SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

8MVA, 33/11kV THREE PHASE POWER TRANSFORMER

APPLICABLE TO KSEBL	**Rev#0**	DOC. NO.: **SCM-SPEC/XM/8MVA**
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Technical Specification and Evaluation Committee for Transmission Materials

(i) Document Approval & Control Status

	Compiled by	**Verfied by**	**Approved by**
Name	**Smt. Remmi Douglas**	**Smt. Geetha.M**	**Mr. Sanal Kumar K**
Position	Assistant Executive Engineer (O/o Chief Engineer, Supply Chain Management)	Executive Engineer(M) (O/o Chief Engineer, Supply Chain Management)	Chief Engineer (Supply Chain Management)
Date	08/04/21	09/04/21	09/04/21
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 8MVA 33/11kV three phase Power Transformer 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 **8MVA 33/11kV three phase Power Transformer** used in field by KSEBL.

3. RESPONSIBILITY

Executive Engineer(M), 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 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 8MVA 33/11KV, THREE PHASE POWER TRANSFORMER

1.0. SCOPE:-

1.1. This specification covers the design, manufacture, shop testing, supply, delivery, supervision of erection, testing and commissioning of 33/11kV, 8MVA three phase two winding transformer. 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. All the transformer mounted relays shall be provided with IP 66 type protection; This is a must.

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 equipment. 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 judgment, is not in accordance therewith .The equipment 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 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 dispatch, delivery, installation and commissioning.

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

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 shall be as per Cl.4.2.5.1 and 4.2.5.2 below. 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 1.5 times the figures mentioned above for no load, load loss and cooler aux. losses. However losses exceeding 10% of specified value will be rejected.

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 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 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 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.

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 10028	Code of practice for selection, installation &maintenance of transformers
IS 13947	LV switchgear and control gear part-1
IS 2026	Power transformers
IS5	Colours for ready mix paints
IS5561	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	Maximum ambient temperature	50°C
4.1.3	Type	Oil immersed, Core type, Step down
4.1.4	Type of cooling	ONAN
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 : 50°C

		Maximum humidity : 100% Average number of thunderstorm days per annum : 50 Average number of dust storm days perannum: 5 Average number of rainy days per annum: 90 Average annual rainfall: 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	33/11kV
4.1.14	Rated voltage of HV winding, kV	33
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 (HV/LV)	36 / 12
4.1.19.2	Lightning Impulse withstand voltage, kV peak (1.2/50 micro Sec.)	170 /75 kVp
4.1.20	Power frequency withstand voltage, kV rms (HV/LV)	70 / 28
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	8 MVA (ONAN)
4.2.2	Vector group	YNyn0
4.2.3	Impedance	% impedance at principal tap at rated voltage, frequency at 8MVA Base shall be 8.35%, 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 5.5kW
4.2.4.2	Load losses at principal tap	Maximum load loss at rated condition @ 75°C and principal tap allowed without any positive tolerance shall be 40kW
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
4.2.6	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 1.60 Tesla
4.2.8	Current density	Maximum current density on any portion of the winding (HV/LV) shall not exceed 2.8 Amp/Sq.mm
4.2.9	Tappings on HV winding	Off Load units with steps of +2.5% to −7.5% to be provided on the HV winding in steps of 2.5% for rated voltage on the LV side
5. CONSTRUCTION & DESIGN		
5.1	Type	ONAN, Copper wound, Core type, three phase, two winding, oil immersed with off load tap changer
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 vacuum as mentioned in CBIP manual (Section. A clause 6.1.3) and continuous internal gas pressure of 0.35 atmosphere with oil at operating level. 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) Off Load TC to winding connection from both sides. 6) Bushing CTs connections 7) Core assembly grounding 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 system	Normal free air breathing conservator with standard silica gel breathing device.

5.2.2.3	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 minimum 25mm 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) Conservator to main tank piping shall be supported at minimum two points.
5.2.2.4	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 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, 50 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. 11) The connection from the transformer tank to the conservator shall be arranged at a raising angle of 3 to 9 degrees to the horizontal up to buchholz relay and the pipe shall have a dia of 50mm. One valve each shall be provided on both sides of the buchholz relay.
5.2.2.5	Essential provision for mounting of conservator	Conservator to be mounted in such a manner that the top cover of the transformer, and any other cover or fitting on the transformer can be lifted without disturbing the conservator.
5.2.2.6	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. 4. The design of the breather shall be such that, water shall not retain on any part of the breather and water shall not enter in to the breather directly during any climatic condition. 5. It shall be possible to remove/fill silica gel in the breather without much difficulty.
5.2.3	Cooling System	
5.2.3.1	Radiators	
5.2.3.1.1	General	The total capacity of the coolers for each transformer shall be minimum 120% of actual requirement
5.2.3.1.2	Thickness	1.2mm (Min.)
5.2.3.1.3	Features	Detachable type with lifting lugs, air release plug, drain plug, isolating valve top and bottom for each radiator, Radiator support from ground if required.
5.2.3.1.5	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 (if applicable)
5.2.4	Core	
5.2.4.1	Material	High grade, non ageing, low loss, high permeability, grain oriented, cold rolled (CRGO) silicon steel laminations specially made for the construction of power transformers Confirming Hi-B grade
5.2.4.2	Grade	Hi-B
5.2.4.3	Lamination thickness	0.23 to 0.27mm
5.2.4.4	Design flux density at rated conditions at principal tap	<1.7 T
5.2.4.5	Maximum flux density at 10% over excitation / over fluxing	<1.7 T
5.2.4.6	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 / displacement during transportation and positioning 5)Percentage harmonic potential with the maximum flux density under any condition limited to avoid capacity overloading in the system 1) 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 rms 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.
5.2.5	Winding	
5.2.5.1	Material	Electrolytic Copper
5.2.5.2	Maximum current density allowed	2.80 A/ mm2
5.2.5.3	Winding Insulating material	Class A, non catalytic, inert to transformer oil, free from compounds liable to ooze out, shrink or collapse
5.2.5.4	Winding Insulation	HV winding: Uniform insulation as amended in IS 2026. LV winding: Uniform insulation as amended in IS 2026.
5.2.5.5	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.
5.2.5.6	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.
5.2.6	Transformer Oil	See Clause-19 for the specification of transformer oil.
5.2.6.1	Type	Class 1 new mineral insulating oil as per IS 335, IEC 296 shall be supplied. No inhibitors shall be used.
5.2.6.2	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.
5.2.7	Bushings and Terminations	
5.2.7.1	HV Phase & Neutral bushings	36kV class, porcelain bushing as per IS 3347 having minimum 400Amp. rating without arcing horn.
5.2.7.2	LV & LV Neutral bushings	17.5kV class, oil communicating type porcelain bushing as per IS 3347(as per section C, clause 11.0 of CBIP) of having minimum 630 Amp. rating without arcing horn.
5.2.7.3	Minimum creepage distance of bushing	25mm/kV (Refer GTP)

5.2.7.8	Protected creepage distance	At least 40% of total creepage distance
5.2.7.9	Continuous Current rating	Minimum 20 % higher than the current corresponding to the minimum tap of the transformer
5.2.7.10	Rated thermal short time current	
5.2.7.10.1	HV Line and Neutral bushing	25 times rated current for 2 sec.
5.2.7.10.2	LV line and Neutral bushing	25 times rated current for 2 sec.
5.2.7.11	Atmospheric protection for clamp and fitting of iron and steel	Hot dip galvanizing as per IS 2633
5.2.7.12	Bushing terminal lugs in oil and air	Tinned copper
5.2.7.13	Sealing washers /Gasket ring	Nitrile rubber/ Expanded TEFLON (PTFE) as Applicable
5.2.8	Current Transformers	
5.2.8.1	WTI CT	As per Requirement
5.2.8.2	Rating	As per Requirement
5.2.8.3	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 CI. 5.7.1 of this specification
5.2.9	Marshalling Box Cubicle	
5.2.9.1	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
5.2.9.2	Major equipments in Marshalling box	1) Mechanical gauge for WTI 2) Mechanical gauge for OTI 3) Space heater with thermostat control. 4) cubicle illumination lamp with door switch 5) 5A socket with switch. 6) Other panel accessories listed elsewhere
5.2.9.3	Gland plate	Min. 3 mm thick detachable with knockout 6 x 1 inch
5.2.9.4	Contacts wired to terminal block	WTI alarm and trip OTI alarm and trip Buchholz relay alarm and trip MOG low level alarm PRD trip
5.2.9.6	Ingress protection	IP 55 plus additional rain canopy to be provided

5.2.9.7	Welding	Continuous welding on joints, welding at regular intervals on joints and filling of gaps with use of M-seal not accepted.
5.2.9.8	Cable entry	Bottom for all cables
5.2.9.9	Panel internal Access	Front only through front door double leaf with antitheft hinges
5.2.9.10	Panel back access	None
5.2.9.11	Mounting of marshalling box	On tank.
5.2.9.12	Panel supply	240 V AC, single phase, 50 Hz / 110 V DC
5.2.9.13	Panel accessories	1) Cubicle lamp with door switch and separate MCB 2) Approved space heaters controlled by Thermostat & hygrostat and with separate MCB 3) 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. 7) All hinged parts (doors etc) shall be properly grounded. 8) Dual earthing facility for the M.K
5.2.9.14	Painting of marshalling box	As per Cl No. 5.10 of this Specification
5.2.9.15	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
5.3	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, surfaces interfacing with oil like inspection cover etc.	Nitrile rubber based cork

5.4.2	For marshalling box,	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 multi strand copper conductor.
5.6.2	Specification of wires to be used inside marshalling box,	PVC insulated multi strand 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 screw driver 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, Radiator, cable boxes marshalling box.	
5.10.1	Surface preparation	By 7 tank pre-treatment process or shot blasting method
5.10.2	Finish on internal surfaces of the transformer interfacing with oil	Bright Yellow heat resistance 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 resistance 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 anticondensation type two coats, 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.
5.12.	CENTRE OF GRAVITY:-	The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as far as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric relative to track either with or without oil, its location shall be shown on the outline drawing.
6.0 MINIMUM PROTECTIVE DEVICES ON TRANSFORMER		
6.1	Spring loaded with detachable diaphragm type pressure relief valve with two trip contacts for the main tank with limit switch design IP 65 with additional rainhood.	Required
6.2	Double float Bucholz relay with alarm and trip contacts, service and test position, with test cock and draining provision for the main tank, terminal box shall be IP 65 with drain plug for rainwater draining.	Required
6.3	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
6.4	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. winding temperature indication wired up to TBs in marshalling box for external connection	Required
7	**FITTINGS AND ACCESSORIES ON TRANSFORMER:** Following shall be fixed on each transformer.	

7.1	Rating and diagram plate: Anodized aluminum black lettering on satin silver background fixed by rivet
7.2	Oil filling instruction plate : Anodized aluminum black lettering on satin silver background fixed by rivet
7.3	Valve schedule plate: Anodized aluminum black lettering on satin silver background fixed by rivet
7.4	Terminal marking plate for bushing WTI, OTI etc.: Anodized aluminum black lettering on satin silver background fixed by rivet
7.5	Company monogram plate
7.6	Lifting lugs / bollards with anti skid head to lift complete transformer with oil
7.7	Lashing lug
7.8	Jacking pad with Haulage hole to raise or lower complete transformer with oil
7.9	Essential provision for jacking pads
7.10.	Detachable bi-directional roller assembly with corrosion resistant bearing, 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 anti rolling clamp for 90 lb rail minimum 4 nos. shall be provided
7.11	Pockets for OTI, WTI, on tank
7.12	Pockets for ordinary thermometer on tank cover (top)
7.13	Ordinary thermometer 1 no.
7.14	Drain valve (gate valve) on the base of main tank
7.16	Drain valve (gate valve) for all headers, if headers are provided.
7.17	Filter valve (gate valve) at top and bottom of the main tank, 50 mm
7.18	Sampling valve (gate valve) at top and bottom of the main tank, 15 mm
7.19	Vacuum breaking valve (gate valve), 25 mm
7.20	Air release plug on various fitting and accessories
7.21	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.
7.22	Vacuum pulling pipe with blanking plate on main conservator pipe work

7.23	Rainhood (canopy) PRV on main transformer	
7.24	Oil level gauge on tank for transformer shipment	
7.25	Earthing bridge by copper strip jumpers on all gasketted joints at least two points for electrical continuity	
7.26	Ladder with anticlimbing device and safety flap, with lockable hinged plate for at least 1.5 m from ground level	
7.27	Skid base welded type	
7.28	Core, frame to tank earthing	
7.29	Danger plate made of anodized aluminum white lettering on red background fixed by rivet	
7.30	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	
8.0 OFF LOAD TAP CHANGER		
8.1	Requirement	Each transformer shall be provided with an off load tap changing Mechanism. Tap changing shall be carried out by means of an externally operated self positioning tap switch when the transformer is de-energised condition. The operating spindle shall be carried through an oil tight gland in the tank side with locking arrangement and position indicator. Off circuit tap changer shall be located on the side of the transformer tank at a convenient operating height from the floor level i.e. approximately 1200 mm from rail level. Shall have a tap position indicator. The pad-locking arrangement of the transformer shall be such that it can be locked only when the contacts are properly engaged. The contacts shall be silver plated and the design shall ensure very low contact resistance.
8.2	Tappings	As per Clause 4.2.9 of this specification.
9.0 MAKE OF DIFFERENT COMPONENTS		
9.1	Magnetic oil level indicator	Sukrut or Superior make
9.2	Pressure relief valve	Sukrut / Qualitrol or Superior make

9.3	Bucholz relay	Proyog / ATVUS or Superior make
9.4	Oil surge relay	Proyog / ATVUS or Superior make
9.5	Winding Temperature Indicator	Precimeasure / Perfect Controls / Pradeep sales
9.6	Oil Temperature Indicator	Precimeasure / Perfect Controls / Pradeep sales
9.7	WCT	Pragati /ECS / KAPPA/ or Superior make
9.8	Switch	L &T (Salzer) / Siemens or Superior make
9.9	HRC fuse links	Siemens / L &T / GE or Superior make
9.10	Fuse base	Siemens / L &T / GE or Superior make
9.11	Meters	IMP / AE / MECO or Superior make
9.12	Terminals	Connectwell / Elmex or Superior make
9.13	Push buttons / Actuator	L &T / Siemens or Superior make
9.14	Thermostat	Velco or Superior make
9.15	Heater	Velco or Superior make
9.16	Control selector switch	Siemens or Superior make
9.17	Auxiliary relays	Jyoti / EasunReyrolle or Superior make
9.18	Timers	L &T / Siemens or Superior make
9.19	MCBs	Schneider / Legrand/ Siemens/L&T or Superior make
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.		
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) Oil leakage test on all tanks at normal head of oil plus 35 kN / sqm at the base of the tank for 24 hrs 6) 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 at lamination the vendor , Customer shall randomly select / seal lamination for testing at ERDA / CPRI for Specific core loss, accelerated ageing test, surface insulation resistivity , AC permeability and magnetization , Stacking factor , ductility etc . This testing shall be in the scope of vendor. 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 ever 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 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 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 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 HV WTI CT, LV WTI CT as applicable. 17) Oil leakage test on assembled transformer 18) Magnetic balance test 19) Power frequency voltage withstand test on all auxiliary circuits 20) 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) Impulse withstand test on all three HV and LV limbs of the transformers for chopped wave as per standard 2) Temperature rise test as per IS 3) Dissolved gas analysis before and after Temperature rise test 4) Pressure relief device test 5) Pressure and Vacuum test on tank* (* Stage Inspection)
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	Special Tests	Following Special tests shall be conducted on one transformer of each rating and type.
		1) Specific Resistance of oil to be tested at NABL accredited third party labs, whose samples shall be selected &sealed by customer inspection engineer 2) Measure of zero seq. impedance (CI.16.10 IS 2026 part-1) 3) measurement of acoustic noise level (CI.16.12 IS 2026 part-1) 4) measurement of harmonic level on no load current 5) High voltage withstand test shall be performed on the auxiliary equipment and wiring after complete assembly. Cost of such tests, if extra, shall be quoted separately by the bidder.
10.4.1	Note for special 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. CT/PT used for testing shall have accuracy 0.2S/0.2
10.5	**Test Reports**	
	After all tests have been completed, five 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 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 .All spanners shall be single ended case hardened. 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 cutting &making various type holes on gaskets All the tools except jack must be supplied in a toolbox.	
13	**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 copies 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. a) Out line dimensional drawings of transformer and accessories. b) Assembly drawings and weights of main component parts c) Shipping drawings showing dimensions and weights of each package. d) Drawings giving details of foundation and structure. e)Tap changing gear arrangement showing constructional details and general arrangement. f) Schematic control and wiring diagram for all auxiliary equipments and cooler control system. g) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross sectional views showing the duct sizes, cooling pipes etc. for the transformer drawn to scale shall be furnished. h) Large scale drawings of high and low tension windings of the transformers showing the nature and arrangement of insulation and terminal connections. i) Bushing drawing and specification. j) Details of name plate, terminal marking and connection diagram. k) All type Test results for transformer of same type and design shall be submitted, not older than 5 years. l) Six copies of instruction books/operation and maintenance manuals and spare part bulletins per transformer. m) Description, literature and data on transformer construction, winding, bushing, tap changing gear etc. (2 sets per transformer)

14	**EXPERIENCE** The tenderers are required to furnish information regarding the experience on the following points along with the tender document. 1)Name of Manufacturer. 2) Status of the Firm as manufacturer of the transformer quoted. 3) 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. 4) Details as where the transformers were installed, their performance etc. 5) Testing facilities at manufacturer's works. 6) 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 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. Also KSEB 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.
15	**SUPERVISION OF ERECTION**
	Service of engineers for supervision of erection and commissioning of the transformer at site to be provided free of cost if required.
16	**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.

17. SPECIFICATION FOR TRANSFORMER OIL (IEC:296, 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 20°C Max.	0.89 g/cm3	IS.1448,ISO 3675/12185
3.	Kinematic Viscosity at 27°C Max.	27 CST	IS.1448
4.	Interfacial tension at 27°C Min.	0.04 N/m	IS.6104,ISO 6295
5.	Flash point (Penskey Marten – closed cup)	140 °C(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 prior to filling.	IS.6792 IEC 60814
	b)After treatment	60KV(rms)	IS.6792. IEC 60814
10.	Dielectric dissipation factor (tan delta) at 90°C Max.	0.002	IS.6262 IEC60247/61620
11	Specific resistance (resistivity)		
	a)at 90°C Min.	35x1012 ohm-cm	IS.6103
	b)at 27°C 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)27°C	2.5x1012 ohm cm.	
	ii)90 °C	0.2x1012 ohm cm.	
	b) Tan delta at 90°C	0.2 (Max.)	
	c) Total acidity	0.05 mg/KOH/gm (Max.)	
	d) Total Sludge content % by mass	0.05% (Max.)	

18. 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 = $IC + AW_L + BW_N$

Where, IC = 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 , A & B are load and noload capitalization figures

A =Rs 251,106 per KW B = Rs. 472,003/- per kW

19) 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.

20) 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.

v. Transformer fails on power frequency voltage withstand test.

vi. 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.

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

Sd/-

Chief Engineer (SCM)

Guaranteed Technical Specification for 33/11kV 8MVA Power Transformer
(Values to be offered with relevant IS/IEC/CBIP/IEEMA Standard only)

Sl. No.	Particular	Offered
1.0	General	
1.1	Make & Country of origin	
1.2	Type	
2.0	Nominal continuous rating, kVA	
3.0	Type of Cooling	
4.0	Normal ratio of transformation	
5.0	Rated voltage (KV)	
5.1	HV winding	
5.2	LV winding	
6.0	Rated current (Amps)	
6.1	HV winding	
6.2	LV winding	
7	Connections	
7.1	HV winding	
7.2	LV winding	
7.3	Vector group reference	
8.0	Impedance at principal tap on rated MVA Base at current and frequency at 75 °C with 100 % Rating (%)	
8.1	Impedance (%)	

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°C at principal tap (ohm)	
9.1	a) HV	
9.2	b)LV	
10.0	Zero sequence impedance at reference temperature of 75°C at principal tap %), Ω / phase	
11.0	**Losses**	
11.1	Guaranteed maximum losses at principal tap at full load and 75° C without any positive tolerance(kW)	
11.1.1	No load loss at rated voltage and frequency at principal tap (max.), kW	
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° C winding temperature at	
11.2.1	Principal tap (kW)	

11.2.2	Highest tap (kW)	
11.2.3	Lowest tap (kW)	
11.2.4	Tolerance if any on the above	
12.0	**Temperature rise**	
12.1	Temperature rise of oil above reference design ambient of 35°C (By thermometer) at full ONAN rating °C	
12.2	Temperature rise of winding above reference design ambient of 35 °C (By thermometer) at full ONAN rating °C	
12.3	Temperature gradient between oil and winding (°C)	
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 ° 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°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	Short time rating for 2 seconds of	
14.1	HV winding	
14.2	LV winding	
15.0	Permissible over loading	
15.1	HV winding	
15.2	LV winding	
16.0	Terminal arrangement	
16.1	High voltage	
16.2	HV Neutral	
16.3	LV winding	
16.4	LV Neutral	
17.0	Test voltage	**HV /HVN / LV / LVN**
17.1	Lightning impulse test voltage, kV peak	
17.2	Power frequency with stand test voltage for 1 minute, kV rms	
19	Noise level when energized at normal voltage, frequency without load (db)	
20	External short circuit withstand capacity (MVA) and duration (Seconds)	
21	Over flux withstand capacity of the transformer and duration.	
22	Regulation (%)	
22.1	Regulation at full load at 75 ° C	
22.1.1	At unity power factor	
22.1.2	At 0.8 power factor lagging	
22.2	Regulation at 110% load at 75 ° C	

22.2.1	At unity power factor	
22.2.2	At 0.8 power factor lagging	
23	Tapping	
23.1	Type	
23.2	Capacity	
23.3	Range-steps x % variation	
23.4	Taps provided on HV winding (Yes/No)	
23.8	No.of steps	
23.9	Range (variation)	
24	Radiators	
24.1	Overall dimensions l x b x h ,mm	
24.2	Total weight with oil, Kg	
24.3	Total weight without oil	
24.4	Vacuum withstand capacity, tor	
24.5	Capacity of cooling units	
24.6	Mounting of radiators	
24.7	Number of radiators	
24.8	Type & size of individual radiator valve	
24.9	Total radiating surface, sq mm	
2410	Thickness of radiator tubes, mm	
24.11	Oil drain plug and air release plug provided on each radiator Yes/No	
24.12	Schematic flow diagram of the cooling system furnished (Yes/No)	
25	Core	

25.1	Type of core construction	
25..2	Type of core joints	
25.3	Core material grade	
25.4	Thickness of lamination mm	
25.5.	Insulation of core lamination, mm	
25.6	Specific loss of core material (Watts/Kg)	
25.7	Whether core construction is without core bolts	
25.13	Details of oil duct	
25.14	Whether in the plane and at right angle to the plane of winding	
25.15	Across the plane of laminations	
25.16	Design flux density of the core at rated voltage &frequency at principal tap, Tesla	
25.16.1	a)Core	
25.16.2	b)Yoke	
25.17	Maximum flux density allowed in the core at extreme over excitation / over fluxing , Tesla	
25.18	Magnetising current at normal ratio and frequency	
25.18.1	85 % of rated voltage	
25.18.2	100 % of rated voltage	
25.18.3	105 % of rated voltage	
25.19	Power factor of Mag. Current at normal voltage ratio and frequency	
25.20	Materials of core clamping plate	

25.21	Thickness of core clamping plate	
25.22	Insulation of core clamping plate	
25.23	Describe Location/ method of core grounding	
25.24	Details of oil ducts in core	
25.25	Equivalent cross section area of core, mm2	
25.25.1	Designed stack height	
25.25.2	Designed perturn voltage	
25.26	Guaranteed No load current at 90% / 100% / 110% rated voltage &frequency (Amp)	
25.26.1	HV	
25.26.2	LV	
26	Type of winding	
26.1	HV	
26.2	LV	
26.3	HV winding Conductor material	
26.4	LV winding Conductor material	
26.5	Maximum current density allowed, Amp per mm2	
26.5.1	a)HV winding	
26.5.2	b)LV winding	
26.6	Whether HV windings are interleaved	

26.7	Whether HV windings are pre shrunk	
26.8	Whether electro-static shields are provided to obtain uniform voltage distribution in the HV winding	
26.9	Gauge/area of cross section of conductor, mm2	
26.9.1	HV	
26.9.2	LV	
26.10	Maximum current density achieved in winding (LV/HV/) –Amps/ mm2	
26.11	Insulating material used for	
26.11.1	HV turn	
26.11.2	Tap winding - Earth	
26.11.3	LV turn	
26.12	Insulating material used in between	
26.12.1	LV- core	
26.12.2	HV-LV	
2612.3	Tap winding to earth	
26.13	Insulating material thickness, mm	
26.13.1	HV turn	
2613.2	LV turn	

26.13.4	LV to core	
26.13.5	HV to LV	
26.14	Type of coil axial supports	
26.14.1	HV winding	
26.14.2	LV winding	
26.15	Type of coil radial supports	
26.15.1	HV winding	
26.15.2	LV winding	
26.16	Maximum allowable torque on coil clamping bolts	
26.17	Inter-turn insulation	
26.17.1	Extent of extreme end turns reinforcement	
26.17.2	Extent of end turns reinforcement	
26.17.3	Extent of turns adjacent to tapings	
26.17.4	Test voltage for 10 Seconds 50 cycles inter turn insulation test on 26.17.1), kV rms	
26.17.5	Test voltage for 10 Seconds 50 cycles inter turn insulation test on (26.17.2), kV rms	
26.17.6	Test voltage for 10 Seconds 50 cycles inter turn insulation test on 26.17.3), kV rms	

2617.7	Test voltage for 10 Seconds 50 cycles inter turn insulation test on main body of the winding, kV rms	
27	Minimum design clearance , mm	
27.1	HV to earth in air	
27.2	HV to earth in oil	
27.3	LV to earth in air	
27.4	LV to earth in oil	
27.5	Between HV &LV in Air	
27.6	Between HV &LV in oil	
27.7	Top winding and yoke	
27.8	Bottom winding and yoke	
28	Insulating oil	
28.1	Governing standard	
28.2	Spec. resistance (ohms-cm) at 27°C / 90° C	
28.3	Tan delta	
28.4	Water content , ppm	
28.5	Dielectrc strength (BDV), kV	

28.6	Characteristics of oil after ageing test		
28.7	Spec. resistance (ohms-cm) at 27°C / 90° C		
28.8	Tan delta		
28.9	Sludge content		
28.10	Neutralisation number		
28.11	Quantity of oil Ltrs		
28.12	In the transformer tank		
28.13	In each radiator		
28.14	Total quantity		
28.15	10% excess oil furnished?		
28.16	Type of oil		
29	Conservator		
29.1	Details of oil preservation equipment offered		
29.2	Oil preservation system provided (Yes/No)		
29.3	Total volume of conservator (Ltr)		
29.4	Volume between highest and lowest visible oil levels (Ltr)		

		HV	HV Neutral	LV	LV Neutral
	HV Bushings				
30.1	Make				
30.2	Type				
30.3	Reference standard				
30.4	Rated Voltage class, kV				
30.5	Rated current , Amp				
30.6	Lightning Impulse withstand voltage, kV				
30.8	Power frequency withstand voltage, kV				
30.14	Creepage distance in mm				
30.15	Creepage distance (protected)				
30.18	Weight of assembled bushing, Kg				
30.19	Minimum clearance height for removal of bushings, mm				
30.20	Recommended gap setting for Arcing horn				
30.21	Terminal connections	As per Clause 5.2.7			
31	Marshalling box cubicle provided as per clause no. 5.2.9 of spec. (Yes / no)				
31.1	Make &Type				
31.2	Details of apparatus proposed to be housed in the kiosk				
35	Details of bushing CT				
35.1	Purpose				
35.2	Installed on which bushing HV/LV				
35.3	No. of bushing CTs installed				
35.4	Type				
35.5	Make				

35.6	Reference standard	
35.7	No.of cores	
35.8	Whether TEST winding provided or not	
35.9	CT ratio	
35.10	Burden ,VA	
35.11	Class of accuracy	
36	Details of protective devices	
36.1	Pressure release device	
36.1.1	Make &Type	
36.1.2	Minimum pressure the device is set to rupture.	
36.1.3	Rain hood provided or not	
36.2	Explosion vent	
36.2.1	Type & make	
36.2.2	Minimum pressure the device is set to rupture.	
36.3	Bucholz relay of main tank	
36.3.1	Type & make	
36.3.2	No. of contacts	
36.5	OTI	
36.5.1	Make &Type	
36.5.2	No. of contacts	
36.5.3	Setting range	
36.6	WTI	
36.6.1	Make &Type	

36.6.2	No. of contacts	
36.6.3	Setting range	
36.7	Oil Level guage	
36.7.1	Type &make	
36.7.2	No. of contacts	
37	Lifting Jacks	
37.1	No. of jacks in one set	
37.2	Type and make	
37.3	Capacity (tonnes)	
37.4	Pitch, mm	
37.5	Lift, mm	
37.6	Height in closed position, mm	
37.7	Mean dia. of thread, mm	
38	Alarm and trip contact ratings of protective devices	
38.1	Rated/making/ breaking currents , Amp @ voltage for	
38.2	PRV for main tank	
38.3	Bucholz relay	
38.4	OTI	
38.5	WTI	
38.6	Magnetic oil level gauge	
38.0	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)	
38.0	Painting: as per clause 5.10 for the transformer , cable boxes, radiator, marshalling box, etc (Yes/No)	

39	Details of Tank	
39.1	Material	
39.2	Approximate thickness of sheet	
39.2.1	Sides mm	
39.2.2	Bottom mm	
39.2.3	Cover (Top) mm	
39.2.4	Radiators mm	
39.3	Pressure mm of Hg	
39.4	Vacuum recommended for Hot oil Circulation	
39.5	Vacuum to be maintained during oil filling in transformer tank	
39.6	Vacuum to which the tank can be subjected without distortion as per specification	
39.7	Confirmation of tank designed and tested for vacuum pressure (Ref: CBIP manual) (Yes/No)	
39.8	Is the tank lid slopped?	
39.9	Inspection cover provided (Yes/No)	
39.10	Location of inspection cover (Yes/No)	
39.11	Min. dimensions of inspection cover (provide list of all inspection cover with dimension), mm x mm	
39.12	No. of bi-directional wheels provided	
39.13	Track gauge required for the wheels in longitudinal axis	
39.12	Type of pressure relief device/ explosion vent and the pressure at which it operates.	
39.15	Minimum clearance height for lifting core and winding from tank, mm	
39.16	Minimum clearance height for lifting tank cover, mm	
40.	Over all transformer dimensions	
40.1	Length , mm	

40.2	Breadth , mm		
40.3	Height , mm		
40.4	Transformer tank dimensions		
40.4.1	Length , mm		
40.4.2	Breadth , mm		
40.4.3	Height , mm		
40.5	Marshalling box dimensions		
40.5.1	Length , mm		
40.5.2	Breadth , mm		
40.5.3	Height , mm		
40.6	Weight data		
40.6.1	Core, Kg		
40.6.2	Frame parts, Kg		
40.6.3	Core and frame, Kg		
40.6.4	Total winding Kg		
40.6.5	Core and frame winding, Kg		
40.6.6	Tank, Kg		
40.6.7	Tank lid, Kg		
40.6.8	Empty conservator tank , Kg		
40.6.9	Each radiator empty , Kg		
40.6.10	Total weight of all radiator empty , Kg		
40.6.11	Weight of oil in tank , Kg		
40.6.12	Weight of oil in each conservator , Kg		
40.6.13	Weight of oil in each radiators , Kg		
40.6.14	Total weight of oil in radiator , Kg		

40.6.16	Total transport weight of the transformer , Kg	
40.7	Volume data	
40.7.1	Volume of oil in main tank , liters	
40.7.2	Volume of oil between highest and lowest levels of main conservator ,liters	
40.7.4	Volume of oil in each radiator , liters	
40.7.5	Total volume of oil in radiators , liters	
40.7.7	Transformer total oil volume , liters	
40.8	Shipping data	
40.8.1	Weight of heaviest package, kG	
40.8.2	Dimensions of the largest package (L x B x H) mm	
41.	Tests	
41.1	All in process tests confirmed as per Cl.10.1.4.1 and10.1.4.2 (Yes /No)	
41.2	All types tests confirmed as per Cl. 10.3 (Yes /No)	
41.3	All routine tests confirmed as per Cl.10.2 (Yes /No)	
41.4	All special tests confirmed as per Cl.10.4 (Yes /No)	
42	Transformer will transport with oil/gas	
43	Quality Assurance Plan: An outline of quality assurance plan used by the bidder	
44	General warranty for the transformer	
45	IP class of protection for transformer realys	
46)	**Important design parameters**	
46.1	Maximum no load loss at rated condition allowed without any positive tolerance (kW).	

46.2	Maximum load loss at rated condition @ 75°C and principal tap allowed without any positive tolerance (kW).	
46.3	Grade of core sheet, Hi-B or better	
46.4	Type of winding for HV	
46.5	Design value of flux density	
46.6	Design value of current density	
46.7	Weight of HV winding	
46.8	Weight of LV winding	
46.9	Weight of support insulators including insulation cylinders	
46.10	Weight of core(kg)	
46.11	Weight of core clamp	
46.12	Per turn voltage	
46.13	Conductor cross section HV LV	
46.14	Winding stack height(mm)	
46.15	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.	
46.16	Transformer tank dimensions(mm)(l x b x h)	
46.17	Weight of tank (kg)	
46.18	Total volume of oil in tank (Litres)	
46.19	Weight of core, winding and frame(kg)	
46.20	Overall dimensions of the transformer	

	(mm)(lxbxh)	

Sd/-

Chief Engineer (SCM)