aux. losses. However losses exceeding 5% of specified value will be rejected. 2) 'The transformer ratting shall be 16 MVA (ONAN) / 20 MVA (ONAF). The required fans and cooler control cubicle for 20 MVA (ONAF) requirements shall be provided. The temperature rise of the transformer shall be within the values specified at Cl. Nos. 4.2.6.1 & 4.2.6.2 above. 20% spare cooling fans shall be provided. The cooling fan shall have provision for easy replacement at site in service condition of the transformer. Design of cooling equipment and control shall comply to CBIP clause no. 2.1.3 of Section A (general). 3) If turrets are provided for LV bushings, then it shall be confirmed that, the oil in the turret is getting proper circulation to avoid overheating, by inter connecting from these turrets to cooling system.
5.2	**Major parts**	
5.2.1	Tank	
5.2.1.1	Material of construction	The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness.
5.2.1.2	Plate thickness	Adequate for meeting the requirements of pressure and vacuum type tests as per CBIP
5.2.1.3	Welding features	1) All seams and joints shall be double welded. 2) All welding shall be stress relieved for sheet thickness greater than 35 mm. 3) All pipes, radiators, stiffeners, welded to the tank shall be welded externally
5.2.1.4	Tank feature	1) Adequate space at bottom for collection of sediments

		2) Stiffeners provided for rigidity shall be adequately sloped to prevent accumulation of water 3) No internal pockets in which gas / air can accumulate 4) No external pockets in which water can lodge 5) Tank bottom with welded skid base. 6) Tank cover sloped to prevent retention of rain water. 7) Minimum disconnection of pipe work and accessories for cover lifting. 8) Tanks shall be of a strength to prevent permanent deformation during lifting, jacking, transportation with oil filled. 9) Tank to be designed for oil filling under full vacuum. 10) Fitted with lifting lug to lift the tank cover only. 11) Manhole of sufficient size required for inspection of core and winding. 12) Oil level indicator for transportation.
5.2.1.5	Flanged type adequately sized inspection cover rectangular in shape required for	1) HV line bushing 2) HV neutral bushing 3) LV line bushing 4) LV neutral bushing 5) OLTC to winding connection from both sides. 6) Bushing CTs connections 7) Core assembly earthing inspection covers should be provided with jacking screws handle and shall not weight more than 25 KG Overall design shall be in such a way that there shall not be any hindrance / overlapping of some other component, in front of any of inspection covers.
5.2.1.6	Fittings and accessories on main tank	See under fittings and accessories, section 7.0 of this specification.
5.2.2	Conservator for the main tank	
5.2.2.1	Capacity	Adequate between highest and lowest visible levels to meet the requirement of expansion of oil volume in the transformer and cooling equipment from minimum ambient temperature to 100°C
5.2.2.2	Conservator oil preservation	By flexible rubber bag (air cell) placed inside

	system	conservator
5.2.2.3	Air cell material	Special type of fabric coated with special grade nitrile rubber, outer surface oil resistant and inner surface ozone resistant
5.2.2.4	Conservator features	1) Conservator shall be bolted into position so that it can be removed for cleaning / other maintenance purposes. 2) Main pipe from tank shall project about 20 mm above conservator bottom for creating a sump for collection of impurities. 3) Conservator minimum oil level corresponding to minimum temperature shall be well above the sump level. 4) It shall be possible to remove and replace the air cell if required. 5) Conservator to main tank piping shall be supported at minimum two points.
5.2.2.5	Fittings and accessories on main tank conservator	1) Prismatic oil gauge with NORMAL, MINIMUM and MAXIMUM marking. 2) End cover 3) Oil filling hole with cap. 4) Magnetic oil gauge with LOW LEVEL Alarm contact. 5) Silica Gel dehydrating breather with Oil seal and dust filter with clear acrylic single piece clearly transparent cover resistant to UV rays. 6) Drain cum filling valve (gate valve) with locking rod and position Indicator made of Brass, 25 mm with Cover plate. 7) Shut off valve (gate valve) with Position indicator made of Brass Located before and after Bucholz relay, 80 mm. 8) Flange for breather connection. 9) Air release valve on conservator (gate valve)made of Brass, 25 mm with cover plate. 10) Air release plug as required
5.2.2.6	Essential provision for mounting of conservator	Conservator to be mounted in such a manner that the top cover of the transformer, OLTC diverter switch and any other cover or fitting on the transformer can be lifted without disturbing the conservator.
5.2.2.7	Essential provision for breather	1) Breather piping shall not have any Valve placed in between. 2) Breather piping from conservator

		shall be supported in such a way that the maximum unsupported length of the breather piping shall not be more than 3 meters. 3) Breather shall be removable type mounted at height of 1400mm from the ground level so that it can be attended to easily for inspection / maintenance
5.2.3	Conservator for OLTC	
5.2.3.1	Capacity	Adequate between highest and lowest visible levels to meet the requirement of expansion of oil volume in the OLTC from minimum ambient temperature to 100 deg cent.
5.2.3.2	Conservator oil preservation system	Conventional
5.2.3.3	OLTC conservator features	Same as 5.2.2.4 except air cell feature
5.2.3.4	Fittings and accessories on OLTC conservator	1) Prismatic oil gauge with NORMAL, MINIMUM and MAXIMUM marking 2) End cover 3) Oil filling hole with cap 4) Magnetic oil gauge with LOW LEVEL Alarm contact 5) Silica gel dehydrating breather with oil seal and dust filter with clear acrylic single piece clearly transparent cover resistant to UV rays. 6) Drain valve (gate valve)With locking rod and position Indicator made of Brass, 25 mm with cover plate. 7) Shut off valve (gate valve) with Position indicator made of Brass located before oil surge relay, 25 mm. 8) Flange for breather connection. 9) Air release plug as required.
5.2.3.5	Essential provision for mounting of OLTC conservator	OLTC conservator to be mounted in such a way that the OLTC can be inspected / maintained without disturbing the OLTC conservator
5.2.3.6	Essential provision for OLTC breather	1) Breather piping shall not have anyvalve placed in between. 2) Breather piping from conservator shall be supported in such a manner that the

		maximum unsupported length of the of the breather piping shall not be more than 3 meters 3) Breathers shall be removable type mounted at suitable height from ground so that it can be attended to easily for inspection / maintenance
5.2.4	Cooling System	
5.2.4.1	Radiators	
5.2.4.1.1	General	The total capacity of the coolers for each transformer shall be minimum 120% of actual requirement
5.2.4.1.2	Thickness	As per GTP
5.2.4.1.3	Features	Detachable type with lifting lugs, air release plug, drain plug, isolating valve top and bottom in each radiator, Radiator support from ground if required
5.2.4.1.4	Essential provision if radiators mounted separately	Expansion bellow to be provided in the pipes between main tank and radiator headers
5.2.4.1.5	Essential provision for all type of radiators provided	Radiator header pipes shall not originate from tank top cover , to make the tank top cover removable at site with minimum labour
5.2.4.2	Air Blowers	
5.2.4.2.1	General	1) Shall confirm to CBIP guidelines. 2) Shall be motor driven. Bearing shall be sealed type, which doesn't require frequent lubrication. 3) Shall be suitable for outdoor application. Proper wire-mesh guards shall be provided for blades and shaft to avoid accidental contact. 4) There shall be two group of fans, each group having minimum one stand by fan also each group shall be capable of dissipating 50% of the losses at CMR. 5) All fans shall be properly labeled as ***fan1(Gr-1),fan2 (GR-1), Standby (GR-1)*** etc. as required on permanent type labels with engraved letters.
5.2.4.2.2	Fan motors	Shall be suitable for 3phase 415V, 50Hz AC supply and outdoor application. The terminal box shall be suitable for connecting 3 phase supply.
5.2.4.2.3	Control	1) Each fan motors shall be provided with a 3 pole electrically operated contactors with control gear for motor operation by hand and automatically through WTI contacts. 2) All connections shall be so arranged as to allow

		either individual or collective operation. 3) Also the stand by motor shall automatically start if any one of the fans in that group fails. Also it shall be possible to run the Standby fan in manual mode. 4) Necessary single phasing preventor, motor protection relays etc. shall be provided. 5) Separate 3 phase MCB/ fuses shall be provided for each fan circuit. 6) All contactors, protective devices, MCBs etc. shall be properly labeled. 7) Selector switch for ON, OFF, AUTO shall be provided. 8) The switching ON/OFF of fans in AUTO mode shall be done through winding temperature contacts. 9) All the required components shall be mounted in a separate or combined (For fan control & WTI, OTI) marshalling kiosk as mentioned in clause 5.2.10 of this spec. If combined marshalling kiosk is used, there shall be separated compartment for WTI & OTI mounting.
5.2.5	Core	
5.2.5.1	Material	High grade, non ageing, low loss, high permeability, grain oriented, cold rolled(CRGO) silicon steel laminations conforming to Hi-B grade specially made for the construction of power transformers. CRGO steel core shall be purchased only from the approved vendors (http://apps.powergridindia.com)
5.2.5.2	Grade	Hi-B grade
5.2.5.3	Lamination thickness	0.23-0.27 mm
5.2.5.4	Design flux density at rated conditions at principal tap	<1.7 Tesla
5.2.5.5	Maximum flux density at 10% over excitation / overfluxing	<1.9 Tesla
5.2.5.6	Core design features	1) Magnetic circuit designed to avoid short circuit paths within core or to the earthed clamping structure. 2) Magnetic circuit shall not produce flux components at right angles to the plane of lamination to avoid local heating.

		3) Least possible air gap and rigid clamping for minimum core loss and noise generation. 4) Adequately braced to withstand bolted faults on secondary terminals without mechanical damage and damage / dis-placement during transportation and positioning. 5) Percentage harmonic potential with the maximum flux density under any condition limited to avoid capacitor overloading in the system. 6) All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling, welding. 7) Provision of lifting lugs for core coil assembly. 8) Supporting framework designed not to obstruct complete drainage of oil from transformer. 9) The insulation of core to bolts and core to clamps plates shall be able to withstand a voltage of 2KV dc for one min. However boltless construction shall be preferred to avoid generation of hot spots and decomposition of oil as well as to reduce noise level.
5.2.6	Winding	
5.2.6.1	Material	Electrolytic Copper
5.2.6.2	Maximum current density allowed	2.80 A/ mm2
5.2.6.3	Winding Insulating material	Class A, non catalytic, inert to transformer oil, free from compounds liable to ooze out, shrink or collapse
5.2.6.4	Winding Insulation	HV winding: Graded insulation. The insulation class of the neutral end of the windings shall be graded to 95KV (Impulse) and 38 kV (Power frequency with stand). LV winding: Uniform
5.2.6.5	Design features	1) The windings shall be designed to withstand the impulse and power frequency test

		voltages as per standards. 2) The windings shall be designed to reduce to a minimum the out of balance forces in the transformer at all voltage ratios. 3) The insulation of the windings and connections shall be free from insulating composition liable to soften, ooz out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service. 4) Stacks of winding to receive adequate shrinkage treatment before final assembly. Adjustable devices shall be provided for taking up any possible shrinkage of coils in service. 5) Connection braced to withstand shock during transport, switching, short circuit, or other transients. 6) Conductor width on edge exceeding six times its thickness. 7) Threaded connection with locking facility. 8) Winding leads rigidly supported, using guide tubes if practicable. 9) Winding structure and major insulation not to obstruct free flow of oil through ducts. 10) Provision of taps as indicated in the technical particulars. 11) The conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperature along the windings.
5.2.6.6	Essential provision for core coil assembly	Core coil assembly shall be mounted on bottom of the tank. Earthing of core clamping structure and earthing of magnetic circuit shall be in line with CBIP reference guidelines / manual.
5.2.7	Transformer Oil	See clause 18 for the specification of transformer oil.
5.2.7.1	Type	Class 1 new mineral insulating oil as per IS 335 shall be supplied. No inhibitors shall be used.
5.2.7.2	Quantity	The transformer and associated oil filled equipments shall be supplied along with the first filling of oil and 10% excess quantity of oil shall also supplied in non-refundable drums.
5.2.8	Bushings and Terminations	
5.2.8.1	HV Bushing	145 kV class, 800Amp. OIP condenser bushing of

		appropriate with adjustable arcing horns. The bidder shall furnish calibration gap to decide actual gap setting. Shall be provided with TEST TAP rated for 2kV.
5.2.8.2	HV Neutral bushing	36 kV class, oil communicating type porcelain bushing of 1000 Amp. rating without arcing horn.
5.2.8.3	LV & LV Neutral bushings	17.5 kV class, oil communicating type porcelain bushing of 2000 Amp. rating without arcing horn, as per Section C, 11.0 of CBIP
5.2.8.4	Terminal Connectors (TCs)	
5.2.8.4.1	HV side	Suitable to connect between transformer HV bushing and ACSR KUNDAH conductor. Proper bimetallic (ALCO) shall be provided. Shall have proper bolts to get proper connection and shall be easily removable on requirement. The contact area between bushing & TC and TC and conductor shall be suitable for carrying 120% of the rated current continuously and fault currents as per standards.
5.2.8.4.2	HV Neutral side	Suitable to connect between transformer HV bushing and ACSR KUNDAH/ earthing copper bar. Proper bimetallic (ALCO) shall be provided. Shall have proper bolts to get proper connection and shall be easily removable on requirement. The contact area between bushing & TC and TC and conductor shall be suitable for carrying the fault current as per standards.
5.2.8.4.3	LV side	Suitable to connect between transformer LV bushing and multiple cable suitable for carrying 120% of rated current continously. Proper bimetallic (ALCO) shall be provided. Shall have proper bolts to get proper connection and shall be easily removable on requirement. The contact area between bushing & TC and TC and conductor shall be suitable for carrying 120% of the rated current continuously and fault currents as per standards.

5.2.8.4.4	LV Neutral side	Suitable to connect between transformer LV bushing and multiple cable suitable for carrying 120% of rated current continously. Proper bimetallic (ALCO) shall be provided. Shall have proper bolts to get proper connection and shall be easily removable on requirement. The contact area between bushing & TC and TC and conductor shall be suitable for carrying 120% of the rated current continuously and fault currents as per standards.
5.2.8.5	Minimum creepage distance of bushing	25mm/kV (Refer GTP)
5.2.8.6	Protected creepage distance	At least 50 % of total creepage distance
5.2.8.7	Continuous Current rating	Minimum 20 % higher than the current corresponding to the minimum tap of the transformer
5.2.8.8	Rated thermal short time current	
5.2.8.8.1	HV Line and Neutral bushing	25 times rated current for 2 sec.
5.2.8.8.2	LV line and Neutral bushing	25 times rated current for 2 sec.
5.2.8.9	Atmospheric protection for clamp and fitting of iron and steel	Hot dip galvanizing as per IS 2633
5.2.8.10	Bushing terminal lugs in oil and air	Tinned copper
5.2.8.11	Sealing washers /Gasket ring	Nitrile rubber/ Expanded TEFLON(PTFE) as Applicable
5.2.9	Current Transformers	
5.2.9.1	WTI CT	As per GTP
5.2.9.2	Rating	As per GTP
5.2.9.3	Mounting	In the turret of the bushing. Test winding shall be provided.
5.2.9.4	Essential provision	1) CT mounting shall be such that CT can be replaced without removing tank cover 2)CT secondaries shall be wired upto TB with TB spec. as per Cl. 5.7 of this specification

5.2.10	Marshalling Box Cubicle	
5.2.10.1	Material of construction	CRCA sheet steel of thickness minimum 2.5 mm for load as well as non load bearing member, with toughened glass window in front of gauges
5.2.10.2	Major equipments in Marshalling box	1) Mechanical gauge for WTI 2) Mechanical gauge for OTI 3)Control & Protection Equipment for Fan Control 4) Other panel accessories listed elsewhere
5.2.10.3	Gland plate	Min. 3 mm thick detachable with knockout 6 x 1 inch
5.2.10.4	Contacts directly wired from initiating source to terminal block	WTI alarm and trip OTI alarm and trip Buchholz relay alarm and trip OSR trip contacts MOG low level alarm MOG on OLTC low level alarm PRV main tank trip PRV OLTC trip Sudden pressure relay trip. Fan Control Fan failure alarm Fan ON indication
5.2.10.5	Signals to be wired to terminal block	WTI CT Capillaries for WTI and OTI 4 to 20 mA signals for remote WTI and OTI repeater shall be made available at M.K.
5.2.10.6	Ingress protection	IP 55 plus additional rain canopy to be provided
5.2.10.7	Welding	Continuous welding on joints, welding at regular intervals on joints and filling of gaps with use of Mseal not accepted
5.2.10.8	Cable entry	Bottom for all cables
5.2.10.9	Panel internal Access	Front only through front door double leaf with antitheft hinges
5.2.10.10	Panel back access	None
5.2.10.11	Mounting of marshalling box	On tank.
5.2.10.12	Panel supply	240 V AC, single phase, 50 Hz / 110 V DC
5.2.10.13	Panel accessories	1) Cubicle lamp with door switch and separate fuse / MCB 2) Approved space heaters controlled by thermostat and separate fuse / MCB 3) Incoming fuse switch / MCB for the incoming supply 4) Panel wiring diagram fixed on back of

		panel door (inside) on Aluminum plate engraved fixed by rivet 5) Stainless steel door handle with lock & additional facility for padlock. 6) Earthing boss for the marshaling box. 7) Single phase power plug industrial type 15/5 Amp. With MCB. 8) All hinged parts (doors etc) shall be properly grounded. 9) Dual earthing facility for the M.K
5.2.10.14	Painting of marshalling box	As per Cl No. 5.10 of this Specification
5.2.10.15	Hardware, Gasket, Cables and Wires, Terminal blocks, Cable gland, Cable lugs of marshalling box	As per Cl No. 5.3, 5.4, 5.6, 5.7, 5.8, 5.9 of this Specification
5.2.10.16	Fan motors control installed in marshalling box or separate fan control cubicle	1) 2 x 50% fans (One Standby fan on each group Required) 2)Complete fan control with fuse switch, contactor, Bimetallic relay, in starter circuit as per IS 3) Automatic control from WTI contact 4) Provision for manual control both from local/ remote. 5) Single phase preventor
5.3	**Hardware**	
5.3.1	External	M 12 Size & below Stainless Steel & above M12 Hot Dip galvanized Steel
5.3.2	Internal	Cadmium plated except special hardware for frame parts and core assembly as per manufacturer's design
5.4	**Gasket**	
5.4.1	For transformer, OLTC chamber, surfaces interfacing with oil like inspection cover etc.	Nitrile rubber based
5.4.2	For marshalling box, OLTC drive mechanism etc.	Neoprene rubber based
5.5		

	Valves	
5.5.1	Material of construction	Brass
5.5.2	Type	Both end flanged gate valve / butterfly valve depending on application
5.5.3	Size	As per manufacture's standard
5.5.4	Essential provision	Position indicator, locking rod, padlocking facility, valve guard, cover plate.
5.6	**Cable routing on Transformer**	Control cable for accessories on transformer tank to marshalling box and WTI, OTI Capillaries shall be routed through perforated GI covered trays.
5.6.1	Control cable specification	PVC insulated, extruded PVC inner sheathed, armoured, extruded PVC outer sheathed 1100 V grade control cable as per latest edition of IS:1554 Part-1 minimum 2.5 sqmm for signals and 4 sqmm for CT with multistrand copper conductor.
5.6.2	Specification of wires to be used inside marshalling box, OLTC drive mechanism.	PVC insulated multistrand flexible copper wires of minimum 2.5 sqmm size, 1100 V grade as per latest edition of relevant IS
5.6.3	Essential provision for Capillary routing from transformer to marshalling box	Routing shall be done in such a way that adequate protection is available from mechanical and fire damage.
5.7	**Terminal Blocks to be used by the vendor**	Nylon 66 material, minimum 4 sq mm, screw type for control wiring and potential circuit. Terminal blocks to be located in such a way to achieve the termination height as min 250mm from gland plate
5.7.1	Essential provision for CT terminals	Sliding link type disconnecting terminal block screwdriver operated stud type with facility for CT terminal shorting material of housing melamine/Nylon66
5.8	**Cable glands to used by the vendor**	Nickel plated brass double compression weatherproof cable gland
5.9	**Cable lugs to be used by the vendor**	
5.9.1	For power cables	Tinned copper pre insulated Ring type as application shall be used.
5.9.2	For control cable	Tinned copper pre insulated flat,Ring, Fork type as application. For CT connection ring type lug shall be

		used.
5.10	**Painting of transformer conservator, OLTC, Radiator cable boxes marshalling box.**	
5.10.1	Surface preparation	By 7 tank pretreatment process or shot blasting method
5.10.2	Finish on internal surfaces of the transformer interfacing with oil	Bright Yellow heat resistant and oil resistant paint two coats. Paint shall neither react nor dissolve in hot transformer insulating oil.
5.10.3	Frame parts	Bright Yellow heat resistant and oil resistant paint two coats. Paint shall neither react nor dissolve in hot transformer insulating oil.
5.10.4	Finish on inner surface of the marshalling box	White Polyurethane paint anti condensation type two costs, minimum dry film thickness 80 microns
5.10.5	Finish on outer surface of the transformer, conservator,radiator, cable boxes, marshalling box.	Light Admiralty Grey (IS shade 697) polyurethane paint two coats, minimum dry film thickness 80 microns
5.11	**Internal Earthing Arrangements**	
5.11.1	General	All metal parts of the transformer with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at same potential.
5.11.2	Earthing of core clamping structure	The top main core clamping structure shall be connected to the tank body by a copper strap. The bottom clamping structure shall be earthed by i) Connection through vertical tie rods to the top structure. Or ii) By a connection to the top structure on the same side of the core as the main earth connection to the tank.
5.11.3	Earthing of Magnetic Circuit	The magnetic circuit shall be earthed at one point only through a link placed in an accessible position beneath an inspection opening in the tank cover. The connection to the link shall be on the same side of the core as the main earth connection. When magnetic circuits are subdivided into separate isolated sections by ducts perpendicular to the plane of laminations all

		such sections should be earthed.
5.11.4	Earthing of Coil Clamping Rings	Where coil clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of transformer as the main earth connections.
6.0 MINIMUM PROTECTIVE DEVICES ON TRANSFORMER		
6.1	Spring loaded with detachable diaphragm type pressure relief valve with two tripcontacts for the main tank with limit switch design IP 65 with additional rainhood.	Required
6.2	Spring loaded with detachable diaphragm type pressure relief valve with two trip contacts for OLTC with limit switch design IP65 with additional rain hood. OR Suitable diaphragm, which may crack and release the excess pressure generated internally during an abnormal condition.	Required
6.3	Double float Bucholz relay with alarm and trip contacts, service and test position, with test cock for the main tank, terminal box shall be IP 65 with drain plug for rainwater draining.	Required
6.4	Oil surge relay with two contacts, services and test position, with test cock for OLTC tank, terminal box shall be IP 65 with drain plug for rainwater draining.	Required
6.5	Oil temperature indicator metallic bulb type 150 mm diameter with maximum reading pointer, potential free independent adjustable alarm and trip contacts, resetting device with temperature sensing element.	Required
6.6	Winding temperature indicator with maximum reading pointer, two sets of potential free independent adjustable alarm, fan controls and trip contacts, resetting device with temperature sensing element, thermal image coil.	Required

	winding temperature indication wired up to TBs in marshalling box for external connection	
7	**FITTINGS AND ACCESSORIES ON TRANSFORMER:**	**Following shall be fixed on each transformer.**
7.1	Rating and diagram plate	
7.1.1	Material	
7.1.2	Background	
7.1.3	Letters, diagram & border	
7.1.4	Process	
7.1.5	Name plate details	
7.2	Instruction plate for OLTC anodized aluminum black lettering on satin silver background fixed by rivet	
7.3	Oil filling instruction plate anodized aluminum black lettering on satin silver background fixed by rivet	
7.4	Valve schedule plate anodized aluminum black lettering on satin silver background fixed by rivet	
7.5	Instruction plate anodized aluminum black lettering on satin silver background for flexible air cell for oil conservator	
7.6	Terminal marking plate for bushing WTI, OTI etc. anodized aluminum black lettering on satin silver background fixed by rivet	
7.7	Company monogram plate	
7.8	Lifting lugs / bollards with antiskid head to lift complete transformer with oil	
7.9	Lashing lug	
7.10	Jacking pad with Haulage hole to raise or lower complete transformer with oil	
7.10.1	Essential provision for jacking pads	
7.11	Detachable bi-directional roller assembly with corrosion resistant fitting / nipple for lubrication or with permanently lubricated bearing, anti earthquake locking device. The wheels shall be capable of swiveling when transformer is lifted with provision for locking the swivel movement. Roller shall be suitable for 90 lb rail. Suitable antirolling clamp for 90 lb rail minimum 4 nos. shall be provided	
7.12	Pockets for OTI, WTI, on tank	
7.13	Pockets for ordinary thermometer on tank cover (Bottom & top)	
7.14	Ordinary thermometer 2 nos.	
7.15	Drain valve (gate valve) for the main tank, 80 mm	
7.16	Drain valve (gate valve) for OLTC, 50 mm	

7.17	Drain valve (gate valve) for all headers, 50 mm	
7.18	Filter valve (gate valve) at top and bottom of the main tank, 50 mm	
7.19	Sampling valve (gate valve) at top and bottom of the main tank, 15 mm	
7.20	Vacuum breaking valve (gate valve), 25 mm	
7.21	Drain plug on tank base	
7.22	Air release plug on various fitting and accessories	
7.23	Earthing pad on tank for transformer earthing complete with non ferrous nut, bolt, washers, spring washers etc. The earthing pads shall be non rusted & corrosive, made of stainless steel and shall not be painted. It shall have the capacity to carry the fault current as per specification.	
7.24	Vacuum pulling pipe with blanking plate on main conservator pipe work	
7.25	Rainhood (canopy) PRV on main transformer	
7.26	Oil level gauge on tank for transformer shipment	
7.27	Earthing bridge by copper strip jumpers on all gasketted joints at least two points for electrical continuity	
7.28	Ladder with anticlimbing device and safety flap, with lockable hinged plate for at least 1.5 m from ground level	
7.29	OLTC panel as specified	
7.30	Skid base welded type	
7.31	Core, frame to tank earthing	
7.32	Danger plate made of anodized aluminium white lettering on red background fixed by rivet	
7.33	Identification plate for all accessories, protective devices, instruments, thermometer pockets, earthing terminals, all inspection covers, cable boxes, marshalling boxes etc.made of anodized aluminium black lettering on silver background fixed by rivet	
7.34	Remote Tap Changer Control (RTCC) panel for erecting in the control room.	
8.0	**On Load Tap Changer (OLTC)**	
8.1	Requirement	Each transformer shall be provided with an on load tap changing Mechanism. The tap changer shall be suitable for bidirectional power flow. The OLTC shall be based on Dr. Jansen Principle, comprising tap selectors and diverter switch of high speed transition. This shall be designed suitable for remote operation from the remote tap changer control (RTCC) panel in the control room in addition to being capable of local manual as

		well as local electrical operation.
8.2	Type of OLTC gear	The tapings shall be controlled by a high speed resistor transition type gear in which tap change is carried out virtually under 'no volt' 'no ampere' condition and the selector switches do not make and break any current, main current is never interrupted and a resistor is provided to limit the arching at diverter contacts to a minimum suitable for outdoor mounting and continuously rated for operating at all position including positions in the middle of tap change. In particulars, the tap change gear shall be suitable when delivering the full output plus permissible overload and operating the lowest voltage tap on the HV side. The value of the transition resistor shall be indicated on the rating plate of the OLTC with continuous current rating with reference to design ambient temperature specified.
8.3	Tappings	As per Clause 4.2.9 of this specification.
8.4	Operation of OLTC gear	Selection of local / remote operation by selector switch on OLTC drive mechanism
8.4.1	Local operation	From OLTC drive mechanism through pistol grip rotary switch as well as emergency mechanical hand operation
8.4.2	Remote operation	From RTCC panel installed in the control room.
8.5	Safety interlocks in OLTC	Following safety interlock to be provided in OLTC as minimum 1) Positive completion of tap changing step once initiated 2) Blocking of reverse tap change command during a forward tap change already in progress until the mechanism resets and vice – versa. 3) Cutting of electrical circuits during mechanical operation 4) Mechanical stops to prevent overrunning of the mechanism at the end taps 5) Interlock to avoid continuous tap change which will

		cut off motor supply in such events 6) Raise / lower command in OLTC shall be positively interlocked
8.6	Features of OLTC	1) OLTC mechanism and associated controls shall be housed in an outdoor, IP 55, weatherproof, vermin proof and dust proof cabinet 2) It shall be ensured that oil in compartments containing contacts making and breaking current and compartments containing contacts not making and breaking current in main transformer tank does not mix 3) The hand cranking arrangement shall be such that it can be operated at standing height from ground level 4) Mechanical indicator to indicate completion of tap change operation shall be provided with suitable (Green & Red) colour code to confirm correct method of completion of tap change operation 5) Contactors shall be placed in the OLTC driving mechanism in such a way that the name-plate shall be visible on opening of door. 6) Protective cover shall be provided for raise and lower push buttons, external ON-OFF switch, which are mounted on OLTC driving mechanism door. This is required to prevent unauthorized person operating these buttons. 7) It shall be possible to remove the top cover of the OLTC tank without difficulty. The OLTC conservator, piping & oil surge relay shall be placed accordingly. 8) The tap change equipment shall be so designed that if the mechanism is struck in an intermediate position, the transformer shall be capable of delivering full load without any damage. 9) Limit switches may be connected in the contro circuit of the operating motor provided that mechanical de-clutching mechanism i incorporated. Otherwise it shall be directl connected to the operating motor circuit an mechanical stop. 10) Thermal devices or other means shall be

		provided to protect the motor and control circuits. 11) The tap changer shall be capable of permitting parallel operation with other transformer for which necessary wiring and accessories, if any, shall be provided 12) The control scheme for the tap changer shall be provided for independent control of the tap changers when the transformers are in Independent service. In addition provision shall be made to enable parallel operation control also at times so that the tap changer will be operated simultaneously when one unit is in parallel with another it will not become out of step and this will eliminate circulating current. Additional features like master / follower and visual indication during the operation of motor shall also be incorporated. 13) OLTC shall be suitable for bi- directional power flow in transformer 14) Mechanical indicator and operation counter shall be visible through glass window OLTC drive mechanism door 15) External ON /OFF switch in addition to door switch 16) All HRC fuses shall be located in such a way that they are easily replaceable. 17) Motor protection relay shall be provided with single phasing prevent for both current and voltage unbalance. 18) All accessories inside drive mechanism shall be provided with metallic label, no sticker permitted. 19) Emergency stop button with proper shroud shall be provided on RTCC and driving mechanism panels.
8.7	Essential BOM for OLTC drive mechanism (indicative only, bidder to provide all necessary components to complete the function of the OLTC)	1) Control circuit transformer 415/55-0-55 V, adequate capacity 2)Local remote selector switch 1 pole, 2 way, 6A, pistol grip 3) Retaining switch raise / lower 4) Handle interlock switch 5) Raise / lower switch 1 pole, 2way, 6A, pistol grip

		6) Lower limit switch 7) Raise limit switch 8) Tap changer motor, 415 V AC, 3 phase, adequate rating 9) Motor protection relay with single phasing preventer 10) Motor control contactors raise / lower 11) Stepping relay 12) Out of step switch 13) Tap position indicator 14) Operation counter 15) Emergency stop push button 16) Tap change incomplete scheme with timer 17) Required indication lamp
8.8	Essential provision of accessories on OLTC	1) Pressure relief valve/ diaphragm 2) Oil surge relay
8.9	Drive mechanism accessories	1) Cubicle lamp with door switch and separate fuse / MCB with external ON /OFF switch on front cover of OLTC drive mechanism 2) Approved space heaters controlled by thermostat and separate fuse / MCB 3) Incoming fuse switch / MCB for the incoming supply 4) Panel wiring diagram fixed on back of panel door aluminium engraved fixed by rivet 5) Nylon 66 terminal block min 4 sqmm screw type, with 10% spare terminals shall provided for interfacing with RTCC panel and to connect 415V, three phase AC supply etc. 6) Stainless steel door handle with lock & additional facility for padlock 7) Earthing boss. 8) Operation counter.
8.10	Hardware, Gasket, Cables andWires, Terminal blocks, Cable gland, Cable lugs of OLTC drive mechanism	As per GTP
8.11	OLTC and drive mechanism painting	As per GTP
8.12	Remote Tap Changer Control (RTCC) panel	
8.12.1	Remote Tap Changer Control (RTCC) panel	The supplier shall supply one indoor cubicle for each transformer (RTCC panel) for installation in the

		purchaser's control room for the remote operation of the tap changer from control room and from remote (viz. Load dispatch centre).
8.12.2	Material of construction	CRCA sheet steel of thickness minimum 2.5 mm for load as well as non load bearing member.
8.13.3	Gland plate	Min. 3 mm thick detachable with knockout 6 x 1 inch
8.13.4	Major equipments in the RTCC panel	The RTCC shall have minimum the following
8.13.4.1	Control switches / Push buttons	Push button for 'RAISE" Push button for "LOWER" "EMERGENCY STOP" button to stop Tap Changer operation. "Control Supply ON/OFF" switch. "OFF/MASTER/FOLLOWER/INDEPENDENT" Mode Selector Switch.
8.13.4.2	Annunciation Relay	The RTCC panel shall be provided with an annunciation Relay system having TEST, ACCEPT & RESET facilities. The relay shall be suitable for TRIP and NON-TRIP alarms. In the event of any contact initiates, the corresponding window shall glow and an audible alarm shall be operated. The TRIP window shall have Black text in Red background and Non-Trip alarm window shall have black text in white background. There shall be minimum two nos. each of TRIP & NON TRIP windows as SPARES. The relay shall be suitable for the following TRIP and NON-TRIP alarms. WTI alarm and trip OTI alarm and trip Bucholz relay alarm and trip for main tank OSR trip. MOG low level alarm for main tank and OLTC PRV main tank trip PRV OLTC Trip Sudden pressure relay trip Main fan in GR-1 fail Main fan in GR-2 fail Drive Motor Auto trip Out of step alarm
8.13.4.3	Bunched LED Indications	The RTCC panel shall have low power consumption bunched LED bulb indications for the following. Supply ON- Green Tap Change in Progress- Amber OLTC control supply On- Green DC Supply ON- Green TC Upper limit reached- Yellow

		TC Lower limit reached- Red TC in LOCAL mode- Red TC in REMOTE mode- Blue 4 to 20 mA signals for WTI, OTI repeater and tap positions for SCADA use.
8.13.4.4	Other Indicators	1) Two digit TAP POSITION INDICATOR. 2) One no.Digital Winding Temperature and Oil temperature indicators. The indicators can read temperature up to 200°C, with 0.1°C resolution.
8.13.4.5	Signals/controls to Remote	Following signals / controls shall be available for connecting to remote 7) TAP positions 8) Winding and Oil temperatures 9) Tap changer LOW and RAISE controls. 10) Each relay for tripping function shall have two normally open and two normally closed contacts for connection to tripping relays. These are to be wired up to TBs. 11) 4 to 20mA signal for SCADA for tap positions for connecting from RTCC
8.13.5	Welding	Continuous welding on joints, welding at regular intervals on joints and filling of gaps with use of Mseal not accepted
8.13.6	Cable entry	Bottom for all cables
8.13.7	Panel internal Access	Access from rear side only.
8.13.8	Panel front access	None
8.13.9	Mounting	Mounting on floor with foundation bolts
8.13.10	Panel supply	240 V AC, single phase, 50 Hz / 110 V DC
8.13.11	Panel other accessories	1) Cubicle lamp with door switch and separate fuse / MCB 2) Approved space heaters controlled by thermostat and separate fuse / MCB 3) Incoming fuse switch / MCB for the incoming supply 4)A table showing voltages on each tap position engraved in stainless steel plate shall be fixed on the front of the panel by rivet. 5)Stainless steel door handle with lock &

		additional facility for padlock 6)Earthing strip inside the panel for connecting to the substation grounding. 7) Single phase power plug industrial type 15/5 Amp. With MCB. 8) All hinged parts (doors etc) shall be properly grounded.
8.13.12	Painting of marshalling box	As per Cl No. 5.10 of this Specification
8.13.13	Hardware, Gasket, Cables andWires, Terminal blocks, Cable gland, Cable lugs of marshalling box	As per Cl No. 5.3, 5.4, 5.6, 5.7, 5.8, 5.9 of this Specification
9.0 MAKE OF DIFFERENT COMPONENTS		
9.1	Magnetic oil level indicator	Sukrut or equivalent
9.2	Pressure relief valve	Sukrut / Qualitrol or equivalent
9.3	Bucholz relay	Proyog / ATVUS or equivalent
9.4	Oil surge relay	Proyog / ATVUS or equivalent
9.5	Winding Temperature Indicator	Precimeasure / Perfect Controls / Pradeep sales
9.6	Oil Temperature Indicator	Precimeasure / Perfect Controls / Pradeep sales
9.7	Sudden Pressure Relay	Sukrut / Qualitrol or equivalent
9.8	Aircell	Sukrut / Pronol & Rubber Product or equivalent
9.10	WCT	Pragati /ECS / KAPPA/ or equivalent
9.11	Switch	L & T (Salzer) / Siemens or equivalent
9.12	HRC fuse links	Siemens / L & T / GE or equivalent
9.13	Fuse base	Siemens / L & T / GE or equivalent
9.14	Meters	IMP / AE / MECO or equivalent
9.15	AC contractors & O / L relay	L & T / Siemens / Schneider or equivalent
9.16	Terminals	Connectwell / Elmex or equivalent
9.17	Push buttons / Actuator	L & T / Siemens or equivalent
9.18	Thermostat	Velco or equivalent
9.19	Heater	Velco or equivalent

9.20	Control selector switch	Siemens or equivalent
9.21	Auxiliary relays	Jyoti / Easun Rayrole or equivalent
9.22	Timers	L & T / Siemens or equivalent
9.22	Tap position indicator	Accord or equivalent
9.23	Annunciator	Accord or equivalent
9.24	Digital Tape change counter	Selectron or equivalent
9.25	LED cluster type indication lamp	MIMIC / Siemens / binay or equivalent
10.	**INSPECTION & TESTING:-** All testing equipments and instruments shall be got calibrated from national accredited labs (NABL) and shall have valid calibration certificates at the time of testing. The CT/PT units used shall be with accuracy class 0.2s/0.2.	
10.1	**Inspection and Testing during manufacture**	Client shall be intimated minimum 20 days in advance for the stage inspection during manufacturing and all test results shall be got approved before proceeding to next stage of production.
10.1.1	Tank and conservator	1) Check correct dimension between wheels demonstrate turning of wheels through 90 deg and further dimensional check. 2) Check for physical properties of material for lifting lugs, jacking pads etc. all load bearing welds, including lifting lug welds shall be subjected to required load tests. 3) Leakage test of the conservator & radiators as per CBIP. 4) Certification of all test results. 5) Vacuum and pressure test on tank as type test as per CBIP
10.1.2	Core	1) Vendor to submit the documentary evidence for procurement of CRGO laminations and prove that they have procured / used new core material. During in process inspection of lamination the vendor & Customer shall randomly select / seal lamination for testing at ERDA / CPRI (Accredited NABL labs) for Specific core loss ,accelerated ageing test , surface insulation resistivity , AC permeability and magnetization , Stacking factor , ductility etc. 2) Check on the quality of varnish if used on the stampings. a) Measurement of thickness and hardness of varnish on stampings.

		b) Solvent resistance test to check that varnish does not react in hot oil. c) Check overall quality of varnish by sampling to ensure uniform hipping color, no bare spot. No over burnt varnish layer and no bubbles on varnished surface 3) Check on the amount of burrs. 4) Bow check on stamping. 5) Check for the overlapping of stampings. Corners of the sheet are to be apart. 6) Visual and dimensional check during assembly stage. 7) Check on complete core for measurements of iron- loss and check for any hot spot by exciting the core so as to include the designed value of flux density in the core. 8) Check for inter laminar insulation between core sectors before and after pressing. 9) Visual and dimensional check for straightness and roundness of core, thickness of limbs and suitability of clamps. 10) High voltage test (2KV dc for one minute) between core and clamps. 11) Certification of all test results.
10.1.3	Insulating material	1) Sample check for physical properties of material 2) Check for dielectric strength, DP 3) Visual and dimensional checks 4) Check for the reaction of hot oil on insulating materials 5) Certification of all test results
10.1.4	Windings	1) Sample check on winding conductor for mechanical properties and electrical conductivity. 2) Visual and dimensional check on conductor for scratches, dept. mark etc. 3) Sample check on insulating paper for bursting strength, electric strength. 4) Check for the reaction of hot oil on insulating paper. 5) Check for the binding of the insulating paper on conductor. 6) Check and ensure that physical condition of all materials taken for winding is satisfactory and free of dust.

		7) Check for absence of short circuit between parallel strands. 8) Check for Brazed joints wherever applicable. 9) Measurement of voltage ratio to be carried out when core / yoke is completely restocked and all connections are ready. 10) Certification of all test results.
10.1.4.1	Checks before drying process	1) Check conditions of insulation on the conductor and between the windings. 2) Check insulation distance between high voltage connection cables and earthed and other live parts
10.1.4.1	Checks before drying process	1) Check conditions of insulation on the conductor and between the windings 2) Check insulation distance between high voltage connection cables and earthed and other live parts 3) Check insulation distance between low voltage connection cables and earthed and other parts 4) Insulation test of core earthing 5) Check for proper cleanliness 6) Check tightness of coils i.e. no free movements 7) Certification of all test results
10.1.4.2	Checks during drying process	1) Measurement and recording of temperature and drying time during vacuum treatment. 2) Check for completeness of drying 3) Certification of all test result.
10.1.5	Oil	As per IS 335
10.1.6	Test on fittings and accessories	As per manufacturer's standard
10.2	**Routine tests**	The sequence of routine testing shall be as follows. 1) Visual and dimension check for completely assembled transformer 2) Measurements of voltage ratio 3) Measurements of winding resistance at principal tap and two extreme taps. 4) Vector group and polarity test 5) Measurements of insulation resistance.

		6) Separate source voltage withstand test. 7) Measurements of iron losses and exciting current at rated frequency and 90%, 100% and 110% rated voltage. 8) Induced voltage withstand test. 9) Load losses measurement. 10) Impedance measurement of principal tap (HV and LV) of the transformer. 11) Routine test of tanks 12) Induced voltage withstand test (to be repeated if type tests are conducted). 13) Measurement of iron loss (to be repeated if type tests are conducted). 14) Measurement of capacitance and Tan Delta for transformer oil and windings.(for all transformers). 15) Phase relation test, polarity, angular displacement and phase sequence. 16) Ratio of WTI CT. 17) Routine test on on–load tap changer. 18) Oil leakage test on all tanks at normal head of oil plus 35 kN / sqm at the base of the tank for 24 hrs 19) Magnetic balance test 20) Power frequency voltage withstand test on all auxiliary circuits 21) Certification of all test results.
10.3	**Type tests**	Following type test shall be carried out on one transformer of each rating and type (In Govt. recognized independent test laboratory / Internationally accredited test lab or at manufacturer's facility if it is approved by competent authority) from the lot offered for inspection. Type test(clause 10.3) results for transformer of same type and design shall be submitted along with Bid not older than 5 years 1) Test of temperature rise. This test shall be carried out on the tap having maximum losses. 2) Measurement of open-circuit and short

		circuit zero-sequence impedance of the HV and LV windings. 3) Measurement of capacitance. 4) Short Circuit test. 5) Impulse Test - I) Full-wave impulse voltage withstand test. The test voltage shall be applied to each line and neutral terminal. The applied voltage shall be the relevant lightning impulse voltage specified in the clause on Insulation Levels. ii) Chopped-wave impulse voltage withstand test. The test voltage shall be applied to line terminals only. The applied voltage shall be 115% of the relevant lightning impulse voltage specified in the clause on Insulation Levels. The tst sequence to each terminal shall be as follows; • One reduced full impulse (Calibration) • One 100% full impulse. • Two 115% chopped impulse. • Two 100% full impulse 6) Noise level measurement, in accordance with IEC Publication 551 using a precision sound level meter conforming IEC Publication 651. In addition the test shall be repeated with narrow band filters for the harmonic frequencies from 100Hz up to 350 Hz. 7) Vacuum Test. 8) Tap – changer tests required by IEC:214 as follows. • Temperature rise of contacts. • Switching tests. • Short circuit current test • transition impedance test. • Mechanical tests • dielectric tests.
10.3.1	Note for type test & special test	Cost of the tests, which are not mandatory as per

		IEC/IS if any shall be quoted separately by the Bidder, which shall be considered in the price evaluation.
10.3.2	Notification to bidders	The product offered must be of type tested quality. In case the product offered is never type tested the same as per above list to be conducted by bidder at his own cost at Govt. recognized independent test laboratory / Internationally accredited test lab or at manufacturer's facility if it is approved by component authority.
10.4.1	Note for type test	**In case the product offered is never tested for dynamic short circuit the same to be conducted by bidder at his own cost at Govt. recognized independent test laboratory / internationally accredited test lab.**
10.5	**Test Reports**	
	After all tests have been completed, two certified copies of each test report shall be furnished. Each report shall furnish the following information. 1) Complete identification data including serial number of the transformer. 2) Method of application, where applied, duration, and interpretation of results in each tests. 3) Temperature data corrected at 75°C including ambient temperature. Permissible limit of test results as per relevant standards, guaranteed value as per offer and actual test results shall be indicated in the test reports.	
11.	**Packing**	
	The packing may be in accordance with the supplier's standard practice but he should give full particulars of packing for the approval of the purchaser.Special arrangement should be made to facilitate handling and to protect and projecting connections from damage in transit. Vibration monitoring device shall be fitted on the transformer to monitor the vibration during transit. The maximum weight of a single package should not be more than 40 tons and maximum size of package should not be more than 4m x 4m x 2.4m (hxlxb). The transformer shall be shipped filled with oil/with inert gas (which ever way desired by the purchaser depending on the size etc.). All parts shall be adequately marked to facilitate field erection. Boxes and crates shall be marked with the contact number and shall have a packing list enclosed showing the parts contained therein, weight and special lifting and storing instruction if any. As the equipment is liable to be stored in the open, packing shall be suitable for outdoor	

	storage under humid atmospheric conditions.
12	**TOOLS**
	The following tools of reputed firms having high quality shall be supplied along with each transformer 1) DE Spanner set from 32 mm to 6 mm size 2) 20 cm heavy duty cutting pliers 3) Nose pliers 4) Circlip pliers (Inner & Outer) 5) Hydraulic jacks suitable for this transformer 6) Screw drivers – 4 nos (1 large, 2 medium, 1 small) 7) Star screw driver 8) Monkey pliers 9) Adjustable spanners 10) Tomy bar – 2 nos and any special tool required. 11) Tools for making various type holes on gaskets All the tools except jack must be supplied in a toolbox.
13	**SPECIAL WARRANTY- deleted**
14	**DRAWINGS AND DATA TO BE FURNISHED BY THE SUPPLIER**
	Within two weeks after the award of the contract the manufacturer shall supply four copies of drawings along with soft copy which will describe the equipment in detail for approval. All Schedule of stage inspection shall be submitted and got approved well in advance before the commencement of stage inspections. All test procedures and test formats shall be submitted and got approved by KSEB The following drawings of technical literature for each item are to be supplied as part of this contract. 1) Outline dimensional drawings of transformer and accessories. 2) Assembly drawings and weights of main component parts 3) Shipping drawings showing dimensions and weights of each package. 4) Drawings giving details of foundation and structure. 5) Tap changing gear arrangement showing constructional details and general arrangement. 6) Schematic control and wiring diagram for all auxiliary equipments and cooler cont

	system. 7) Schematic diagram showing the flow of oil in the cooling system as well as each li and winding. Longitudinal and cross sectional views showing the duct sizes, cool pipes etc. for the transformer drawn to scale shall be furnished. 8) Large scale drawings of high and low tension windings of the transformers showing the nature and arrangement of insulation and terminal connections. 9) Bushing drawing and specification. 10) Details of name plate, terminal marking and connection diagram. 11) All type Test results for transformer of same type and design shall be submitted, not older than 5 years. 12) Six copies of instruction books/operation and maintenance manuals and spare part bulletins per transformer. 13) Description, literature and data on transformer construction, winding, bushing, tap changing gear etc. (2 sets per transformer)
15	EXPERIENCE:- The tenderers are required to furnish information regarding the experience on the following points along with the tender document. a. Name of Manufacturer. b. Status of the Firm as manufacturer of the transformer quoted. c. Description of the transformers similar to that quoted supplied and installed during the last 5 years with the name of the party to whom supply was made. d. Details as where the transformers were installed, their performance etc. e. Testing facilities at manufacturer's works. f. If the manufacturer has collaboration with another firm details regarding the same shall be submitted along with tender documents. But the Kerala State Electricity Board Ltd. will have the Power to waive the stipulation in respect of experience in the case of new firms having collaboration with well experienced firms (Experience not less than 10 years) provided, the collaborator furnish the purchaser with performance guarantee for the equipment and on facility inspection at Manufactures' works and approval by KSEB Ltd. Also KSEB Ltd. have the full authority to reject the offer of any vendor, if the facilities are found to be inadequate for all necessary testing and manufacturing processes in accordance with the referred standards in tender documents.
16	**Service of engineers for supervision of erection and commissioning of the transformer**

	at site to be provided free of cost if required.

17. DEVIATION:- Deviation from this specification, if any, shall be clearly bought out in the offer. Unless owner explicitly accepts such deviations, it shall be constructed that the offer fully complies with the specification.

18. SPECIFICATION FOR TRANSFORMER OIL (IS 335)

Sl. No.	Characteristics.	Requirement	Methods of Test.
1.	*Appearance*	The oil shall be clear and transparent and free from suspended matter or sediment.	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temperature.
2.	Density at 20oC Max.	0.89 g/cm3	IS.1448,ISO 3675/12185
3.	Kinematic Viscosity at 27oC Max.	27 CST	IS.1448
4.	Interfacial tension at 27oC Min.	0.04 N/m	IS.6104,ISO 6295
5.	Flash point (Penskey Marten – closed cup)	140oC(Min.)	IS.1448,ISO2719
6.	Pour point	**-6** (Max.)	IS.1448,IEC 60296, ISO 3016
7.	Neutralization value (total acidity) Max.	0.03 mg KOH/g	IS.335 Appx.A. IEC62021-1
8.	Corrosive sulphur (in term of classification of copper strip)	Non-corrosive	IS.335 Appx.B. DIN51353, BS2000 PART373
9.	Electric strength (break down voltage) Min.		
	a) New untreated oil	30KV(rms) (if the above value is not attained, the oil shall be treated.	IS.6792 IEC 60814

	b)After treatment	60KV(rms)	IS.6792. IEC 60814
10.	Dielectric dissipation factor (tan delta) at 90oC Max.	0.002	IS.6262 IEC60247/61620
11	Specific resistance (resistivity)		
	a)at 90oC Min.	35x1012 ohm-cm	IS.6103
	b)at 27oC Min.	1500x1012 ohm-cm	
12	Oxidation stability		IEC 61125 part C
	a) Neutralization value after oxidation (Max.)	0.40 mg/KOH/g	
	b) Total sludge after Oxidation Max.	0.10 percent by weight.	
13.	Presence of oxidation inhibitor.	The oil shall not contain anti-oxidant inhibitors.	IS.335 Appendix .D
14	Water contents Max.	50 ppm	IS.2362.IEC 60814
15	Ageing characteristics After 96 hrs. with catalyst (copper)		
	a) Resistivity		As per ASTM –D 1934.
	i) 27oC	2.5x1012 ohm cm.	
	ii) 90oC	0.2x1012 ohm cm.	
	b) Tan delta at 90oC	0.2 (Max.)	
	c) Total acidity	0.05 mg/KOH/gm (Max.)	
	d) Total Sludge content % by mass	0.05% (Max.)	

19) TRANSFORMER LOSSES & EVALUATION OF BID:

1) The transformers are to be designed with minimum permissible losses.

2) The quoted losses shall be considered as maximum, without any positive tolerance. The bidders are, however, at liberty to quote the guaranteed losses. The evaluation of the offer shall be done on basis of maximum guaranteed loss.

3) In case of any order, if the figure/s of losses during test are found, higher than the figures guaranteed for maximum losses without any positive tolerance on individual components of losses, the transformer will, at the option of the purchaser / owner be rejected, or accepted with the reduction in prices as under. The measurement of losses shall be carried out with 3 (Three) Watt meter method only and CT,s, PT,s and meters used for these measurements shall be of class of accuracy of 0.2S/0.2.

4) For the purpose of evaluation of bids, the quoted losses shall be compared for all the bidders of particular tender.

The following formula adopted by the KSEBL for working out comparable costs with difference in prices and losses:

Capitalized cost of transformer $= I_C + AW_L + BW_N + CW_O$

Where, I_C = Cost of Transformer (All inclusive unit rate offered);

W_L = Load losses in KW at rated tap and rated voltage ;

W_N = No load loss in KW at rated tap and rated voltage .

W_0 = Auxiliary loss in KW, A, B and C are load, no load and auxiliary capitalization figures.

A =Rs 251,106 per KW B = Rs. 472,003/- per kW and C =RS 1,88801 per KW

20). PENALTY FOR HIGHER LOSSES:- In case of order if the figures of losses measured during tests or in service are found to be higher than the figures guaranteed, at the option of the KSEBL, will be rejected or accepted with the reduction in price with 1.5 times of the above figures.

21) REJECTION:- The Purchaser may reject transformer, if any of the following conditions during or service arises:

i) If the losses found exceeds the 10% above the specified value .

ii) Impedance value exceeds the guaranteed value by + 10% or more.

iii) Oil or winding temperature rise exceeds the specified value by 5 deg. C.

iv) Transformer fails on impulse test.

iv) Transformer fails on power frequency voltage withstand test.

v) The difference is impedance values of any two phase during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the manufacturer / contractor.

vi) Transformer is proved to have been manufactured not in accordance with agreed specification.

Sd/-

Chief Engineer (SCM)

Guaranteed Technical Particulars for 110/11kV 20MVA Power Transformer

(Note:The values to be furnished with relevant standard IS/IEC/CBIP/IEEMA only)

Sl. No.	Particular	Specified / Required	Offered
1.0	General		
1.1	Make & Country of origin		
1.2	Type	The transformer shall be of two winding, 3 phase oil immersed core type with ONAN/ONAF cooling suitable for outdoor service as step down transformers. The transformer shall not be provided with tertiary delta winding.	
2.0	Nominal continuous rating, kVA	20000	
3.0	Type of Cooling	ONAN/ONAF	
4.0	Normal ratio of transformation	110/11kV	
5.0	Rated voltage (KV)		

5.1	HV winding	110	
5.2	LV winding	11	
6.0	Rated current (Amps)		
6.1	HV winding	105.09	
6.2	LV winding	1050.97	
7.0	Connections		
7.1	HV winding	STAR with Neutral directly earthed	
7.2	LV winding	STAR with Neutral directly earthed	
7.3	Vector group reference	YNyn0	
8.0	Impedance at principal tap on rated MVA Base at current and frequency at 75 °C with 100 % Rating (%)		

8.1	Impedance (%)	10% , Tolerance +10% No negative tolerance allowed	
8.2	Reactance (%)		
8.3	Resistance (%)		
8.4	Impedance at Lowest tap on rated MVA Base at current and frequency at 75 °C with 100 % Rating (%)		
8.5	Impedance at highest tap on rated MVA Base at current and frequency at 75 °C with 100 % Rating (%)		
9.0	Resistance of the winding at 75^{0}C at principal tap (ohm)		
9.1	a) HV		
9.2	b)LV		
10.0	Zero sequence impedance at reference temperature of 75^{o}C at principal tap %), Ω / phase		
11.0	**Losses**		

11.1	Guaranteed maximum losses at principal tap at full load and 75^0 C without any positive tolerance(kW)		
11.1.1	No load loss at rated voltage and frequency at principal tap (max.), kW	12.0	
11.1.2	Tolerance if any on the above		
11.1.3	No load loss at rated voltage and frequency at highest tap (max.)		
11.1.4	Tolerance if any on the above		
11.2	Load loss at rated output, rated frequency and 75 deg C winding temperature at		
11.2.1	Principal tap (kW)	102.0	
11.2.2	Highest tap (kW)		
11.2.3	Lowest tap (kW)		
11.2.4	Tolerance if any on the above		

11.3.1	Cooler fan losses (kW)		
11.3.2	Tolerance if any on the cooler loss		
11.4	Total losses at normal ratio inclusive of aux. losses (max), kW		
11.5	No load loss at maximum permissible voltage and frequency (approx.) kW		
12.1	Temperature rise of oil above reference design ambient of 35 ^{0}C (By thermometer)		
12.1.1	At full ONAN rating ^{0}C	45°C	
11.1.2	At full OFAF rating ^{0}C	45°C	
12.2	Temperature rise of winding above reference design ambient of 35^{0}C (By thermometer)		
12.2.1	At full ONAN rating ^{0}C	55°C	
12.2.2	At full OFAF rating ^{0}C	55°C	

12.3	Temperature gradient between oil and winding (^{0}C)	As per IS 2026	
12.4	Temp. rise by hot spot temperature °C indicator		
12.5	Limit for hot spot temperature for which transformer is designed.		
13.0	**Efficiency**		
13.1	Efficiency at 75^{U}C winding temperature and unity power factor %		
13.1.1	At 110% load		
13.1.2	At 100% load		
13.1.3	At 75% load		
13.1.4	At 50% load		
13.1.5	At 25% load		
13.2	Efficiency at 75^{U}C winding temperature & 0.8 power factor lag %		

13.2.1	At 110% load		
13.2.2	At 100% load		
13.2.3	At 75% load		
13.2.4	At 50% load		
13.2.5	At 25% load		
13.3	Maximum efficiency %		
13.4	% Load and power factor at which Max efficiency occurs		
14.0	Time in minutes for which the transformer can be run at full load without exceeding the max. Permissible temperature at reference temperature when power supply to fans is cut off		
15.0	Short time rating for 2 seconds of		
15.1	HV winding		

15.2	LV winding		
16.0	Permissible over loading		
16.1	HV winding		
16.2	LV winding		
17.0	Terminal arrangement		
17.1	High voltage		
17.2	HV Neutral		
17.3	LV winding		
17.4	LV Neutral		
18.0	**Test voltage**		**HV HVN LV&LVN**
18.1	Lightning impulse test voltage, kV peak		
18.2	Power frequency withstand test voltage for 1 minute, kV rms		

18.3	Switching impulse test voltage, kV peak		
19	PD level at 1.5Um/√3kV rms (PC)		
20	Noise level when energized at normal voltage, frequency without load (db)		
21	External short circuit withstand capacity (MVA) and duration (Seconds)		
22	Over flux withstand capacity of the transformer and duration.		
23	**Regulation (%)**		
23.1	Regulation at full load at 75^0C		
23.1.1	At unity power factor		
23.1.2	At 0.8 power factor lagging		
23.2	Regulation at 110% load at 75^0C		
23.2.1	At unity power factor		

23.2.2	At 0.8 power factor lagging		
24	**Tapping**		
24.1	Type	On load tap changer	
24.2	Capacity	Full capacity	
24.3	Range-steps x % variation	As per clause 4.2.9 of this specification	
24.4	Taps provided on HV winding (Yes/No)	Yes	
24.5	Tappings		
24.6	Constant flux/variable flux/combined regulation		
24.7	Location (line /Neutral/Central) end of winding		
24.8	No.of steps		
24.9	Range (variation)		

25	**Radiators**		
25.1	Overall dimensions l x b x h, mm		
25.2	Total weight with oil, Kg		
25.3	Total weight without oil		
25.4	Vacuum withstand capacity, *tor*		
25.5	Capacity of cooling units		
25.6	Mounting of radiators		
25.7	Number of radiators		
25.8	Type & size of individual radiator valve		
25.9	Total radiating surface, sq mm		
25.1	Thickness of radiator tubes, mm	Minimum 1.2 mm	

25.11	Oil drain plug and air release plug provided on each radiator Yes/No	Yes	
25.12	Schematic flow diagram of the cooling system furnished (Yes/No)		
26	**Type of cooling (Fan Motors &Fan)**	Design of cooling equipment and control shall comply to CBIP clause no. 2.1.3 of Section A (general)	
26.1	Make and type		
26.2	No. of fans in each group excluding standby fans		
26.3	No. of connected units		
26.4	No. of standby units		
26.5	Rated power input, watts		
26.6	Capacity (cu m/minute)		
26.7	Rated voltage, Volts		

26.8	Locked rotor current, Amp		
26.9	Efficiency of motor at full load, %		
26.10	Temp.rise of motor at full load, °C		
26.11	Temperature range over which the control is adjustable, °C		
26.12	Whether fans suitable for continuous operation		
26.13	Estimated time constant in hours for 1. Natural cooling 2. Forced air cooling		
26.14	Period of continuous working at full load without fan for ONAN/ONAF		
26.15	Continuous MVA rating without fan for ONAN/ONAF		
27	**Core**		
27.1	Type of core construction		
27..2	Type of core joints		

27.3	Core material grade	High grade, non ageing, low loss, high permeability, grain oriented, cold rolled silicon steel laminations, CRGO, Hi-B grade.	
27.4	Thickness of lamination mm	Max. 0.27 mm with insulating coating on both sides	
27.5	Insulation of core lamination, mm		
27.6	Specific loss of core material (Watts/Kg)		
27.7	Whether core construction is without core bolts		
27.8	Insulation of core bolts		
27.9	Insulation of core bolt washers		
27.10	Insulation between core laminations		
27.11	Core bolt insulation power frequency withstand test voltage for 1 mt.		
27.12	Are the core bolts grounded, if so how?		

27.13	Details of oil duct		
27.14	Whether in the plane and at right angle to the plane of winding		
27.15	Across the plane of laminations		
27.16	Design flux density of the core at rated voltage & frequency at principal tap, Tesla		
27.16.1	1) Core		
27.16.2	2) Yoke		
27.17	Maximum flux density allowed in the core at extreme over excitation / over fluxing , Tesla		
27.18	Magnetising current at normal ratio and frequency		
27.18.1	85 % of rated voltage		
27.18.2	100 % of rated voltage		
27.18.3	105 % of rated voltage		

27.19	Power factor of Mag. Current at normal voltage ratio and frequency		
27.20	Materials of core clamping plate		
27.21	Thickness of core clamping plate		
27.22	Insulation of core clamping plate		
27.23	Describe Location/ method of core grounding		
27.24	Details of oil ducts in core		
27.25	Equivalent cross section area of core, mm2		
27.26	Guaranteed No load current at 90% / 100% / 110% rated voltage & frequency (Amp)		
27.26.1	HV		
27.26.2	LV		
28	**Type of winding**		

28.1	HV		
28.2	LV		
28.3	HV winding Conductor material	Electrolytic copper as per relevant standard	
28.4	LV winding Conductor material	Electrolytic copper as per relevant standard	
28.5	Maximum current density allowed, Amp per mm2		
28.5.1	a)HV winding	2.8A / sq.mm	
28.5.2	b)LV winding	2.8A / sq.mm	
28.6	Whether HV windings are inter leaved		
28.7	Whether HV windings are preshrunk		
28.8	Whether electro-static shields are provided to obtain uniform voltage distribution in the HV winding		
28.9	Gauge/area of cross section of		

	conductor, mm^2		
28.9.1	HV		
28.9.2	LV		
28.10	Maximum current density achieved in winding (LV/HV/) –Amps/ mm^2		
28.11	Insulating material used for		
28.11.1	HV turn		
28.11.2	Tap winding - Earth		
28.11.3	LV turn		
28.12	Insulating material used in between		
28.12.1	LV- core		
28.12.2	HV-LV		

28.12.3	Tap winding to earth		
28.13	Insulating material thickness, mm		
28.13.1	HV turn		
28.13.2	LV turn		
28.13.3	LV to core		
28.13.4	HV to LV		
28.14	Type of coil axial supports		
28.14.1	HV winding		
28.14.2	LV winding		
28.15	Type of coil radial supports		
28.15.1	HV winding		

28.15.2	LV winding		
28.16	Maximum allowable torque on coil clamping bolts		
28.17	Inter-turn insulation		
28.17.1	Extent of extreme end turns reinforcement		
28.17.2	Extent of end turns reinforcement		
28.17.3	Extent of turns adjascent to tappings		
28.17.4	Test voltage for 10 Seconds 50 cycles inter turn insulation test on 28.17.1), kV rms		
28.17.5	Test voltage for 10 Seconds 50 cycles inter turn insulation test on (28.17.2), kV rms		
28.17.6	Test voltage for 10 Seconds 50 cycles inter turn insulation test on 28.17.3), kV rms		
28.17.7	Test voltage for 10 Seconds 50 cycles inter turn insulation test on main body of the winding, kV rms		
29	**Minimum design clearance , mm**		

29.1	HV to earth in air		
29.2	HV to earth in oil		
29.3	LV to earth in air		
29.4	LV to earth in oil	-	
29.5	Between HV & LV in Air		
29.6	Between HV & LV in oil		
29.7	Top winding and yoke	-	
29.8	Bottom winding and yoke		
30	**Insulating oil**		
30.1	Governing standard	IS:335	
30.2	Spec. resistance (ohms-cm) at 27°C / 90° C		

30.3	Tan delta		
30.4	Water content , ppm		
30.5	Dielectrc strength (BDV), kV		
30.6	Characteristics of oil after ageing test		
30.7	Spec. resistance (ohms-cm) at 27°C / 90° C		
30.8	Tan delta		
30.9	Sludge content		
30.10	Neutralisation number		
30.11	Quantity of oil Ltrs	-	
30.12	In the transformer tank		
30.13	In each radiator		

30.14	Total quantity					
30.15	10% excess oil furnished?	Yes				
30.16	Type of oil	New insulating oil as per IS: 335, and Cl. 5.2.7 of the specification				
31	**Conservator**			.		
31.1	Details of oil preservation equipment offered	As per Clause 5.2.2 .2of this specification				
31.2	Oil preservation system provided (Yes/No)	Yes				
31.3	Total volume of conservator (Ltr)					
31.4	Volume between highest and lowest visible oil levels (Ltr)					
32	**Bushings**					
	HV Bushings			**HV**	**HV Neutral**	**LV & LV Neutral**
32.1	Make					
32.2	Type					

32.3	Reference standard			
32.4	Rated Voltage class, kV			
32.5	Rated current , Amp			
32.6	Lightning Impulse withstand voltage, kV			
32.7	Switching Impulse withstand voltage, kV			
32.8	Power frequency withstand voltage, kV			
32.9	Wet for 1 minute, kV			
32.10	Dry for 1 minute, kV			
32.11	Wet Flash over voltage, kV			
32.12	Dry Flash over voltage, kV			
32.13	Partial discharge level			

32.14	Creepage distance in mm						
32.15	Creepage distance (protected)						
32.16	Whether test tap is provided?. If so, power frequency withstand test voltage of test tap,						
32.17	Quantity of oil used in bushing & specification of oil used.						
32.18	Weight of assembled bushing, Kg						
32.19	Minimum clearance height for removal of bushings, mm						
32.20	Recommended gap setting for Arcing horn						
32.21	Terminal connections	As per Clause 5.2.8.4.1.	As per Clause 5.2.8.4.2	As per Clause 5.2.8.4.3 and 5.2.8.4.4	As per Clause 5.2.8.4.1.	As per Clause 5.2.8.4.2	As per Clause 5.2.8.4.3 and 5.2.8.4.4
33	Marshalling box cubicle provided as per clause no. 5.2.10 of spec. (Yes / no)	Yes					

33.1	Make & Type		
33.2	Details of apparatus proposed to be housed in the kiosk	As per clause 5.2.10 of this specification.	
34	Details of anti-earth-quake device provided, if any		
35	Separate conservator and bucholz relay provided or not.		
36	**Tap Changing equipment**		
36.1	Make		
36.2	Type		
36.3	Power flow-uni directional/ bidirectional/restricted bi directional	Bidirectional	
36.4	Rated voltage to earth, kV		
36.5	Rated currents, Amp		

36.6	Step voltage, Volts		
36.7	No. of steps		
36.8	Control – Manual/Local electrical/ Remote electrical		
36.9	Parallel operation		
36.10	Protective devices		
36.11	Auxiliary supply details		
36.12	Time for complete tap change(One step), Sec		
36.13	Diverter selector switch transient time, cycles		
36.14	Value of maximum short circuit current, kA		
36.15	Maximum impulse withstand test voltage with 1.2/50µS, full wave between switch assembly and ground, kV peak		

36.16	Maximum Power frequency test voltage between switch assembly and earth, kV rms		
36.17	Maximum impulse withstand test voltage with 1.2/50µs, across the taping range, kV peak		
36.18	Approx. overall dimensions of the tap changer (in case of separate tank type), mm		
36.19	Approx. overall weight, (in case of separate tank type), Kg		
36.20	Approx. mass of oil ((in case of separate tank type),Kg		
36.21	Particulars of the OLTC control panel for installation in the control room (RTCC panel)		
36.22	Driving Mechanism box		
36.23	Make and Type		
36.24	Details of apparatus proposed to be housed in the box.		
37	**Details of bushing CT**		

37.1	Purpose		
37.2	Installed on which bushing HV/LV		
37.3	No. of bushing CTs installed		
37.4	Type		
37.5	Make		
37.6	Reference standard		
37.7	No.of cores		
37.8	Whether TEST winding provided or not		
37.9	CT ratio		
37.10	Burden ,VA	Manufacturer Std.	
37.11	Class of accuracy	Manufacturer Std.	

38	**Details of protective devices**		
38.1	Pressure release device		
38.1.1	Make & Type		
38.1.2	Minimum pressure the device is set to rupture.		
38.1.3	Rain hood provided or not		
38.2	Explosion vent		
38.2.1	Type & make		
38.2.2	Minimum pressure the device is set to rupture.		
38.3	Bucholz relay of main tank		
38.3.1	Type & make		
38.3.2	No. of contacts		

38.4	Oil Surge relay		
38.4.1	Type & make		
38.4.2	No. of contacts		
38.5	OTI		
38.5.1	Make & Type		
38.5.2	No. of contacts		
38.5.3	Setting range		
38.6	WTI		
38.6.1	Make & Type		
38.6.2	No. of contacts		
38.6.3	Setting range		

38.7	Oil Level guage		
38.7.1	Type & make		
38.7.2	No. of contacts		
39	Lifting Jacks		
39.1	No. of jacks in one set		
39.2	Type and make		
39.3	Capacity (tonnes)		
39.4	Pitch, mm		
39.5	Lift, mm		
39.6	Height in closed position, mm		
39.7	Mean dia. of thread, mm		

40	Alarm and trip contact ratings of protective devices		
40.1	Rated/making/ breaking currents , Amp @ voltage for		
40.2	PRV for main tank and OLTC tank		
40.3	Bucholz relay		
40.4	OTI		
40.5	WTI		
40.6	Magnetic oil level gauge		
41.0	Fittings accessories for each transformer are furnished as per different clauses in the specification (Bidder shall attach separate sheet giving details, make and bill of materials)	Yes	
42.0	Painting: as per clause 5.10 for the transformer , cable boxes, radiator, marshalling box, etc (Yes/No)	Yes	

43	**Details of Tank**		
43.1	Material	Robust mild steel plate without pitting and low carbon content	
43.2	Approximate thickness of sheet		
43.2.1	Sides mm		
43.2.2	Bottom mm		
43.2.3	Cover (Top) mm		
43.2.4	Radiators mm		
43.3	Pressure mm of Hg	Twice the normal head of oil / normal pressure + 35 kN/m^2 whichever is lower , As per CBIP	
43.4	Vacuum recommended for Hot oil Circulation		
43.5	Vacuum to be maintained during oil filling in transformer tank		
43.6	Vacuum to which the tank ca be subjected without distortion as per specification	As per CBIP	

43.7	Confirmation of tank designed and tested for vacuum pressure (Ref: CBIP manual) (Yes/No)	Yes	
43.8	Is the tank lid slopped?	Yes	
43.9	Inspection cover provided (Yes/No)	Yes,as per clause No 5.2.1.5	
43.10	Location of inspection cover (Yes/No)	As per clause No 5.2.1.5	
43.11	Min. dimensions of inspection cover (provide list of all inspection cover with dimension), mm x mm		
43.12	No. of bi-directional wheels provided		
43.13	Track gauge required for the wheels in transverse axis	1435mm	
43.14	Track gauge required for the wheels in longitudinal axis	1435mm	
43.15	Type of pressure relief device explosion vent and the pressure at which it operates		
43.16	Minimum clearance height for lifting core and winding from tank, mm		

43.17	Minimum clearance height for lifting tank cover, mm		
44.	**Over all transformer dimensions**		
44.1	Length , mm		
44.2	Breadth , mm		
44.3	Height , mm		
44.4	Transformer tank dimensions		
44.4.1	Length , mm		
44.4.2	Breadth , mm		
44.4.3	Height , mm		
44.5	Marshalling box dimensions		
44.5.1	Length , mm		

44.5.2	Breadth , mm		
44.5.3	Height , mm		
44.6	Weight data		
44.6.1	Core, Kg		
44.6.2	Frame parts, Kg		
44.6.3	Core and frame, Kg		
44.6.4	Total winding Kg		
44.6.5	Core and frame winding, Kg		
44.6.6	Tank, Kg		
44.6.7	Tank lid, Kg		
44.6.8	Empty conservator tank , Kg		

44.6.9	Each radiator empty , Kg		
44.6.10	Total weight of all radiator empty , Kg		
44.6.11	Weight of oil in tank , Kg		
44.6.12	Weight of oil in each conservator , Kg		
44.6.13	Weight of oil in each radiators , Kg		
44.6.14	Total weight of oil in radiator , Kg		
44.6.15	OLTC gear including oil , Kg		
44.6.16	Total transport weight of the transformer , Kg		
44.6.17	Total transport weight of the transformer with OLTC and all accessories, Kg		
44.7	Volume data		
44.7.1	Volume of oil in main tank , liters		

44.7.2	Volume of oil between highest and lowest levels of main conservator ,liters		
44.7.3	Volume of oil between highest and lowest levels of OLTC conservator, liters		
44.7.4	Volume of oil in each radiator , liters		
44.7.5	Total volume of oil in radiators , liters		
44.7.6	Volume of oil in OLTC , liters		
44.7.7	Transformer total oil volume , liters		
44.8	Shipping data		
44.8.1	Weight of heaviest package, kG		
44.8.2	Dimensions of the largest package (L x B x H) mm		
45.	**Tests**		

45.1	All in process tests confirmed as per Cl.10.1.4.1 and10.1.4.2 (Yes /No)		
45.2	All types tests confirmed as per Cl. 10.3 (Yes /No)		
45.3	All routine tests confirmed as per Cl.10.2 (Yes /No)		
45.4	All special tests confirmed as per Cl.10.4 (Yes /No)		
46	Transformer will transport with oil/gas		
47	Quality Assurance Plan: An outline of quality assurance plan used by the bidder	To be submitted	
48	General warranty for the transformer	Here specify clearly the conditions of general warranty terms	
49	**Important design parameters**		
1	Maximum no load loss at rated condition allowed without any positive tolerance (kW).		
2	Maximum load loss at rated condition @ 75°C and principal tap allowed without any positive tolerance (kW).		
3	Grade of core sheet, Hi-B or better		

4	Type of winding for HV	
5	Design value of flux density	
6	Design value of current density(at any tap)	
7	Minimum weight of covered conductor	
7.1	HV winding(with and without insulation)	
7.2	LV winding(with and without insulation)	
7.3	Tap winding(with and without insulation)	
8	Weight of support insulators including insulation cylinders	
9	Weight of core(kg)	
10	Weight of core clamp	
11	Per turn voltage	
12	Conductor cross section HV LV	
13	Winding stack height(mm)	

14	Confirm that the weight of copper in winding and CRGO in core during detailed design and manufacturing and supply of the transformer is not less than the values mentioned above.	
15	Transformer tank dimensions(mm)(lxbxh)	
16	Weight of tank (kg)	
17	Minimum quantity of oil in tank (Litres)	
18	Weight of core, winding and frame(kg)	
19	Overall dimensions of the transformer(mm)(lxbxh)	
20	Minimum cross sectional area of CRGO	

Name,address,mobile No.& email-id of the Bidder