SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

33/11KV 5MVA POWER TRANSFORMER WITH CABLE ENTRY BOX ON BOTH HV & LV

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Technical Specification and Evaluation Committee for Transmission Material

(i) Document Approval & Control Status

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(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 **33/11kV 5MVA Power Transformer with Cable Entry Box on Both HV & LV** 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 **33/11kV 5MVA Power Transformer with Cable Entry Box on Both HV & LV** 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 33/11kV 5MVA Power Transformer with cable entry box on both HV & LV

1) **Scope:-**

1.1. This specification covers the design, manufacture, shop testing, supply, delivery, supervision of erection, testing and commissioning of 33/11kV, 5MVA three phase two winding transformer with Cable Entry Box at various substations. **The transformers shall be delivered at the transformer plinth 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) **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.

3) **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
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.
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 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) **Major Design Criteria & Parameters of the Transformer:-** In the event of direct conflict between various order documents, the precedence of authority of documents shall be as follows –

4.1	Major design criteria	
4.1.1	Location of equipment	OUTDOOR
4.1.2	Reference design temperature	-5 to 40^{o}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 in shade: 40^{o}C Minimum temperature of air in shade:15^{o}C 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 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	36	12
4.1.19.2	Lightning Impulse withstand voltage, kV peak	170	75
4.1.20	Power frequency withstand voltage, kV rms	70	28
4.1.21	Design Clearances, mm	Phase to Phase	Phase to Earth
4.1.21.1	For nominal system voltage of 11kV	280	140
4.1.21.2	For nominal system voltage of 33kV	350	320
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	5 MVA (ONAN)
4.2.2	Vector group	YNyn0
4.2.3	Impedance	% impedance at principal tap at rated voltage, frequency at 5MVA Base shall be 7.15%, 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 4.0 kW
4.2.4.2	Load losses at principal tap	Maximum load loss at rated condition @ 75^{o}C and principal tap allowed without any positive tolerance shall be 27 kW
4.2.5	Loss capitalization formulae	As per CBIP manual section : J
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^{o}C b) Maximum ambient daily temperature:35^{o}C c) Maximum yearly weighed ambient temp. 32^{o}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 2.40 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 ^{o}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 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) 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 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, 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 rainy time.
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 (minimum)
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.
5.2.3.1.4	Essential provision if radiators mounted separately	Expansion bellow to be provided in the pipes between main tank and radiator headers
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
5.2.4	Core	
5.2.4.1	Material	High grade, non ageing, low loss, high permeability, grain oriented, cold rolled silicon steel laminations specially made for the construction of power transformers.
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 Tesla
5.2.4.5	Maximum flux density at 10% over excitation / overfluxing	<1.9 Tesla
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 / 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 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	2.40 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 si 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 Appendix-1 for the specification of transformer oil. Confirming IEC:296/ IS:335.
5.2.6.1	Type	Class 1 new mineral insulating oil as per IEC:296/ IS 335 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	HV phase & HV Neutral terminal connectors	Shall be suitable to connect single 33kV 1C x 300 sqmm, aluminium XLPE cable on each phase bushings and a single 11kV 1C x 300 sqmm, aluminium XLPE cable on HV neutral bushing.
5.2.7.3	HV cable box	All HV phase and neutral bushings shall be mounted in a suitable air filled metallic cable box. The cable box shall be designed and mounted as per CBIP manual section A, 12.0. 1) The cable box shall be box shall be suitable for terminating the cables directly on the bushings. 2) The cable box shall be designed to accommodate all the cable joint fittings including heat shrinkable sleeves, stress cones etc. or other approved means of grading the voltage stress on terminal insulation. 3) The cable box shall be fitted with suitable non-ferrous wiping glands with combined armour and earthing clamps. The ends of all wiping glands shall be tinned before dispatch to site. Wiping glands for single core cables shall be insulated from the box. Wiping glands insulation cables shall withstand a dry HV test of 2kV AC for 1 minute. The glanding shall be such that, no load is transmitted to the bushing end.

		4) An approved earthing terminal shall be provided on each cable for earthing the transformer winding during testing. 5) The cable box shall be capable of withstanding for 15minutes, both at the time of first tests on the cables and at any subsequent time as may be required, between phases and to earth a DC test equal to 2EkV or AC test equal to 4E/3 kV. 6) The creepage distances and clearances to earth and between phases shall be not less than that mention in CBIP manual Section A, table 1. 7) All terminals shall be marked in a clear permanent manner. 8) Unless otherwise specified, the cable entry shall be from the bottom side of the cable box. 9) All air insulated cable boxes for the transformer shall have thermostat and hygrostat controlled space heaters. Means shall be provided to resist ingress of dust into the cable box, whilst allowing moisture accumulations from condensation to drain. Also cable boxes shall be provided with Silica gel breathers having required capacity to eliminated the admission of moisture in to the cable box. The minimum Protection Class shall be IP65. 10) The cable glands shall be suitable for a) 33kV single core, 300sqmm. Aluminium XLPE cables for HV phases and b) 11kV single core 300sqmm. Aluminium XLPE cable for HV neutral.
5.2.7.4	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 400 Amp. rating without arcing horn.
5.2.7.5	LV Phase & LV Neutral terminal connectors	Shall be suitable to connect 11kV 1C x 500 sqmm, aluminium XLPE cable on each phase and neutral bushings.
5.2.7.6	LV cable box	Same as 5.2.7.3, but suitable to accommodate 11kV 1C x 500 sqmm. Aluminium XLPE cables for all three phases

		and neutral. The cable glands shall be suitable for the cables mentioned above.
5.2.7.7	Minimum creepage distance of bushing	25mm/kV (Refer GTP)
5.2.7.8	Protected creepage distance	Protected creepage distance of at least 40% of total creepage distance is to be provided
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 GTP
5.2.8.2	Rating	As per GTP
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 Cl. 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 PRV trip3
5.2.9.5	Signals to be wired to terminal block	WTI CT 4 to 20 mA signals for remote WTI and OTI repeater shall be made available at M.K.
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 fuse/ MCB 2) Approved space heaters controlled by Thermostat & hygrostat 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
5.2.9.14	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	M12 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. shall be used to ensure perfect oil tightness. All gasket shall be closed design. (without open ends) and shall be one piece only. Rubber gaskets used in flange type connection of various compartment shall be laid in grooves or groove equivalent section on bolt side of the gasket, throughout the length.	Nitrile rubber based

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 1554Part 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 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, 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 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 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	Required

	contacts, resetting device with temperature sensing element.	
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:- F**ollowing 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 antiskid 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 uni directional/ 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) for the 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	Drain plug / Drain valve on tank base
7.21	Air release plug on various fitting and accessories
7.22	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.
7.23	Vacuum pulling pipe with blanking plate on main conservator pipe work
7.24	Rainhood (canopy) PRV on main transformer
7.25	Oil level gauge on tank for transformer shipment
7.26	Earthing bridge by copper strip jumpers on all gasketted joints at least two points for electrical continuity
7.27	Ladder with anticlimbing device and safety flap, with lockable hinged plate for at least 1.5 m from ground level
7.29	Skid base welded type
7.30	Core, frame to tank earthing

7.31	Danger plate made of anodized aluminum white lettering on red background fixed by rivet	
7.32	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	**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 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	WCT	Pragati /ECS / KAPPA/ or equivalent
9.8	Switch	L & T (Salzer) / Siemens or equivalent
9.9	HRC fuse links	Siemens / L & T / GE or equivalent
9.10	Fuse base	Siemens / L & T / GE or equivalent
9.11	Meters	IMP / AE / MECO or equivalent
9.12	Terminals	Connectwell / Elmex or equivalent
9.13	Push buttons / Actuator	L & T / Siemens or equivalent
9.14	Thermostat	Velco or equivalent
9.15	Heater	Velco or equivalent
9.16	Control selector switch	Siemens or equivalent
9.17	Auxiliary relays	Jyoti / Easun Reyrolle or equivalent
9.18	Timers	L & T / Siemens or equivalent
10.0	**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 (Accredited NABL labs) 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 CRGO steel for core shall be purchased only from the approved Vendors. List available at http://apps.powergridindia.com/ims.
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/ IEC:296
10.1.6	Test on fittings and accessories	As per standard practice
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). 6) Noise level Measurement.
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 (Cl.16.10 IS 2026 part-1) 3) measurement of acoustic noise level (Cl.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.
10.4.1	Note for special test	The dynamic short circuit test report of transformer with higher MVA rating upto 12.5MVA and voltage rating 33kV/11kV from Government recognized independent test laboratory/ internationally accredited test lab will also be accepted. This test is mandatory for each design shall be supplied by the manufacturer and no exemption shall be allowed – IEC:76/IS:2026.
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.	
11.0.	**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
12/01/00	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	**SPECIAL WARRANTY:- Deleted**
14	D**RAWINGS 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 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)
15)	**SPARES :- Deleted**
16)	**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.
17)	**SUPERVISION OF ERECTION:-**
	For the erection and commissioning of the transformer the rate of the Engineer and the probable duration required for the erection and commissioning shall also be specified. (Full details of the conditions shall be furnished in the tender)
18)	**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.

Appendix – I

19) 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.)	

20. 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 + AWL + BWN

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

WL = Load losses in KW at rated tap and rated voltage ; WN = 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

21) **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.

22) **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 Particulars for 33kV/11kV 5MVA Outdoor Power Transformer with Cable Entry Box

SL. No.	Particular	Specified / Required	
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 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	5000	
3.0	Type of Cooling	ONAN	
4.0	Normal ratio of transformation	33/11kV	
5.0	Rated voltage (KV)		
5.1	HV Winding	33	
5.2	LV Winding	11	
6.0	Rated Current (Amps.)		
6.1	HV Winding	87.48	
6.2	LV Winding	262.43	
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 (%)	7.15% , 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°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	3.90	
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)	27	
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	45°C	
12.2	Temperature rise of winding above reference design ambient of 35 °C (By thermometer) at full ONAN rating °C	55°C	
12.3	Temperature gradient between oil and winding (°C)	10°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 13.1.1	Efficiency at 75 ° C winding temperature and unity power factor % 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 ^{o} C winding temperature & 0.8 power factor lag %		
13.2.1	At 110% load		
13.2.2 13.2.3	At 100% load 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/ LV**	**HV/ LV**
17.1	Lightning impulse test voltage, kV peak		
17.2	Power frequency withstand test voltage for 1 minute, kV rms		
17.3	Switching impulse test voltage, kV peak		
18	PD level at 1.5Um/√3kV rms (PC)		
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 ^{o} 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 ^{o} C		
22.2.1	At unity power factor		
22.2.2	At 0.8 power factor lagging		
23	**Tapping**		
23.1	Type	Off load tap changer	
23.2	Capacity	Full capacity	
23.3	Range-steps x % variation	As per clause 4.2.9 of this specification	
23.4	Taps provided on HV winding (Yes/No)	Yes.	
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	Minimum 1.2 mm	
24.11	Oil drain plug and air release plug provided on each radiator Yes/No	Yes	
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	High grade, non ageing, low loss, high permeability, grain oriented, cold rolled silicon steel laminations,	
25.4	Thickness of lamination mm	Max. 0.27 mm with insulating coating on both sides	
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		
25.8	Insulation of core bolts		
25.9	Insulation of core bolt washers		
25.10	Insulation between core laminations		
25.11	Core bolt insulation power frequency withstand test voltage for 1 mt.		
25.12	Are the core bolts grounded, if so how?		
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		
25.26	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	Electrolytic copper as per relevant standard	
26.4	LV winding Conductor material	Electrolytic copper as per relevant standard	
26.5	Maximum current density allowed, Amp per mm2		
26.5.1	a)HV winding	2.4A / sq.mm	
26.5.2	b)LV winding	2.4A / sq.mm	
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	IEC 296/ IS335	
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?	Yes		
28.16	Type of oil	New insulating oil as per IS: 335, and Cl. 5.2.6 of the specification		
29	**Conservator**			
29.1	Details of oil preservation equipment offered	As per Clause 5.2.2 2 of this specification		
29.2	Oil preservation system provided (Yes/No)	Yes. Comply clause 5.2.2.2 of Technical Specification.		
29.3	Total volume of conservator (Ltr)			
29.4	Volume between highest and lowest visible oil levels (Ltr)			
30	**Bushings**			
	HV Bushings	**HV**	**HV Neutral**	**LV & LV Neutral**
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			
30.7	Switching Impulse withstand voltage, kV			
30.8	Power frequency withstand voltage, kV			
30.9	Wet for 1 minute, kV			
30.10	Dry for 1 minute, kV			
30.11	Wet Flash over voltage, kV			
30.12	Dry Flash over voltage, kV			
30.13	Partial discharge level			
30.14	Creepage distance in mm			
30.15	Creepage distance (protected)			
30.16	Whether test tap is provided?. If so, power frequency withstand test voltage of test tap,			
30.17	Quantity of oil used in bushing & specification of oil used.			
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	As per Clause 5.2.7.	As per Clause 5.2.7
31	Marshalling box cubicle provided as per clause no. 5.2.9 of spec. (Yes / no)	Yes		
31.1	Make & Type			
31.2	Details of apparatus proposed to be housed in the kiosk	As per clause 5.2.9 of this specification.		
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	Manufacturer Std.		

35.11	Class of accuracy	Manufacturer Std.	
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)	Yes	
38.0	Painting: as per clause 5.10 for the transformer, cable boxes, radiator, marshalling box, etc (Yes/No)	Yes	
39	**Details of Tank**		
39.1	Material	Robust mild steel plate withoutpitting and low carbon content	
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	Twice the normal head of oil / normal pressure + 35 kN/m2 whichever is lower , As per CBIP	

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	As per CBIP	
39.7	Confirmation of tank designed and tested for vacuum pressure (Ref: CBIP manual) (Yes/No)	Yes	
39.8	Is the tank lid slopped?	Yes	
39.9	Inspection cover provided (Yes/No)	Yes, as per clause No 5.2.1.5	
39.10	Location of inspection cover (Yes/No)	As per clause No 5.2.1.5	
39.11	Min. dimensions of inspection cover (provide list of all inspection cover with dimension), mm x mm		
39.12	No. of uni directional / bi-directional wheels provided		
39.13	Track gauge required for the wheels in longitudinal axis	1435mm	
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	To be submitted	
44	General warranty for the transformer	Here specify clearly the conditions of general warranty terms	
45	Do you agree with the special warranty mentioned in Clause 13, of this specification. YES/ NO.		

Name and Address of Bidder