



BIHAR STATE POWER TRANSMISSION CO. LTD.

(Regd. Office: Vidyut Bhawan, Bailey Road, Patna)

CIN No: U74110BR2012SGC018889

[Office of Director (Project)]

Letter No: 474

Contact No: +91-7763815039


Dated: 07/5/26

E-mail: director.project@bsptcl.bihar.gov.in

Notice

In order to ensure consistent quality, reduce procurement timelines, and strengthen supply chain reliability, BSPTCL proposes to establish a pre-qualified and empanelled vendor base for either supply through Turn Key Contractor (TKC) under different projects being executed by BSPTCL or procurement of power transformers through online Tendering. Accordingly, Expression of Interest (EOI) is invited from eligible and experienced manufacturers for vendor registration and empanelment for supply of 3-Phase 132/33KV 50MVA and 80MVA Power Transformer and 3-Phase 220/132KV 160MVA and 200MVA Auto Transformer for different turnkey projects and direct procurement in BSPTCL for a period of 5 years and the same is being uploaded on the website of BSPTCL for inviting the comments on the draft EOI.

It is hereby requested to submit the comments on the said EOI by 25.05.2026 on the email address as mentioned above so that it could be finalized before uploading the tender on eproc.2 portal for the Empanelment/Vendor Registration for Manufacturers of Power/Auto Transformers for different projects/ direct procurement in BSPTCL.


(I.C. Yadav)

Director (Project), BSPTCL





**BIHAR STATE POWER TRANSMISSION COMPANY
LIMITED**
(A Government of Bihar Undertaking)

EoI No: 19/PR/BSPTCL/2026

**Expression Of Interest (EOI) for Empanelment/Vendor
Registration for Manufacturers of Power/Auto Transformers for
different projects/ direct procurement in BSPTCL**

May, 2026

BIHAR STATE POWER TRANSMISSION COMPANY LIMITED
Registered Office: 4thFloor, Vidyut Bhawan, Bailey Road, Patna – 800001
A Govt. of Bihar Undertaking, CIN:U74110BR2012SGC018889

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DISCLAIMER

1. Though adequate care has been taken while preparing the EOI document (inclusive of Formats and Annexure), the Bidder shall satisfy themselves that the document is complete in all respects. Intimation of any discrepancy shall be given to this office immediately. If no intimation is received from prospective Bidder on or before pre-bid meeting date, it shall be considered that the EOI document is complete in all respects and has been received by the Bidder.
2. BSPTCL reserves the right to modify, amend or supplement EOI documents including all formats and annexure at any time before Bid submission date. Interested Bidders are advised to follow and keep track of web-site <https://eproc2.bihar.gov.in/> for updated information. BSPTCL is not obligated to send/ communicate separate notifications for such notices/ amendments/ clarification etc. in the print media or individually. BSPTCL shall not be responsible and accountable for any consequences to any party.
3. While this EOI has been prepared in good faith, neither BSPTCL nor their employees or advisors make any representation or warranty, expressed or implied, or accept any responsibility or liability, whatsoever, in respect of any statement or omissions herein, or the accuracy, completeness or reliability of information and shall incur no liability under any law, statute, rules or regulations as to the accuracy, reliability or completeness of this EOI, even if any loss or damage is caused by any act or omission on their part.
4. The capitalized term or any other terms used in this EOI, unless as defined in EOI or repugnant to the context, shall have the same meaning as assigned to them by the Electricity Act, 2003 or Company Act, 1956/2013, Income Tax Act, and the rules or regulations as per applicable Acts.

BIHAR STATE POWER TRANSMISSION COMPANY LIMITED, PATNA



(An ISO 27001:2013 Certified Company)

(Regd. office: Vidyut Bhawan, 4th floor, Bailey Road, Patna-21)

A Govt. Of Bihar Undertaking

[DEPARTMENT OF Planning & Engineering]

CIN:- U74110BR2012SGC018889

E-mail address – engg.dept@bsptcl.bihar.gov.in, Website - www.bsptcl.in

[INVITATION FOR EXPRESSION OF INTEREST]

(Through e-procurement mode only www.eproc2.bihar.gov.in)

Bihar State Power Transmission Company Limited (BSPTCL) invites Expression of Interest (EoI) for Empanelment of Manufacturers for Supply of Power/Auto Transformers in Bihar State Power Transmission Company Limited (BSPTCL) for all Central/State Govt. Funded schemes and internal Procurement for a period of 5 Years. Eligible Manufacturers of Power/Auto Transformers as per terms & conditions of EOI are invited to participate through online

EOI/NIT No	Particulars	Cost of BOQ/ Tender Document	Bid Processing Fees
19/PR/BSPTCL/2026	Expression of Interest (EoI) for Empanelment of Manufacturers for Supply of 3-Phase 132/33 KV 50 MVA, 80 MVA Power Transformers and 3-Phase 220/132 KV 160 MVA and 200 MVA Auto Transformers in Bihar State Power Transmission Company Limited (BSPTCL) for all Central/State Govt. Funded schemes and internal Procurement for a period of 5 Years	100000+ GST @18% =118000/-	As per actual

The Time line for the above EOI are as follows:

Start date of Online Sale of Bid Documents/ request of Bid/ Bid Documents:-	11.05.2026, 11:30 Hrs onwards
Pre-bid Query Submission Type and Date: -	Through email: engg.dept@bsptcl.bihar.gov.in up to 17.05.2026
Pre-Bid Discussion Date:-	18.05.2026, 12:30 Hrs onwards
Submission Due Date: -	02.06.2026, up to 17:00 Hrs
EOI Opening Date: -	03.06.2026, 11:30 Hrs onwards
Venue Details: -	Conference Hall, 4th floor, Vidyut Bhawan-1, Bailey Road, Patna - 800021
The detailed EOI document can be downloaded from website www.eproc2.bihar.gov.in .	

1. Bid Processing Fee is mandatory to be paid through online mode i.e., Internet Payment Gateway (Credit/Debit Card), Net Banking, NEFT/RTGS”.
2. “Bid along with necessary online payments must be submitted through e-payment portal <https://eproc2.bihar.gov.in/> before the date & time specified in the NIT. The department doesn't take responsibility for the delay/ Non submission of Tender/ Non-Reconciliation of online Payment caused due to Non-availability of Internet Connection, Network Traffic/ Holidays or any other reason”.
3. Tender may be cancelled at any stage by the competent authority without refunding the Cost of BOQ.
4. Bidder should have valid GST and all other applicable tax registration certificate and copies of the same duly attested shall be furnished.
5. No separate transportation cost shall be paid and the bidder shall have to quote the rate inclusive of transportation cost and all taxes.
6. Eligibility Criteria, tender documents along with General/Special condition, bids and any corrigendum/ addendum of the EOI are available only at website www.eproc2.bihar.gov.in
- 7.

**Chief Engineer
(Planning & Engineering)**

E-tendering is introduced in BSPTCL for tenders above Rs. 25 lacs. For registration log in to www.eproc2.bihar.gov.in and e-Procurement Help Desk Toll free No: 1800 572 6571 , Email Id: eproc2support@bihar.gov.in

Working Hours: 8AM to 7PM (All days in week except few selected state holidays).

While participating in e-tendering process, the contractor shall have to get them registered to get user ID, Passwords and digital signature. This will enable them to access the Website: www.eproc2.bihar.gov.in only.

“विवादों के निष्पादन के लिए लोक अदालत का लाभ उठाये परस्पर सहमति से न्यायिक निर्णय प्राप्त करें समय एवं खर्च की बचत करें।”

Intending respondent/applicant should submit their proposals only in online mode on or before the time and date specified in the expression of Interest.

The proposal shall be opened online at the office of the Chief Engineer (P&E), BSPTCL, Patna on the date and time mentioned above. The EOI details will also be available on the website www.bsptcl.co.in.

If any of the dates mentioned above happens to be a holiday, the actual dates for the same will be on the next working day. No separate intimation in this regard will be issued.

BSPTCL reserves the right to modify /cancel any or all proposals without assigning any reasons thereof. BSPTCL will not be responsible for any errors like missing of schedule data while downloading by the proponent/ non receipt of document / delay if any.

1. Introduction

The power transmission sector in India is witnessing rapid expansion driven by increasing demand, renewable energy integration, and grid modernization initiatives. In this evolving scenario, power transformers form the backbone of transmission systems, enabling efficient voltage transformation, minimizing losses, and ensuring reliable power flow across the network.

In line with the country's and the state's commitment to energy security and sustainability, Bihar State Power Transmission Company Limited (BSPTCL) has significantly expanded its transmission infrastructure over the years to meet the growing power demand of the state. The state is actively working towards finalizing its policy framework towards uninterrupted power supply.

The highest peak demand met by Bihar in 2025-26 was 8,752 MW, and projected peak Demand by 2034-35 is estimated to 18,708 MW. Presently, the state has 13, 622 ckm of 132 KV lines, 6,988 ckm of 220KV lines and 312 ckm of 400KV lines. It has transformation capacity of 18,700MVA at 132KV level, 14, 560 MVA at 220KV and 3,000 MVA at 400 KV level and counting.

In order to ensure consistent quality, reduce procurement timelines, and strengthen supply chain reliability, BSPTCL proposes to establish a pre-qualified and empaneled vendor base for either supply through Turn Key Contractor (TKC) under different projects being executed by BSPTCL or procurement of power transformers through online Tendering. That is only those vendors can participate in all future tenders for supply of Power Transformers to BSPTCL who have got vendor approval through instant EOI. Accordingly, Expression of Interest (EOI) is invited from eligible and experienced manufacturers for vendor registration and empanelment for supply of power transformers.

2. Aim & Objectives

This Expression of Interest (EOI) seeks response from Original Equipment Manufacturers (OEMs) of Power/Auto transformer manufacturers, who are willing to be associated with BSPTCL for supply of transformers to BSPTCL through Turnkey Contract/Direct Procurement by BSPTCL tender as per BSPTCL specification and supervision as elaborated in subsequent paras of this EOI.

The aim is to identify technically competent, financially sound and strategically aligned Power transformer Manufacturers who shall be empaneled with BSPTCL (A government of Bihar undertaking).For supply of transformers to BSPTCL through Turnkey Contract/Direct Procurement by BSPTCL tender as per BSPTCL Technical specification (attached as Annexure- A) within specified time frame and as per guidelines of SBD of BSPTCL and other qualifying requirements. In case of supply in EPC mode, the turnkey contractor must submit MAF of transformer manufacturer selected from the list of empaneled manufacturer/vendor. However, Technical specification, inspection clause and delivery schedule shall be matching with time frame of BSPTCL.

This EOI provides key information intended to guide interested parties in preparing and submitting their responses.

3. Fees and cost involved: -

Following fees and cost shall be payable by interested/qualified vendors for participation in the empanelment process.

(a) **EOI Processing Fees:**

A non-refundable processing fee of Rs.10000.00 (Rupees Ten Thousand) plus applicable GST Rs.1800 @18% shall be payable (To be paid directly to BELTRON) by each participant through gateway of eproc2.0 website <https://eproc2.bihar.gov.in> (through e-payment mode i.e. NEFT / RTGS, Credit / Debit Card & Net Banking only) for processing on this platform.

(b) **Cost of BOQ/ Tender document:**

A non-refundable cost of BOQ of ₹100000.00 (Rupees One lacs only) plus applicable GST Rs.18,000 @ 18% shall be payable by each participant for empanelment to BSPTCL

Cost of BOQ / Form Fee to be paid through e-Payment mode (i.e. NEFT / RTGS, Credit / Debit Card & Net Banking) only.

(c) **Registration cost:**

A non-refundable registration fee of ₹50,000 (Rupees Fifty Thousand only) shall be payable by each qualified vendor for empanelment under each rated capacity (50MVA, 80MVA, 160MVA & 200MVA Transformer). Vendors applying for multiple rated capacity shall be required to pay the registration fee separately for each category. (50MVA , 80MVA, 160MVA & 200MVA Transformer).

The registration fee can be paid either through online mode or manual mode (BG, DD etc). In case of manual mode of payment of registration fee, the original hard copy of the registration fee which may be a DD / BG or any other instrument that should be submitted in the tendering authority office within the 7 days working day after empanelment list is issued."

The draft shall be in favour of "Accounts Officer, BSPTCL, Patna" Payable at Patna. Original BG towards registration fee from a Public Sector Bank or a Scheduled Commercial Bank must be submitted to Chief Engineer (P&E) of BSPTCL], 4th Floor, Vidyut Bhawan Patna without fail.

Note: "Bids along with necessary online payments must be submitted through e-Procurement portal www.eproc2.bihar.gov.in before the date and time specified in the EOI/NIT/RFP. The department/Tendering Authority doesn't take any responsibility for the delay/Non Submission of Tender/ Non Reconciliation of online Payment caused due to Non-availability of Internet Connection, Network Traffic / Holidays or any other reason."

4. Venue and Deadline for Submission of EOI:

EOI Proposal, in its complete form in all respect as specified in the EOI, must be submitted in online mode through Eproc2.0 to BSPTCL within due date and time at the address specified herein earlier. In exceptional circumstances and at its discretion, BSPTCL may extend the deadline for submission

of proposals by issuing an amendment to be made available on the BSPTCL website/
<https://eproc2.bihar.gov.in/>.

5. Validity of EOI:

The validity of EOI as per this document shall be for a period of 180 days initially which may be extended further if required by BSPTCL.

6. Broad Scope of Work:

The objective of this Expression of Interest (EOI) is to invite submissions from technically competent, financially sound and strategically aligned Power transformer Manufacturers interested in supply power transformer to BSPTCL. BSPTCL has its rolling plan upto 2034-35 and wishes to strengthen its existing power system which needs hassle free time bound and quality supply of transformer from leading manufacturers of India. The transformers shall be manufactured and supplied as per BSPTCL Specification & Quality plan (**Annexure-A**).

This shall be broadly based on eligibility criteria as mentioned in later clauses, and shall be also derived from credentials w.r.t past supplies, performance certificates, Type test & Short circuit test report, technical, manufacturing and testing capability. While the qualification criteria (mentioned in this document) shall be a pre-requisite for meeting the basic requirements, the final decision shall be taken by a cross functional team on the basis of submitted documents, responses, evaluation of vendor works which may include factory visit by BSPTCL representative or third party (ERDA/ CPRI) assigned by BSPTCL and facilities etc. However, QR mention is not limited to the extent mentioned in this document, it may be revised till final date of submission.

BSPTCL may also visit bidder's works to verify the documents/ facilities and may also call bidders to BSPTCL works for techno-commercial discussion. Bidders must be ready to visit BSPTCL office for deliberations.

The tentative requirement of Power/ Auto Transformer in BSPTCL for different voltage levels upto 2029-30 to be procured through Turnkey Contract/Direct Procurement by BSPTCL is as below:

Sl.No.	Voltage level	Rating	Capacity Augmentation	For upcoming projects	Total
1.	220/132KV	200 MVA	4 Nos.	8 Nos.	12 Nos.
2.		160 MVA	4 Nos.	4 Nos.	8 Nos.
3.	132/33KV	80 MVA	25 Nos.	14 Nos.	39 Nos.
4.		50 MVA	20 Nos.	2 Nos.	22 nos.

SCOPE OF WORK:

- a) Vendor has to submit all the documents/formats and meet all the requirements as mentioned in this EOI.
- b) Once vendor is selected by BSPTCL or its executing agency for supply of Power Transformer as covered in this EOI, the following scope shall be covered:
 - (i) Design (as per approved drawings, GTP, specification, BSPTCL design if applicable/ standard improvised by CEA from time to time)
 - (ii) Procurement of raw material, accessories, mountings and fittings (as per BSPTCL enlisted vendor list)
 - (iii) Inspection by BSPTCL representative or authorized third party viz; ERDA/ CPRI etc (List may be updated by BSPTCL from time to time) as per Specific MQP.
 - (iv) Testing at vendor works as per inspection plan mentioned in this document in presence of BSPTCL/authorized Inspecting officer.
- (v) The transformer shall be supplied at BSPTCL sites by the vendor. The assembly work and other activities like oil filling, filtration shall be carried by vendor's team. BSPTCL shall extend support in Transformer commissioning as per specific Terms and Conditions of said NIT.
- (vi) Tests shall be repeated at BSPTCL site in presence of manufacturer. Transformer shall be deemed to have passed, only if it passes all the tests in line with enquiry specification and relevant National/ international standards as applicable.
- (vii) It is responsibility of vendor to transport the transformer and accessories at works for final testing.
- (viii) Supervision at site for erection and commissioning shall be the responsibility of the manufacturer.
- (ix) If any defect is found in any transformer or any component at any stage of manufacturing, testing, commissioning or during warranty/ defect liability period, the same shall be repaired/replaced free of cost in due time.

Note: Warranty on the offered Transformer shall be minimum 60(sixty) months from date of commissioning or 66(sixty six) months from date of delivery at site whichever comes earlier. However, it may be noted that the contractor shall be agreeable to make this guarantee applicable for the main equipment (i.e. transformer), its fittings and accessories, transformer oil, spares as well as the Fire- prevention and extinguishing system, its fittings and accessories and fiber optic system etc. "The Manufacturer shall also provide warranty/guarantee against any DGA violation in the transformer up to five (5) years from the date of delivery of the Transformer. In the event of any DGA violation, the Manufacturer shall undertake the diagnosis, repair, replacement work of the Transformers without any cost burden to the Purchaser". Similarly, the checking of "no load loss", "load loss" etc. may be arranged

by BSPTCL just prior to end of guarantee period to verify the performance of machine w.r.t. initial factory test conditions. Violation in test figures beyond reasonable limits may lead to non-compliance of quality requirement. The obligation under Guarantee clause may be invoked in such conditions. (x) After successful enlistment of the vendor with BSPTCL as per EOI, vendor has to submit the techno-commercial offer against enquiry raised by BSPTCL or its executing agency, as per enquiry terms and conditions within due date. The Techno-Commercial offer shall be evaluated by BSPTCL or TKC of BSPTCL. Separate agreement shall be executed by BSPTCL or TKC for Supply and Payment related Terms and Conditions.

Note:- Once the list of empaneled vendors is issued all kind of supply of Transformer whether through Turnkey/Direct procurement shall be done only according to empaneled vendor list

7. Eligibility Criteria

The bidder shall be empaneled for the class of voltage and rating for which they have submitted following documents:-

- (i) The bidder should themselves be established manufacturer of the Power transformer offered, having adequate experience for design, manufacture, testing & supply of same or higher rating. They should have supplied similar transformer in Central / State Power Utility / Major Qualified Transmission Companies (Transmission Licensee(s)).

At least 01 (One) Transformer for every rated capacity (50MVA, 80MVA, 160MVA & 200MVA Transformer) should be in successful operation for at least two years as on date of opening of techno-commercial bid. The bidder should furnish all the information / documents regarding experience for manufacture & supply of offered item and their satisfactory performance issued from Government utility/ Major Qualified Transmission Companies (Transmission Licensee(s)) as detailed in note below.

- (ii)** The bidder shall be an engineering organization capable of undertaking design, manufacture, testing, supply and commissioning of the quoted materials / equipment. The tender should accompany a list of all the facility available with them for inspection & testing of the transformer and clearly confirm that these will be available to the purchaser or his representative for inspection.

- (iii)** The tender of only those firms shall be considered who have got the offered items type tested as per relevant ISS / IEC at CPRI or third party NABL accredited laboratory of same repute as per latest revision of the specification. The Type/special tests should comply the latest guidelines

of CEA like validity period etc. as on date of tender submission.

- (iv) The bidder must have manufactured and supplied at least **one (01)** Transformer for every rated capacity (50MVA, 80MVA, 160MVA & 200MVA Transformer) of offered rating for empanelment or higher capacity (irrespective of voltage class) every year during last five years from opening of bid. The bidder must submit documentary evidence in support of this in form of excise gate pass or other relevant paper duly authenticated.
- (v) For participation in future tender of BSPTCL for procurement of Power Transformer additional terms and conditions detailed in that particular NIT/ RFP shall also be applicable for that NIT.
- (vi) The transformer, the design of which is similar to the offered transformer, should have been successfully tested for short circuit withstand capability as per IS 2026 Part-5 within last 5 years. The criteria for similar transformer are specified in Annexure-J of CEA guidelines (File No.CEA-PS-14-169/2/2019-PSETD Division) of transformer. The relevant Test Report/certificate shall be enclosed along with bid. Further, design review of offered transformer shall be carried out based on the design of reference transformer, which has already been subjected to short circuit tests in lieu of repetition of short circuit tests. A format (forms part of Annexure-J) filled with data of a typical sample case has been prepared for reference and guidance of utility to compare a Short Circuit tested transformer with the offered transformer in order to verify the similarity criteria as per Annexure J.

The above experience should be for the works executed during the last seven (07) years and these Transformers must be in satisfactory operation# for at least two (02) year as on the originally scheduled date of bid opening (##).

Note:

- (#) Satisfactory operation means certificate issued by the Employer i.e. Central /State Power Utility certifying the operation without any adverse remark. Certificate issued by Joint Venture Company of Central / State Power Utility / Major Qualified Transmission Companies (Transmission Licensee(s)) will also be considered, provided it is supported by Purchase Order & Work Order Copies and satisfactory completion & operation certificate without any adverse remark. Further, the Employer reserves the rights to independently verify such certificates submitted by the bidder from the issuing authority.
- (##) The date of issue of performance certificate should be on or before the date of opening of the tender/ bids. The performance certificate issued after opening of the tender/bids shall not be considered.

FINANCIAL RESOURCE AND EXPERIENCE:

- a. Net Worth for last 3 financial years should be positive.
- b. Bidder shall submit Minimum Average Annual Turnover *(MAAT) for best three years (i.e. 36 months) out of last five financial years to assess the Financial status of the bidder. It should not be less than Rs.500 Crores.
- c. Bidder shall have liquid assets (L.A.) or/and evidence of access to or availability of credit facilities to meet their requirement for manufacturing power transformers order by BSPTCL or its TKC.
- d. In support of its 'Financial Position', in line with the above, the Bidder must provide the relevant information, along with documentary evidence, in the following format duly certified by CA.

Format B:			
Name of the Bidder			
A. Turnover / Net worth details:			
Sl. No.	Financial year	Annual Turnover (in Rs. Crs.)	Net worth (in Rs. Crs.)
01			
02			
03			
04			
05			
Average annual turnover for best three years is:			
B. Liquid Assets details:			
Details of evidence of having Liquid assets (LA) OR, Details of evidence of access to or availability of credit facilities			

BID CAPACITY

~~Bidders who meet the minimum qualification criteria will be qualified only if their available bid capacity is equal to or more than Rs. 100 Crore. The available bid capacity will be calculated as under:~~

Accessed available bid capacity is equal to: $(A * M * N) - B$ where;

A = Maximum annual turnover in any one year during last 5 years (Updated to the price level of last year @ 8% a year. i.e. Indexed at present value of last year taking 8% as indexing rate) taking into account the completed as well as works in progress.

N= No. of years prescribed for completion of works for which bids are invited.

Considering the project completion period of 24 months, N=2

(i.e. for 18 months, N=1.5)

M=3

B = Value, at the current Price level of existing commitments and ongoing works (Electrical and other) to be completed during the period of completion of work for which bids are invited (to be submitted by the bidder)

Note: Declaration to be submitted by the bidder indicating the value of Existing commitments and on-going works as well as the stipulated period of completion remaining for each of the works listed in the declaration.

* Note:-

❖ Annual total income as incorporated in the profit & loss account except non-recurring income e.g. sale of fixed assets.

❖ The tenderer should furnish copy of latest GST Registration certificate EPF code number & Copy of PAN Number.

❖ As per IND/AS guidelines, Net worth means the sum total of the Equity Share Capital and free reserves (excluding reserves created out of revaluation) reduced by aggregate value of accumulated losses (including debit balance in profit and loss account for current year & Miscellaneous expenditures to the extent not written off and carry forward losses) and intangible assets. Further, promoter should not use debt to infuse equity share capital in the bidding entity.

❖ The tenderers shall submit along with their tenders a statement of facts as to their previous experience in executing similar orders of comparable work/ supply as well as their business and technical organization and financial resources available and to be used in executing the contract.

❖ Bidder shall submit audited financial reports for at least five years preceding the date of bid submission. In case of bid by authorized representative in addition to himself, the above shall apply to his manufacturers also.

8. Inspection and testing

a) **Factory inspection**:-Factory inspection of participant shall be done by BSPTCL representative and authorized third party viz; ERDA/ CPRI etc before finalizing the empanelment list.

b) **Pre dispatch inspection**:-

The inspection envisaged by the purchaser is given below. However, the manufacturer shall draw up and carry out a comprehensive inspection and testing programme in the form of detailed quality plan duly approved by Purchaser for necessary implementation during manufacture of the equipment. All accessories and components of transformer shall be purchased from source, approved by the purchaser. All process tests, critical raw material tests and witness/ inspection of these testing shall be carried out as per approved Manufacturing Quality Plan (MQP) by BSPTCL representative and authorized third party viz; ERDA/ CPRI etc (List may be updated by BSPTCL from time to time) .

(i) **Stage Inspection**

Stage inspection will be carried out by the Inspector on Core, Winding, core-coil assembly & Tank during the manufacturing stages of the transformer. The manufacturer will have to call for the stage inspection and shall arrange the inspection at manufacturer's premises or manufacturer's sub-supplier's premises, as applicable, free of cost.

Stage inspection will be carried out on at least one Transformer against an offer of minimum 50% of the ordered quantity as mentioned in delivery schedule. On the basis of satisfactory stage inspection, manufacturer will proceed further.

The manufacturer will offer the core for stage inspection and get approval from purchaser during manufacturing stage. The BIS certified prime core materials are only to be used. The manufacturer has to produce following documents at the time of stage inspection for confirmation of use of prime core materials.

1. Invoice of supplier
2. Mills' approved test certificates
3. Packing list
4. Bill of lading
5. Bill of entry certificate by custom.
6. Description of material, electrical analysis, physical inspection, certificate for surface defects, chemical composition certificate, thickness and width of the materials
7. Place of cutting of core materials

To avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, the imported packed slit coils of CRGO materials shall be opened in the presence of the Inspector. Only after the inspection and approval from purchaser, the core material will be cut in-house or sent to external agency for cutting individual laminations. In case the

core is sent to external agency for cutting, the Inspector will have full access to visit such agency for the inspection of the cutting of core. Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

Typical example for calculation of flux density, core quantity, no-load loss and weight of copper during stage inspection shall be as per “Standard Specifications and technical Parameters for Transformers and Reactors (66 kV & above voltage class)”.

Tank Tests

(A) Oil Leakage Test

All tanks and oil filled compartments shall be completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure equal to normal head of oil plus 35 kN/sq.m (5 psi) measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours for oil and 1 hour for air during which no leakage shall occur.

(B) Vacuum Test

All transformer tanks shall be subjected to the specified vacuum. The tank designed for full vacuum (760 mm of mercury at sea level) shall be tested at an internal pressure of 3.33 KN/Sqm absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length of flat plate(in mm)		Permanent deflection (in mm)
Up to	And including 750	5.0
751	To 1250	6.5
1251	To 1750	8.0
1751	To 2000	9.5
2001	To 2250	11.0
2251	To 2500	12.5
2501 to	3000	16.0
Above	3000	19.0

C) Pressure Test

All transformer tanks, its radiator, conservator and other fittings together or separately shall be subjected to a pressure corresponding to twice the normal head of oil or normal oil head pressure plus 35 KN/ sqm whichever is lower, measured at the base of the tank and maintained for eight hours. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test

(ii) Final Inspection:

The manufacturer shall carry out all type & routine tests specified below as per TS/IS/IEC/CEA guidelines:

No.	Test	Um	Um
		≤ 170kV	> 170kV
1.	Measurement of winding resistance at all taps	Routine	Routine
2.	Measurement of voltage ratio at all taps	Routine	Routine
3.	Check of phase displacement and vector group	Routine	Routine
4.	Measurement of no-load loss and current measurement at 90%, 100% & 110% of rated voltage and rated frequency	Routine	Routine
5.	Magnetic balance test (for three phase Transformer only) and measurement of magnetizing current	Routine	Routine
6.	Short Circuit Impedance and load loss measurement at principal tap and extreme taps	Routine	Routine
7.	Measurement of insulation resistance & Polarization Index	Routine	Routine
8.	Measurement of insulation power factor and capacitance between winding to earth and between windings	Routine	Routine
9.	Measurement of insulation power factor and capacitance of bushings	Routine	Routine
10.	Tan delta of bushing at variable frequency (Frequency Domain Spectroscopy)	Routine	Routine
11.	Full wave lightning impulse test for the line terminals (LI)	Type (for Um≤72.5kV) Routine (for 72.5kV<Um≤170 kV)	-
12.	Chopped wave lightning impulse test for the line terminals (LIC)	Type	Routine
13.	Lightning impulse test for the neutral terminals (LIN)	Type	Type
14.	Switching impulse test for the line terminal (SI) (Not applicable for Um≤72.5 kV)	Type	Routine
15.	Applied voltage test (AV)	Routine	Routine
16.	Line terminal AC withstand voltage test (LTAC) (Not applicable for Um≤72.5 kV)	Routine	Type
17.	Induced voltage withstand test (IVW)	Routine	-
18.	Induced voltage test with PD measurement (IVPD)	Routine*	Routine
19.	Measurement of transferred surge on Tertiary due to HV lightning impulse and LV lighting impulse	- -	Type
20.	Measurement of transferred surge on Tertiary due to HV Switching impulse and LV Switching impulse	-	Type
21.	Test on On-load tap changer (Tap changer fully assembled on the transformer)	Routine	Routine
22.	Measurement of dissolved gasses in dielectric liquid	Routine	Routine
23.	Check of core and frame insulation	Routine	Routine
24.	Leak testing with pressure for liquid immersed transformers (tightness test)	Routine	Routine
25.	Appearance, construction and dimension check	Routine	Routine
26.	Measurement of no load current & Short circuit Impedance with 415 V, 50 Hz AC.	Routine	Routine
27.	Frequency Response analysis (Soft copy of test report to be submitted to site along with test reports)	Routine	Routine
28.	High voltage withstand test on auxiliary equipment and wiring after assembly	Routine	Routine

29.	Tank vacuum test	Routine	Routine
30.	Tank pressure test	Routine	Routine
31.	Check of the ratio and polarity of built-in current transformers	Routine	Routine
32.	Temperature rise test	Type	Type
33.	Overload testing in short-circuit method (applicable for 765 kV transformer only)	-	Type
34.	Short duration heat run test (Not Applicable for unit on which temperature rise test is performed)	Routine	Routine
35.	Over excitation test (applicable for 765 kV transformer only)	-	Routine
36.	Measurement of Zero seq. reactance (for three phase Transformer only)	Type	Type
37.	Measurement of harmonic level in no load current	Type	Type
38.	Determination of acoustic sound level	Type	Type
39.	Measurement of power taken by fans and liquid pump motors (Not applicable for ONAN)	Type	Type
40.	Dynamic Short circuit withstand test	As specified in the specification	

All tests shall be done in line with latest IS: 2026/IEC 60076 or as per procedure specified in Technical specification. Complete test report shall be submitted to purchaser after proper scrutiny and signing on each page by the test engineer of the manufacturer.

The manufacturer shall be fully equipped to perform all the required tests as specified. He shall confirm the capabilities of the proposed manufacturing plant in this regard. Any limitations shall be clearly stated.

The manufacturer shall bear all additional costs related to tests which are not possible to carry out at their own works.

In case, any failure observed during factory testing involving winding/ winding shield/ static shield ring, then affected winding of all phases shall be replaced by new one mutually agreed between manufacturer & Purchaser.

Type Tests on fittings

Following fittings shall conform to type tests and the type test reports shall be furnished along with drawing of the equipment/fittings.

- Bushing (Type test as per IS/IEC:60137)
- OLTC (Test as per IS 8468/IEC:60214 and degree of protection test for IP- 55 on Driving mechanism box)
- Buchholz relay
- OTI and WTI
- Pressure Relief Device (including degree of protection test for IP 55 in terminal box)

- Sudden Pressure Relay (including degree of protection test for IP 55 in terminal box)
- Magnetic Oil Level gauge & Terminal Box degree of protection test for IP-55.
- Air Cell (Flexible air separator) - Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per IS: 3400/ BS: 903/ IS: 7016
- Marshalling & common marshalling box and other outdoor cubicle (IP-55 test)
- Bus post Insulators
- Oil pump
- Cooling fan & motor assembly
- RTCC Panel (IP-43 test)

Pre-Shipment Checks at Manufacturer's Works

The following pre-shipment checks shall be done at manufacturer's works:

- Check for inter-changeability of components of similar transformers for mounting dimensions.
- Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, Buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

Ensure following setting of impact recorder at the time of installation with transformer unit before dispatch from factory:

1g: Start recording 2g: Warning

3g: Alarm

Further, drop-out setting shall be 1g and threshold setting shall be in the range of 5g to 10g.

- Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.
- Gas tightness test to confirm tightness and record of dew point of dry air inside the tank. Derivation of leakage rate and ensure the adequate reserve dry air capacity.
- Due security arrangements to be ensured during transportation to avoid pilferage and tempering with the valves and other accessories used while dry air filling.

9. Vendor selection for mounting accessories: -

S. No.	Item Description	Proposed make
1.	Core	Core materials to be procured directly from authorized dealer of CRGO manufacturer as following:
		POSCO, Korea
		NIPPON, Japan
		JFE, Japan
2.	Winding	HINDALCO
		Hindustan Copper
		Sterlite
	CTC Conversion	Asta India, Vadodara
		KSH International, Chakan
		Precision Wires, Silvassa
		Sri Cables & Conductors (P) Ltd., Bhopal
	3.	Transformer Oil
Savita Oil Technologies Ltd.		
4.	Paper Insulation for Conductor	Weidman Electrical, Switzerland
		Smurift Munksjo, Sweden
5.	Pre-compressed Board	ABB, Sweden
		H Weidman, Switzerland
		Senapathy Whiteley, Bangalore
		Raman Boards, Mysore
6.	Un-impregnated Densified Wood	Permalli Wallace, Bhopal
		Western India Plywood, Cannanore
7.	Bushing CT	Mahindra Electricals, Mumbai
		BHEL, Bhopal
		Pragati Electricals Pvt. Ltd., Thane
		A.U. Electric Machines, Allahabad
8.	Tank	Self-manufacturing as well as out sourced
	Sheet	SAIL, RINL, TISCO, IISCO
	Tank fabricator	Satyam Industries, Bhopal
		Allahabad Enterprises, Allahabad
9.	RIP Bushing	Yes High Voltage Ltd.
		MIM, Haryana

10.	Porcelain Bushing Insulator	CJI, Khurja
		W S Industries, Chennai
		Jayashree Insulators, Halol
		BHEL, Bangalore
11.	Rubber Gasket	Nu Cork Products, Bhiwadi
		Bombay Oil Seal Mfg Co., Mumbai
12.	Marshalling Box	BHEL, Bhopal
		Pyrotech, Udaipur
		C&S, Noida
		United Industrial Components Co., Navi Mumbai
		Ashoka Electronic, Bhopal
		Own make subject to valid type test report
13.	Terminal Connector	Nootan, Vadodara
		Milind Engineering, Mumbai
14.	Bucchohz Relay	EMB,Germany
15.	OTI/WTI	Perfect Control, Chennai
		Precimeasure, Bangalore
16.	OLTC	BHEL, Bhopal
		CTR, Pune
		ABB, Sweden
		Easun MR, Chennai
17.	Radiators	CTR, Pune
		Transpares, Ahmedabad
		Hi Tech Radiators, Mumbai
		Thermal Transfer, Bangalore
		Gururaj Radiators Pvt. Ltd., Naini
18	Silicagel Breather (Maintenance free)	MESSKO,ABB
19.	Fibre Optic Sensor	Rugged Monitoring Inc, Canada,Qualitrol
20.	Valves	Leader Valves, Jalandhar
		GG Valves Ltd, Udaipur
		Petson Valves, Coimbatore
21.	PRV (Pressure Release Valve)	Sukrut, Pune
		Qualitrol Company, USA
		MESSKO, Germany

22.	Cooling fan	Marathon, Kolkata
		Khaitan, Kolkata
		CGL

10. Submission Requirements

Interested bidders for empanelment with BSPTCL shall submit their response to this EOI in prescribed formats along with supporting documents as detailed below:

9.1 Mandatory Documents

The bidder shall submit the following:

- a) Company Profile including organizational structure, list of manufacturing & test facilities, annual manufacturing capacity etc.
- b) Credentials covering details of past supplies/ performance certificates/ short circuit test reports etc. to evaluate capability of vendor to undertake the work
- c) List of major completed and ongoing orders with client details, voltage class, rating, and execution status.
- d) Quality assurance documents including ISO-9001 certification, typical manufacturing quality plan, typical vendor list, related documents for their scope of work are required
- e) Performance report
- f) Technical Proposal including:
 - i) Design document.
 - ii) Bill of materials.
 - iii) Guaranteed Technical Particulars (GTP)
 - iv) Drawings (indicative)
 - v) Quality Assurance Plan (QAP) and Inspection & Testing Plan (ITP)
 - vi) Valid Type Test Reports for similar or higher rating transformers
 - vii) Copies of ISO Certifications (ISO 9001, 14001, 45001/OHSAS)
- g) Financial Documents:
 - i) Audited balance sheets for last 3 years
 - ii) Turnover and net worth details
 - iii) Undertaking for non-blacklisting/debarment
 - iv) Authorization certificate (if applicable)
 - v) Any other relevant document supporting technical and financial capability

9.2 Detailed Technical Submission

The technical proposal shall include, but not be limited to:

- a) Transformer type, rating, and voltage class (400 kV to 33 kV) Guaranteed technical parameters (losses, impedance, efficiency, etc.)
- b) Cooling system details (ONAN/ONAF/ODAF etc.)
- c) Insulation system and dielectric design
- d) Short circuit withstand capability
- e) Details of core, winding, and tank construction.
- f) Details of accessories (OLTC, bushings, protection devices, etc.)
- g) Testing details:
- h) Routine tests.
- i) Type tests.
- j) Special tests.
- k) Transportation and erection methodology.
- l) Installation, commissioning, and maintenance approach

9.3 Manufacturing & Quality Details

- a) Details of manufacturing facilities and installed capacity.
- b) List of major plant & machinery.
- c) Quality control procedures and stage inspection plan

9.4 Performance & Field Experience

- a) List of transformers supplied and in successful operation.
- b) Performance certificates from utilities/clients.
- c) Failure history (if any) and corrective measures taken

9.5 Compliance & Declarations

- a) Compliance to technical specifications and standards (IS/IEC).
- b) Deviation statement (if any).
- c) Integrity Pact (if applicable)

11. Submission Process:

Mode of Submission

The bidder shall submit the EOI response online through e-procurement portal: <https://eproc2.bihar.gov.in> .Online submission is mandatory. No offline submission shall be accepted.

Registration on Portal

Bidders must register themselves on the e-procurement portal prior to submission and obtain valid login credentials.

Submission Format

The bidder shall submit Eligibility documents, Technical proposal, supporting documents in standard formats available on the portal and as prescribed in Annexures.

Document Upload

All documents shall be Scanned clearly Digitally signed, Uploaded in prescribed format, The bidder shall be fully responsible for Authenticity, Legibility, Completeness of documents

EOI-Specific Attachments

Bidders must upload all EOI-specific Annexure duly filled and signed

Multiple Package / Lot Participation

Bidders may apply for one or multiple transformer ratings/voltage classes. Evaluation shall be done package-wise based on Technical capability, financial strength, past performance.

Clarifications & Amendments

Bidders may seek clarifications within stipulated time. Corrigendum/addendum (if any) shall be published on the portal only

Deadline for Submission

EOI must be submitted within the specified date and time. Late submissions shall not be accepted under any circumstances.

Opening of EOI

EOI responses shall be opened online on the scheduled date

Confidentiality

All submitted documents shall be treated as confidential.

Disclaimer

The authority reserves the right to accept/reject any or all EOI response, cancel the EOI without assigning any reason

12. Selection Methodology & Evaluation Criteria

Screening of EOI shall be carried out as per eligibility conditions mentioned in this document and based on verification of testimonials submitted.

- List of empaneled manufacturer shall be revised after every 05 years based on their performance.

- EOI will be evaluated for short listing inter alia based on their past performance, technical and financial criteria.
- Prior to detailed evaluation of qualification requirements, BSPTCL will determine whether each manufacturer is substantially responsive to the requirements of the qualification document. For the purpose of these processes, a substantially responsive qualification is one which conforms to all the terms, conditions and requirements of the qualification documents without material deviation. Please note that the BSPTCL is no obligation to award the contract after determining such successful Bidder. BSPTCL is having right to reject any or all offers received or cancel the EOI itself.

All submissions will be evaluated based on the technical and financial eligibility criteria as mentioned in Clause 7.

13. Timeline:

The Manufacturer shall submit their time schedule for undertaking various works/activities involved in different stages of manufacturing process, inspection and supply.

14. Disclaimer & Other Conditions:

- This EOI is not an offer and is issued with no commitment. BSPTCL reserves the right to place order for supply for power transformer to one or all empaneled vendor. BSPTCL also reserves the right to disqualify any proposal without assigning any reason.
- In the event of ambiguity, BSPTCL's interpretation will be final.

15. Right to amend:

The BSPTCL reserves the right to amend or supplement the EOI, by way of addendum issued on the same e-platform, where the EOI is published. All proponents are requested to verify the e- platform from time to time. BSPTCL has no obligation to communicate to any proponent directly. The BSPTCL will notify any changes made to the EOI or to any appendices or any change in the closing date or time through web site. When these changes occur within five (5) working days of the closing date of the proposal, the EOI closing date may be extended to allow for a suitable number of days for preparation of the proposals by the proponents.

16. Confidentiality and Security

This document, or any portion thereof, may not be used for any purpose other than the submission of proposals. The Proponent must agree to maintain security standards consistent with policies of Government of Bihar and BSPTCL. These include strict control of access to data and maintaining confidentiality of information gained while carrying out their duties as per the contract.

Information pertaining to any department obtained by the proponent as a result of participation in this project is confidential and must not be disclosed without written authorization from the BSPTCL.

17. Compliance with laws

The bidder shall ensure all notices are given and all the licenses and permits are obtained, to perform the work. The bidder shall comply with all the laws applicable to the work or the performance of the contract.

18. Acceptance of proposals

The BSPTCL is not bound to accept a proposal or any proposal of those submitted. Proposals will be assessed in light of the evaluation criteria.

Subsequent to the submission of the Proposals, the negotiations may be conducted with one or more of the bidder, but there shall be no obligation to receive further information, whether in writing or oral, from any of the Proponents. The BSPTCL shall not be obligated in any manner to any bidder whatsoever until a written agreement has been duly executed relating to an accepted proposal.

19. Termination of Contract:

The failure to meet the quality requirement or reach any of the execution milestones mentioned in bid/ Allotment conditions before start of the project construction except due to uncontrollable factors such as force majeure, Government actions, change in law, natural calamity, act of God, pandemic like covid-19 etc, delay in statutory approvals and clearances subject to the satisfaction of State Govt., will result in automatic cancellation from approved vendor list of BSPTCL and forfeiture of any up-front amounts paid. No compensation would be payable to the Developers in such an instance.

20. Dispute resolution.

All matters in dispute under the contract developed from this EOI with BSPTCL may be submitted to BSPTCL, under the jurisdiction of Civil Court, Patna decision of which shall be final and binding.

Contact information.

For any queries related to this EOI, please contact:

Chief Engineer (Planning & Engineering) – BSPTCL

Mobile Number: 7763817730

ANNEXURES OF FORMAT

ANNEXURE A: CHECKLIST FOR SUBMISSION OF EOI

S.No	Enclosures to the Eoi	Status Submitted/ Not Submitted	Comments, if any
1	Letter of Expression of Interest (Annexure-B)		
2	General Information & Eligibility Compliance (Annexure-C)		
3	Technical Experience & Project Capability (Annexure-D)		
4	Site-Wise Proposal Submission Format (Annexure-E)		
5	Financial Information & Compliance Declarations (Annexure-F)		
6	Self-declaration (Annexure-G)		
7	Affidavits of self-certification regarding Minimum Local Content in line with PPP-MII Orders to be submitted by the bidders along with their bids on a Non-Judicial Stamp Paper of Rs1000/-.		
8	Company Profile. (all members in case of JV/consortium)		
9	Certificate of Incorporation. (all members in case of JV/consortium)		
10	Copy of the audited statement of accounts the last three Financial Years ending on 31-Mar-2025 (P&L Account, Audited Balance Sheet) duly certified by the Chartered Accountant.		
11	Valid Professional Tax Registration.		
12	Valid Pan Registration & copy of IT Return of last three years.		
13	Copy of GST Registration.		
14	Declaration for No blacklisting certificate' is also to be provided for Debarment/Blacklisting by BSPTCL or any of its sister or parent companies. Notifications issued by one subsidiary of BSPTCL shall automatically extend to its sister or parent companies.		

ANNEXURE-B: LETTER OF EXPRESSION OF INTEREST

(To be filled up by the Bidder)

Name of work: Invitation of Expression of Interest (EOI) for empanelment/ vendor registration for manufacturers of power/auto transformers for different projects/ direct procurement in BSPTCL-Reg

Ref: Expression of Interest No.:

To
Managing Director,
BSPTCL, Patna.

Sir,

1. I/We have downloaded the Eol document from the web site and I/We have not tampered/ modified the Eol forms in any manner. In case, if the same is found to be tampered/modified at a later stage, I/We understand that my/our Eol will be summarily rejected.
2. Having examined carefully the specifications together with the conditions of Eol & contract, Schedules and the accompaniments, I/whereby offer to carry out the works described in the said specifications, etc.
3. I/Whereby undertake to plan, organize, execute and complete the whole of the work entrusted to me/ us strictly according to the conditions of contract and the specifications, if the work is awarded.
4. If the work is awarded to me/us, I/we also undertake to execute Agreement and commence the work in terms of the Eol conditions and as directed by you.
5. I/We also undertake to abide by the instructions of the BSPTCL from time to time in carrying out the work envisaged under this Eol.

Place:

Yours faithfully,

Date:
Developer/Player

Signature of

Name of Firm & address Seal

ANNEXURE-C: GENERAL INFORMATION & ELIGIBILITY COMPLIANCE

1. General Information

S. No.	Description	Particulars
1.	Name of the Bidder & Address	
2.	Certificate of Incorporation (Attach Copy)	
3.	Type of Organization (Tick Applicable)	<input type="checkbox"/> Private Limited <input type="checkbox"/> Public Limited <input type="checkbox"/> LLP <input type="checkbox"/> Partnership <input type="checkbox"/> PSU <input type="checkbox"/> Others (Specify)
4.	GST Registration No. (Attach Copy)	
5.	PAN No. (Attach Copy)	
6.	Professional Tax Registration No. (Attach Copy)	
7.	Names & Addresses of concerned officer to whom all references shall be made	(Attach Separate Sheet if Required)
8.	Contact Person Name & Designation	
9.	Mobile No.	
10.	Email	
11.	Name, designation and address of local representative, if any	

2. Compliance with Eligibility Criteria (Tick Yes/No)

Criteria	Yes/No	Supporting Document Reference
Registered in India with Registrar of Companies/Firms		
Meets Minimum Financial Criteria (Turnover & Net Worth)		
Meets Technical Experience Criteria		
Not Blacklisted/Debarred		
Submission of Work Orders & Completion Certificates		

3. Joint Venture / Consortium Details (if applicable)

S. No.	Name of Consortium Member	Registered Address	Shareholding %	Role & Responsibility

(Attach Consortium Agreement/MoU)

ANNEXURE-D: TECHNICAL EXPERIENCE & PROJECT CAPABILITY

1. Experience of the Developer/Player

S. No.	Project Name & Location	Project Type (Generation/ Transmission)	Capacity (MW)	Start Date (Month / Year)	Year of Commissioning	Client / Authority	Approx value of services (In Rs.)

(Attach Work Orders, Completion Certificates, or other supporting documents.)

2. Approach & Methodology

S. No.	Description	Details (To be filled by the Bidder)
	Site Identification & Feasibility Study Methodology	
	Techno-Commercial Analysis Approach	
	Preliminary Design and Risk Assessment	
	Other Relevant Details (if any)	

3. Key Personnel & Technical Team

S. No.	Name	Designation	Qualification	Relevant Experience (Years)	Area of expertise	Current task assigned

(Attach Resumes of Key Personnel)

~~ANNEXURE-E: SITE-WISE PROPOSAL SUBMISSION FORMAT~~

~~(To be submitted on the Developer/Player 's letterhead, duly signed and sealed)~~

S.No	Site Name / Location	Proposed Storage Capacity (MWh)	Proposed Instantaneous Capacity (MW)	Any additional support– for local area development (e.g. Drinking Water / Irrigation / Others)
1				
2				
3				

ANNEXURE-F: FINANCIAL INFORMATION & COMPLIANCE DECLARATIONS

1. Financial Information (To be provided on the letter head of the Chartered Accountant with UDIN)

S. No.	Particulars	FY 2023-24	FY 2024-25	FY 2025-26
1.	Authorized, Subscribed & Paid-up Capital (INR Cr.)			
2.	Annual Turnover (INR Cr.)			
3.	Net Worth (INR Cr.)			

(Attach CA-certified financial statements and IT Returns for the last 3 years)

2. Litigation & Blacklisting Declaration

S. No.	Description	Yes/No	Details (if Yes, Attach Proof)
1.	Has the Bidder been blacklisted/debarred by any Government/PSU?		
2.	Is the Bidder involved in any ongoing litigation/arbitration?		
3.	Has the Developer/Player 's contract been terminated due to non-performance in the last 5 years?		

ANNEXURE-G: SELF-DECLARATION

(To be submitted on the Developer/Player 's letterhead, duly signed and sealed)

I/We, the undersigned, do hereby declare that:

1. All information furnished in this document is ****true and correct**** to the best of our knowledge.
2. We comply with the ****eligibility criteria**** as outlined in the EoI.
3. We ****agree to abide**** by all terms and conditions specified in the EoI document.
- 4.
5. We understand that ****any misrepresentation**** will lead to disqualification.

****Signature of the Authorized Signatory****

Name:

Designation:

Date:

Company Seal:

~~Annexure-H: For Installed capacity and Instantaneous Peak Transmission~~

Name of Village (Site):- _____ Name of Block:- _____

Name of District:- _____

S. No.	Alternatives	Gross Head (m)	Length of WCS (m)	IC (MW)	Overall L/H Ratio	Project Cost (Tentative)	Submergence Area (Ha)	
						Rs. Cr/MW	Upper Reservoir	Lower Reservoir
1.	Alternative-I							
2.	Alternative-II							
3.	Alternative-III							

**21. TECHNICAL SPECIFICATION FOR
50 MVA, 132/33 KV POWER TRANSFORMER**

1. Table of Content

2. GENERAL TECHNICAL REQUIREMENTS FOR SUPPLY OF POWER TRANSFORMERS

2.01 SCOPE

2.02 LIST OF CODES/STANDARDS/REGULATIONS/PUBLICATIONS

2.03 DRAWINGS

2.04 SCOPE OF DESIGN REVIEW

2.05 INSTRUCTION MANUALS

2.06 DESIGN AND CONSTRUCTION DETAILS

2.07 CLIMATE AND ISOCRERAUNIC CONDITION

3. Design Review

3.01 SPECIFIC TECHNICAL REQUIREMENTS

3.02 GUARANTEED AND OTHER TECHNICAL PARTICULARS

3.03 PERFORMANCE

3.04 RADIO INTERFERENCE AND NOISE LEVEL

3.05 MAXIMUM LOSSES

3.06 TYPE TESTS REQUIREMENT AND VALIDITY

4. Construction Details

4.01 TANK

4.02 FOUNDATION, ROLLER ASSEMBLY AND ANTI EARTHQUAKE CLAMPING DEVICE.

4.03 CONSERVATOR

4.04 PIPING WORKS FOR CONSERVATOR

4.05 BREATHER

4.06 PRESSURE RELIEF DEVICE :

4.07 BUCHHOLZ RELAY :

4.08 TEMPERATURE INDICATOR :

4.09 Fiber Optic System

4.10 EARTHING TERMINALS :-

- 4.11 CORE
- 4.13 WINDINGS
- 4.14 CURRENT CARRYING CONNECTIONS
- 4.15 WINDING TERMINATIONS INTO BUSHINGS
- 4.16 GAS AND OIL-ACTUATED RELAYS
- 4.17 INSULATING OIL
- 4.18 TAP MECHANISM
- 4.19 CONSTRUCTIONAL FEATURES OF COOLER CONTROL CABINET/
INDIVIDUAL MARSHALLING BOX COMMON MARSHALLING
BOX/ OUTDOOR CUBICLE/DIGITAL RTCC PANEL
- 4.20 AUXILIARY POWER SUPPLY FOR OLTC, COOLER CONTROL AND
POWER CIRCUIT
- 4.21 TRANSFORMER BUSHINGS:-
- 4.22 COOLING:-
- 4.23 CLEANING AND PAINTING

5.0 QUALITY ASSURANCE PROGRAMME

- 5.01 INTRODUCTION
- 5.02 GENERAL REQUIREMENTS - QUALITY ASSURANCE
- 5.03 QUALITY ASSURANCE DOCUMENTS
- 5.04 QUALITY DURING INSPECTION & TESTING (including virtual
inspection) AND INSPECTION CERTIFICATES
- 5.05 VIRTUAL STAGE INSPECTION & FACTORY ACCEPTANCE TEST
(FAT)

6.0 INSPECTION AND TESTING

- 6.1 FACTORY TESTS
- 6.2 TANK TESTS
- 6.3 STAGE INSPECTION
- 6.4 TYPE TESTS ON FITTINGS
- 6.5 PRE-SHIPMENT CHECKS AT MANUFACTURER'S Works

**7.0 UNLOADING OF TRANSFORMERS INCLUDING HANDLING AND
PLACEMENT ON PLINTH, ERECTION, TESTING &
COMMISSINING OF TRANSFORMERS AT SITE.**

8. SPARE PARTS & MAINTENANCE REQUIREMENTS

9. ERECTION AND MAINTENANCE TOOLS

10. VENDOR SELECTION FOR MOUNTING ACCESSORIES

ANNEXURES

ANNEXURE-A-1 GTP FOR 50 MVA 132/33 KV, 3-PHASE POWER TRANSFORMER

ANNEXURE-A-2 GTP FOR 160 MVA 220/132KV, 3-PHASE AUTO TRANSFORMER

**ANNEXURE-B-1 DETAILS OF BUSHING CT AND NEUTRAL CT FOR 50 MVA
132/33 KV, 3-PHASE POWER TRANSFORMER**

**ANNEXURE-B-2 DETAILS OF BUSHING CT AND NEUTRAL CT FOR 160 MVA
220/132KV, 3-PHASE AUTO TRANSFORMER**

**ANNEXURE-C GUARANTEED AND OTHER TECHNICAL PARTICULARS FOR
POWER TRANSFORMER**

ANNEXURE-D TEST PLAN AND PROCEDURES

ANNEXURE-E MANUFACTURING QUALITY PLAN

**ANNEXURE-G BASIC MANUFACTURING FACILITY & MANUFACTURING
ENVIRONMENT**

**ANNEXURE-J CRITERIA FOR SELECTION OF SIMILAR REFERENCE
TRANSFORMER FOR DYNAMIC SHORT CIRCUIT
WITHSTAND TEST**

**ANNEXURE-L UNUSED INHIBITED HIGH GRADE INSULATING OIL
PARAMETERS**

ANNEXURE-R 1100 V GRADE POWER & CONTROL CABLES

2. GENERAL TECHNICAL REQUIREMENTS FOR SUPPLY OF POWER TRANSFORMERS

2.01 SCOPE

This section provides for design, manufacture, assembly, inspection and testing at manufactures works before dispatch, packing, supply and delivery of power Transformers at destination substation / store complete with all fittings, accessories and associated equipment for efficient and trouble free operation as specified hereinafter, unloading at site/destination, placing on plinth, erection, testing and commissioning.

It is not the intent to specify completely herein all details of the design and manufacture of the equipment. However, the equipment shall conform in all respect to the standards of engineering, design & workmanship listed in this specification and shall be capable of performing continuous commercial operation in a manner acceptable to the purchaser who shall have power to reject the material which in his judgment is not in accordance therewith.

The equipment offered shall be complete with all components in all respects. All such components shall be deemed to be within the scope of supply irrespective of whether those are specifically mentioned in this specification and/or the commercial order or not.

The scope of work shall also include erection, testing and commissioning of the equipment to be supplied against this tender.

In case of parallel operation with the existing transformer,

- i. The impedance, vector group, OLTC connection & range etc. of the transformer is to be matched with that of the existing transformer.
- ii. Necessary provision is to be kept in the transformer control scheme for parallel operation with the existing OLTC control scheme having provision of Master/Follower/Independent /Off operation.
- iii. Matching of physical orientation, mounting rail gauge etc. to facilitate interchangeability with the existing single phase transformer.

2.02 LIST OF CODES/STANDARDS/REGULATIONS/PUBLICATIONS

A list of Codes/Standards/Regulations/Publications which shall be used for design review, manufacturing, testing, erection, transportation etc. has been given below. In case of revision/amendment of these, revised/amended versions shall be followed.

IS 2026: Part 1 : 2011 (Reaffirmed Year : 2016)	-	Power transformers: Part 1 General
IS 2026: Part 2 : 2010 (Reaffirmed Year : 2020)	-	Power transformers Part 2 Temperature-rise

IS 2026: Part 3 : 2018	-	Power Transformers Part 3 Insulation Levels, Dielectric Tests and External Clearances in Air (Fourth Revision)
IS 2026: Part 4 : 1977 (Reaffirmed Year : 2016)	-	Power transformers: Part 4 Terminal marking, tappings and connections
IS 2026 : Part 5 : 2011 (Reaffirmed Year : 2016)	-	Power Transformers Part 5 Ability to Withstand Short Circuit
IS 2026 : Part 6 : 2017	-	Power Transformers Part 6
IS 2026 : PART 7 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers Part 7 Loading Guide for Oil-Immersed Power Transformers
IS 2026 : Part 8 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers : Part 8 Applications guide
IS 2026 : Part 10 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers : Part 10 Determination of sound levels
IS 2026 : Part 10 : Sec 1 : 2018	-	Power Transformers part 10 Determination of Sound Levels Section 1 Application guide
IS 2026 : Part 14 : 2018	-	Power Transformers Part 14 Liquid- Immersed Power Transformers Using High- Temperature Insulation Materials
IS 2026 : Part 18 : 2018	-	Power Transformers Part 18 Measurement of Frequency Response
IEC 60076 All parts	-	Power Transformers
IS 3024 : 2015	-	Grain Oriented Electrical Steel Sheet and Strip (Third Revision)
IS 8468 : Part 1 : 2018 IEC 60214-1 : 2014	-	Tap-Changers Part 1 Performance Requirements and Test Methods (First Revision)
IEC / IEEE 60214-2:2019		Tap-changers- Part 2: Application guidelines
IS 8478 : 1977 (Reaffirmed Year : 2016)	-	Application guide for on-load tap changers

IS 649 : 1997 (Reaffirmed Year : 2018)	-	Methods for testing steel sheets for magnetic circuits of power electrical apparatus
IS-10028 (Part 1, 2 & 3)	-	Code of practice for selection, installation & maintenance of transformer
IS 3639 : 1966 (Reaffirmed Year : 2016)	-	Fittings and Accessories for Power Transformers
IS 3637 : 1966 (Reaffirmed Year : 2016)	-	Gas Operated Relays
IS 335 : 2018	-	New Insulating Oils — Specification (Fifth Revision)
IEC 60296-2020	-	Fluids for Electrotechnical applications – Mineral insulating oils for electrical equipment
IEC 60422 : 2013	-	Mineral insulating oils in electrical equipment - Supervision and maintenance guidance
IS 6792 : 2017	-	Insulating Liquids - Determination of the Breakdown Voltage at Power Frequency - Test Method (Second Revision)
IS/IEC 60137 : 2017	-	Bushings for alternating voltages above 1000 Volts
IS 12676 : 1989 (Reaffirmed Year : 2016)	-	Oil Impregnated Paper Insulated Condenser Bushings - Dimensions and Requirements
IS 4257 : Part 1 : 1981 (Reaffirmed Year : 2019)	-	Dimensions for Clamping Arrangements for Porcelain Transformer Bushings - Part I : For 12 kV to 36 kV Bushings
IS 4257 : Part 2 : 1986 (Reaffirmed Year : 2019)	-	Dimensions for clamping arrangements for porcelain transformer bushings: Part 2 For 72.5 kV and 123 kV bushings
IS 8603 : 2008 (Reaffirmed Year : 2019)	-	Dimensions for porcelain transformers bushings for use in heavily polluted atmospheres 12/17.5kV, 24kV and 36kV
IS 8603 : Part 4 : 2003 (Reaffirmed Year : 2019)	-	Dimensions for Porcelain Transformer Bushings for Use in Heavily Polluted Atmospheres - Part 4 : 52 kV Bushings
ANSI-C57.12.80	-	General requirements for Distribution, Power and Regulating Transformers

ANSI-C57.12.90	-	Test Code for Distribution, Power and Regulation Transformers
NEMA-TR-1	-	Transformers, Step Voltage Regulator
IS 1747 : 1972 (Reaffirmed Year : 2016)	-	Nitrogen
IS-5: 2007	-	Colors for Ready Mixed Paints and Enamels
IS 3043 : 2018	-	Code of Practice for Earthing
IS 8263 : 2018	-	Radio Interference Test on High -Voltage Insulators (First Revision)
IS 8269 : 1976 (Reaffirmed Year : 2014)	-	Methods for switching impulse tests on high voltage insulators
IS 2071 : Part 1 : 2016	-	High-voltage Test Techniques Part 1 General Definitions and Test Requirements (Third Revision)
IS 16803 : 2018	-	High Voltage Test Techniques - Measurement of Partial Discharges by Electromagnetic and Acoustic Methods
IS/IEC 60270 : 2000 (Reaffirmed Year : 2016)	-	High — Voltage Test Techniques — Partial Discharge Measurements
IS 13235 : Part 1 : 2019	-	Short-Circuit Currents — Calculation of Effects Part 1 Definitions and Calculation Methods (First Revision)
IS 13235 : Part 2 : 2019	-	Short-Circuit Currents — Calculation of Effects Part 2 Examples of Calculation (First Revision)
IS 16227 : Part 1 : 2016 IEC 61869-2 : 2007	-	Instrument Transformers: Part 1 General requirements
IS 16227 : Part 2 : 2016 IEC 61869-2 : 2012	-	Instrument Transformers Part 2 Additional Requirements for Current Transformers

IS 16227 : Part 100 : 2018	-	Instrument Transformers Part 100 Guidance for Application of Current Transformers in Power System Protection
IS/IEC 60529 : 2001 (Reaffirmed Year : 2019)	-	Degrees of protection provided by enclosures (IP CODE)
IS/IEC-60947	-	Low voltage switchgear and control gear
IS 2062 : 2011 (Reaffirmed Year : 2016)	-	Hot Rolled Medium and High Tensile Structural Steel
IS 9595 : 1996 (Reaffirmed Year : 2019)	-	Metal arc welding of carbon and carbon manganese steels - Recommendations
IS 10801 : 1984 (Reaffirmed Year : 2016)	-	Recommended procedure for heat treatment of welded fabrications
IS 4253 : Part 1 & 2 : 2008 (Reaffirmed Year : 2019)	-	Cork Composition Sheets
IS 11149 : 1984 (Reaffirmed Year : 2019)	-	Rubber Gaskets
IS 12444 : 1988 (Reaffirmed Year : 2015)	-	Continuously cast and rolled electrolytic copper wire rods for electrical conductors
IS 513 : 2016	-	Cold Reduced Carbon Steel Sheet and Strip
IS 12615 : 2018	-	Line Operated Three Phase A.C. Motors (IE CODE) "Efficiency Classes and Performance Specification" (Third Revision)
IS/IEC 60034 : PART 5 : 2000 (Reaffirmed Year : 2018)	-	Rotating electrical machines : Part 5 Degrees of protection provided by the integral design of rotating electrical machines (IP CODE) - Classification
IS 5561 : 2018	-	Electric Power Connectors- Specification
IS 2932 : Part 1 : 2013 (Reaffirmed Year : 2018)	-	Enamel, Synthetic, Exterior : (a) Undercoating (b) Finishing - Specification : Part 1 for Domestic and Decorative Applications

IS 2074 : Part 1 : 2015	-	Ready Mixed Paint, Air Drying, Red Oxide - Zinc Chrome, Priming - Specification
IS 3400	-	Methods of Test for Vulcanized Rubber
IS 456 : 2000 (Reaffirmed Year : 2016)	-	Plain and Reinforced Concrete - Code of Practice (Including Amendment 1, 2, 3,& 4)
IS 13238 : 1991 (Reaffirmed Year : 2017)	-	Epoxy Based Zinc Phosphate Primer (two Pack)
IS 2848 : 1986 (Reaffirmed Year : 2016)	-	Industrial Platinum Resistance Thermometer Sensors
IS/IEC 61850	-	Communication Networks and Systems for Power Utility Automation
IS 16683 : Part 1, 2 & 3 : 2018	-	Selection and Dimensioning of High Voltage Insulators Intended for Use in Polluted Conditions
IEEE 1538-2000		Guide for determination of maximum winding temperature rise in liquid filled transformers
IEEE Standard C57.156- 2016		Guide for tank rupture mitigation of oil immersed transformers
IEEE Standard C57.150- 2012		Guide for Transformer Transportation
IEEE Standard C57.149- 2012		Guide for the application and interpretation of Frequency Response Analysis of oil immersed transformers
IEEE Standard C57.104- 2019		Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers
IEC 60599-2015		Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis
IEEE Std. C57.12.10 - 2017	-	Standard requirements for liquid immersed power transformers
IEEE Std. 57.104-2019		Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers

IEC 60599		Mineral oil-filled electrical equipment in service – Guidance on the interpretation of dissolved and free gases analysis
IEEE Std. 62-1995		Guide for Diagnostic Field Testing of Electric Power Apparatus - Part 1: Oil Filled Power Transformers, Regulator
CIGRE Technical Brochure No. 529 -2013		Guide lines for conducting design reviews for Power Transformers
CIGRE Technical Brochure No. 673-2016		Guide on Transformer Transportation
CIGRE Technical Brochure No. 530-2013		Guide for conducting factory capability assessment for Power Transformers
CIGRE Technical Brochure No. 761 (WG A2.49)		Condition assessment of power transformers
CIGRE TB 209		Short Circuit Performance of Power Transformers
CIGRE TB 436		Experiences in service with new insulating liquids
Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations		
Central Electricity Authority (Technical Standard for Construction of Electrical Plants and Electric Lines) Regulations		
Central Electricity Authority (Installation and Operation of Meters) Regulations		
CBIP Manual on Transformers (Publication No. 317)		
ISO 9001: Quality System – Model for Quality Assurance in Design/Development.		
ISO-14001 (Environmental Management System)		
OHSAS 18001 (Occupational Health and Safety Management System)		

In case of difference in provision between IEC and ISS, the stringent one shall be followed.

2.03 DRAWINGS

LIST OF DRAWINGS/DOCUMENTS TO BE SUBMITTED BY THE MANUFACTURER

Each drawing shall be identified by a drawing number and each subsequent resubmission/revision or addition to the drawing shall be identified by a revision number. All drawings shall be thoroughly checked for accuracy & completeness and signed. Any mistakes or errors in drawings shall not form a basis for seeking extension of delivery period.

In addition to any other drawings which the manufacturer may like to supply the following drawings/calculations/documents/ catalogues shall be submitted in hard and soft copy:

- (a) Guaranteed Technical Particulars (GTPs) and other Technical particulars
- (b) Rating and Diagram Plate giving details of terminal marking and connection diagram
- (c) General Arrangement (GA) drawing (as built drawing) of transformer showing Plan, Elevation, End view (left side & right side view looking from HV side) and 3D view identifying various fittings & accessories, dimensions, weight, clearances, quantity of insulating oil, centre of gravity etc.
- (d) View showing maximum lifting height of core-coil assembly and maximum clearance over tank top required for taking out the bushing.
- (e) List of all accessories, description, make, weight and quantity
- (f) Bill of Materials (BoM) with description, make & quantity
- (g) Foundation Plan showing Rail gauge, fixing details of foundation bolts, clamping arrangement to restrict movement during earthquake & location of jacking pads and loading details
- (h) Bushing Drawing showing dimensions, electrical & mechanical characteristics, mounting details and test tap details (as applicable)
 - i) HV Bushing
 - ii) LV Bushing
 - iii) Neutral Bushing

- (i) Transport Dimension Drawing indicating transport weight, transport condition (oil filled/gas filled), lifting bollards, jacking pads, pulling eyes, quantity and location of impact recorder etc.
- (j) General Arrangement Drawing of Cooler Control Cabinet, Marshalling box
- (k) General Arrangement Drawing of RTCC/Digital RTCC panel
- (l) GA drawing for Junction Box
- (m) GA drawing for Cable Box
- (n) Cooler Control Scheme: Schematic wiring diagram of cooling arrangement along with write up on scheme
- (o) Tap Changer Control Scheme :Schematic wiring diagram of OLTC along with write up on scheme
- (p) Mounting Arrangement and wiring diagram of remote WTI along with write up.
- (q) Alarm/Trip Indication Scheme
- (r) Valve Schedule Plate drawing showing all valves, air vents, drain plugs etc. with type, size, material and quantity of valves
- (s) Technical literature of all fittings and accessories
- (t) Calculation in support of thermal withstand capability of transformer due to short circuit
- (u) Calculation of hot spot temperature
- (v) Value of air core reactance with a typical write-up of calculation
- (w) Magnetization Characteristics of bushing CTs and neutral CTs
- (x) Hysteresis Characteristics of iron core**
- (y) Over fluxing withstand duration curve**
- (z) Typical heating and cooling curves**

- (aa) Drawing showing winding arrangement & geometrical sequence w.r.t core with winding ID/OD, height & separation distance between windings etc.**
- (bb) Twin bi-directional roller assembly drawing**
- (cc) Oil Flow Diagram**
- (dd) List of spares**
- (ee) Connection diagram of all protective devices to marshalling box showing physical location**
- (ff) Customer inspection schedule**
- (gg) Test procedure of transformer**
- (hh) Manufacturer Quality Program (MQP) and Field Quality Plan (FQP)**
- (ii) Type test reports**
- (jj) O&M manual (hard copy and soft copy) of transformer inter-alia including instructions for Aircell, Oil filling, Bushing removal and Core Coil Assembly un-tanking etc.**

2.04 SCOPE OF DESIGN REVIEW

Description
1. Core and Magnetic Design
2. Over-fluxing characteristics up to 1.7 Um (for transformer)
3. Inrush-current characteristics while charging
4. Winding and winding clamping arrangements
5. Characteristics of insulation paper
6. Typical data and parameters mentioned in GTP
7. Short-circuit withstand capability including thermal stress / withstand capability for 2 seconds
8. Thermal design including review of localized potentially hot area
9. Structural design
10. Cooling design
11. Overload capability

12. Calculations of losses, flux density, core quantity etc.
13. Calculations of hot spot temperature
14. Eddy current losses
15. Seismic design, as applicable
16. Insulation co-ordination
17. Tank and accessories
18. Bushings
19. Mechanical layout design including lead routing and bushing termination
20. Tapping design
21. Protective devices
22. Number, locations and operating pressure of PRD
23. Location, Operating features and size of Sudden Pressure Relay/ Rapid Pressure Rise Relay
24. Radiators ,Fans and Pumps
25. Sensors and protective devices– its location, fitment, securing and level of redundancy
26. Oil and oil preservation system (if applicable)
27. Corrosion protection
28. Electrical and physical Interfaces with substation
29. Earthing (Internal & External)
30. Processing and assembly
31. Testing capabilities
32. Inspection and test plan
33. Transport and storage
34. Sensitivity of design to specified parameters
35. Acoustic Noise
36. Spares, inter-changeability and standardization
37. Maintainability
38. Conservator capacity calculation
39. Winding Clamping arrangement details with provisions for taking it “in or out of tank”
40. Conductor insulation paper details
41. Location and numbers of Optical temperature sensors (if provided)
42. The design of all current connections
43. Location & size of the Valves
44. Manufacturing facilities and manufacturing environment (clean, dust free, humidity controlled environment)

- 2.04.1 All drawings should be in ink and suitable for microfilming. The drawings shall include the following information.
- a) Dimensions and Tolerance on dimensions.
 - b) Material designation used for different components with reference to standards.
 - c) Fabrication details such as welds, finishes and coatings.
 - d) Catalogue or part number for each component and the total assembly with bill of materials.
 - e) Identification Marking
 - f) Weight of individual components and total assembled weight.
 - g) All dimensions and date shall be in S.I Units.
- 2.04.2 The successful tenderers within 30 (thirty) days after placement of the order, shall furnish six sets of the following drawings for the approval of the purchaser. The drawing in autocad should also be submitted.
- 2.04.3 The purchaser shall communicate his approval/ comment on the drawings to the supplier within reasonable period. **The supplier will depute his engineer for having discussion and design review. In case any modification is required according to the purchaser's comments, the supplier shall modify the drawings and resubmit six copies of the modified drawings for purchaser's approval within one weeks from the date of communication of comments on the drawings.**
- 2.04.4 The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviations shall be permitted without written approval of the purchaser. All manufacturing & fabrication prior to the approval of the drawing shall be at the supplier's risk.

2.05 INSTRUCTION MANUALS

The supplier shall furnish 06 (six) copies of operation, maintenance and erection manual per unit of transformer to the office of the Chief Engineer (Planning & Engineering), Bihar State Power Transmission Co. Ltd. The manuals shall be bound volumes and shall contain the following documents/information.

- i. Instructions regarding erection, commissioning operation and maintenance of the equipment.
- ii. All relevant information and drawings pertaining to the main equipment as well as auxiliary devices.
- iii. Marked erection drawing identifying the component parts of the equipment as shipped to enable the purchaser to carry out the erection of the equipment with his own personnel.
- iv. Detailed dimensions, assembly and description of all the components.
- v. Apart from the above, each manual shall also contain one set of all the approved drawings, type test reports as well as acceptance/inspection test reports and routing test reports of the corresponding consignment dispatched.

Note :- These manuals shall be invariably furnished to the office of the Chief Engineer (Planning & Engineering), BSPTCL, Patna before dispatch of the transformers.

2.06 DESIGN AND CONSTRUCTION DETAILS

The design and workmanship shall be in accordance with the best engineering practices ensure satisfactory performance throughout the service life.

Any material and equipment not specifically stated in this specification but which are necessary for satisfactory operation of the equipment shall be deemed to be included unless specifically excluded and shall be supplied without any extra cost.

Components having identical rating shall be interchangeable.

2.07 CLIMATE AND ISOCRERAUNIC CONDITION:

The climate and Isoceraunic conditions at site are given below:

(i)	Maximum ambient temperature in shade	-	50° C
(ii)	Minimum ambient temperature in shade	-	40 ° C
(iii)	Maximum daily average ambient temperature	-	35°C
(iv)	Maximum yearly average ambient temperature	-	30° C
(v)	Maximum relative humidity	-	100%
(vi)	Average number of thunderstorm days	-	80 P/U
(vii)	Average rainfall per annum	-	125 cm.
(viii)	Maximum wind pressure	-	150 Kg. /M2
(ix)	Height above sea level	-	Not
	exceeding1000 m		
(x)	Earthquake acceleration	-	0.05x2g.

3. Design Review

3.01 SPECIFIC TECHNICAL REQUIREMENTS

The technical parameters of the Transformer are detailed in Annexure-A: Specific Technical Requirements.

3.02 GUARANTEED AND OTHER TECHNICAL PARTICULARS

The manufacturer shall furnish all the Guaranteed and other technical particulars for the offered transformer as called for in Annexure-C: (format of GTP) Guaranteed and Other Technical Particulars. The particulars furnished by the manufacturer in this Annexure shall make basis for the design review. Any other particulars considered necessary may also be given in addition to those listed in that Annexure.

3.03 PERFORMANCE

3.03.1 The power transformers shall be **used for bi-directional flow of rated power.**

3.03.2 Transformers shall be capable of operating under natural cooled condition (ONAN) up to the specified load. The forced cooling equipment, wherever specified, shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate in forced cooling mode initially as ONAF up to specified load. **The Cooling system shall be so designed that the transformer shall be able to operate at full load for at least ten(10) minutes in the event of total failure of power supply to cooling fans without the calculated winding hot spot temperature exceeding 140 deg C.** If the Transformer is fitted with two cooler banks, each capable of dissipating 50 per cent of the loss at continuous maximum rating, it shall be capable of operating for 20 minutes at full load /continuous maximum rating in the event of failure of the fans/blowers associated with one cooler bank without the calculated winding hot spot temperature exceeding 140 deg C. The contractor shall submit supporting calculations for the above and the same shall be reviewed during design review.

3.03.3 The transformer shall be **free from any Electrostatic Charging Tendency (ECT)** under all operating conditions and maximum oil velocity shall be such that it does not lead to static discharges inside the transformer while all coolers are in operation.

3.03.4 The transformers shall be capable of **operating continuously** at the rated MVA without danger, **at any tapping with voltage variation of ±10%**

corresponding to the voltage of that tapping.

3.03.5 The transformers shall be capable of being overloaded in accordance with IEC 60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

3.03.6 The **hotspot temperature in any location of the tank shall not exceed 110 degree Celsius** at rated MVA. This shall be measured during temperature rise test at manufacturer's works.

3.03.7 The **maximum flux density** in any part of the core and yoke **at the rated MVA, voltage and frequency** shall be such that **under 10 % continuous over-voltage condition it does not exceed 1.9 Tesla at all tap positions.**

3.03.8 The transformer and all its accessories including bushing/built in CTs etc. shall be designed to withstand the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding without damage. **The transformer shall be designed to withstand the thermal stress due to short circuit for duration of 2 seconds** and the same shall be verified during design review.

3.03.9 The following short circuit level shall be considered for the HV & LV System to which the transformers will be connected:

220 kV system	-40 kA for 1 sec (sym, rms, 3 phase fault)
132kV system	- 40 kA for 1 sec (sym, rms, 3 phase fault)
33kV system	- 31.5 kA for 1 sec (sym, rms, 3 phase fault)

However, for transformer design purpose, the through fault current shall be considered limited by the transformer self-impedance only (i.e. $Z_s = 0$).

3.03.10 Transformer shall be capable of withstanding thermal and mechanical stresses due to symmetrical and asymmetrical faults on any terminals.

Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault with rated voltage applied to HV and LV terminals of the transformer. The short circuit shall alternatively be considered to be applied to each of the HV and LV transformer terminals.

3.03.11 Transformers shall withstand, without damage, heating due to the combined voltage and frequency fluctuations which produce the following over fluxing conditions:

- 110 % continuously
- 125 % for 1 minute
- 140 % for 5 seconds

Withstand time for 150% & 170% over fluxing condition shall be indicated. Over fluxing characteristics up to 170 % shall be submitted.

3.03.11 The winding hot spots shall be calculated considering the maximum

localized losses, insulation thickness at the maximum loss and the oil flow patterns in the winding. The oil temperature rise in the windings shall be used to determine hot spots rather than the bulk top oil temperature. The hot spot for all leads shall be calculated and it shall not exceed the calculated hot spot of the windings.

3.03.12 Tank hotspot temperature under over voltage condition specified above shall **not exceed 110 deg C** considering maximum ambient temperature as 50 deg C.

3.03.13 Also, the most onerous temperature of any part of the core and its supporting structure in contact with insulation or non-metal material shall not exceed the safe operating temperature of that material. Adequate temperature margins shall be provided to maintain long life expectancy of these materials.

3.04 Radio Interference and Noise Level

The transformer shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth harmonics so as to minimise interference with communication circuits.

The noise level of transformer, when energised at normal voltage and frequency with fans and pumps running shall not exceed the values specified at Annexure- A, when measured under standard conditions.

3.05 MAXIMUM LOSSES

The maximum permissible losses (No load loss, I^2R loss, auxiliary loss and load loss) at rated voltage/current (at 75 deg C) have been specified in Annexure-A for various ratings of transformers covered under this specification. **Following penalties shall be levied on the manufacturer/contractor (as the case may be) if losses measured during routine test are found to be within +2% tolerance of the losses specified in Annexure-A, beyond which the transformer shall be liable for rejection. No benefit shall be given for supply of transformer, with losses (measured during routine tests) less than the losses specified in Annexure -A.**

<u>S.</u> <u>No</u>	Differential of specified losses vs Measured losses	RATE (in INR per KW)
1	No load Loss	Rs. 10,00,000/KW
2	I^2R Losses/Load Losses (Differential of whichever loss is higher shall be considered for penalty)	Rs. 8,00,000/KW

3	Auxiliary Losses	Rs. 8,00,000/KW
Note: For a fraction of a kW, the penalty shall be applied on pro rata basis.		

3.06 TYPE TESTS REQUIREMENT AND VALIDITY

The offered transformer or the transformer, the design of which is similar to the offered transformer, should have been successfully type tested within last 5 years as on the last date of submission of bid. Manufacturer may use same or different approved make of Bushings, Tap changer and other accessories used in type tested or short circuit tested unit in their transformer. Further, type test report of transformer shall only be acceptable provided the offered transformer has been manufactured from the same plant.

DYNAMIC SHORT CIRCUIT TEST REQUIREMENT

The transformer, the design of which is similar to the offered transformer, should have been successfully tested for short circuit withstand capability as per IS 2026 Part-5 within last 5 years. The criteria for similar transformer are specified in Annexure-J of CEA guidelines (File No.CEA-PS-14-169/2/2019-PSETD Division) of transformer. The relevant Test Report/certificate shall be enclosed along with bid. Further, design review of offered transformer shall be carried out based on the design of reference transformer, which has already been subjected to Short circuit tests in lieu of repetition of Short circuit tests.

A format (forms part of Annexure-J) filled with data of a typical sample case has been prepared for reference and guidance of utility to compare a Short Circuit tested transformer with the offered transformer in order to verify the similarity criteria as per Annexure J.

Central Electricity Authority's "Guidelines for the validity period of type tests conducted on major electrical equipment in power transmission system" shall be followed for details regarding the validity of type tests.

4. Construction Details

4.01 TANK

- 4.01.1** The tank shall be of proven design of either **Bell type with bolted/ welded joint or conventional (preferable) with bolted/welded top cover. Bell type tank, if provided, shall have joint as close as possible to the bottom of the tank.**
- 4.01.2** The tank shall be designed in such a way that **the Transformer can be rested on concrete plinth foundation directly or on roller assembly.**
- 4.01.3** Tank shall be fabricated from tested quality low carbon steel of adequate thickness. Unless otherwise approved, metal plate, bar and sections for fabrication shall comply with IS 2062.
- 4.01.4** The base of each tank shall be so designed that it shall be **possible to move the complete transformer unit by skidding in any direction without damage when using plates or rails** and the base plate shall have following minimum thickness.

Length of tank (m)	Minimum plate thickness (mm)
Flat bases	
Over 2.5 m but less than 5m	20
Over 5 m but less than 7.5m	26
Over 7.5 m	32

- 4.01.5** Tank shall be capable of withstanding, without damage, severe strains that may be induced under normal operating conditions or forces encountered during lifting, jacking and pulling during shipping and handling at site or factory. Tank, tank cover and associated structure should be adequately designed to withstand, without damage or permanent deflection / deformation, the forces arising out of normal oil pressure, test pressures, vacuum, seismic conditions and short circuit forces specified.
- 4.01.6** All seams and joints which are not required to be opened at site, shall be factory welded, and **shall be double welded** [i.e. with a continuous cord on both sides of the plate (inside and outside of the tank), bottom & cover of the tank, turrets, flanges, etc.] to ensure adequate strength. **Butt welds on parts that are mechanically stressed or under pressure must have full penetration.** Welding shall conform to IS 9595. The requirement of post weld heat treatment of tank/stress relieving shall be based on recommendation of IS 10801.
- 4.01.7** The welded joint shall be provided with flanges suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent

excessive temperature rise at the joint.

- 4.01.8** Tank stiffeners shall be provided for general rigidity and welded to the tank continuously along its ends and sides (Intermittent welds will not be accepted). These shall be designed to prevent retention of water. Sharp edges on stiffeners should be avoided for better paint adhesion.
- 4.01.9** **Tank MS plates of thickness >12 mm should undergo Ultrasonic Test (UT) to check lamination defect, internal impurities in line with ASTM 435 & ASTM 577.**
- 4.01.10** After fabrication of tank and before painting, **Non-destructive test (dye penetration test) is mandatory on the load bearing members** such as base plate joints, jacking pads and lifting devices etc.
- 4.01.11** Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the covers & windings and the bottom of the tank for collection of any sediment.
- 4.01.12** Tank should be provided with adequately sized inspection covers, either in circular shape or in rectangular shape, preferably **at diagonally opposite sides of the tank** to access the active part **and one at each end of the tank cover for easy access of the** lower end of the bushings, earthing connections and tap changers etc. for inspection. Inspection covers shall be bolted type and shall not weigh more than 25 kgs. Handles shall be provided on the inspection cover to facilitate its lifting.
- 4.01.13** The tank cover shall be provided with pockets for oil and winding temperature indicators. The location of pockets (for OTI, WTI & RTDs including two spare pockets) shall be in the position where oil reaches maximum temperature. Further, it shall be possible to remove bulbs/probes of OTI/WTI/RTD without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.
- 4.01.14** It should be possible to inspect Buchholz relay or Oil surge relay, standing on tank cover or suitable arrangement shall be made to access Buchholz relay safely.
- 4.01.15** The tank cover shall be designed to prevent retention of rain water Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.
- 4.01.16** Minimum four symmetrically placed lifting lugs of adequate size shall be provided so that it will be possible to lift the complete transformer when filled with oil & without structural damage to any part of the transformer. The factor of safety at any lug shall not be less than 2. Suitable haulage holes shall also be provided.
- 4.01.17** **A minimum of four jacking pads (not fouling with rail, rollers or other accessories) shall be provided in accessible position** to enable the transformer complete with oil to be raised or lowered using hydraulic jacks.

The location shall be such that it should not interfere with loading & unloading from trailer.

4.01.18 Each jacking pad shall be designed with an adequate factor of safety to support at least half of the total mass of the transformer filled with oil in addition to maximum possible misalignment of the jacking force to the centre of the working surface.

4.01.19 The tank shall be provided with suitable valves as specified below. Location of valves shall be finalized during design review.

Sr. No.	Description of Valve	Type
1	Drain Valve	Gate
2	Filter valve	Gate
3	Sampling Valve	Globe
4	Radiator isolation valve	Butterfly
5	Buchholz relay isolation valve	Gate
6	Sudden pressure relay	Gate
7	OLTC- tank equalizing valve	Gate / Needle
8	OLTC Drain cum filling valve	Gate
9	Valve for vacuum application on Tank	Gate
10	Conservator Drain valve	Gate
11	Aircell equalizing valve	Gate/Globe/Ball
12	Valve for Conservator vacuum (top)	Gate
13	Filter valve for Cooler Bank (Header)	Gate
14	Cooler Bank isolation valve	Butterfly
15	Pump Isolation valve	Butterfly

4.01.20 The tank cover and bushing turret shall be fixed to the transformer using copper links in such a way that good electrical contact is maintained around the perimeter of the tank and turrets.

4.01.21 The transformer shall be provided with a suitable diameter pipe flange, butterfly valve, bolted blanking plate and gasket at the highest point of the transformer for maintaining vacuum in the tank.

4.01.22 **Gas venting:** The transformer cover and generally the internal spaces of the transformer and all pipe connections shall be designed so as to provide efficient venting of any gas in any part of the transformer to the Buchholz relay. The space created under inspection /manhole covers shall be filled with suitable

material to avoid inadvertent gas pockets. The Covers shall be vented at least at both longitudinal ends. The design for gas venting shall take into accounts the slopes of the plinth (if any) on which the transformer is being mounted.

- 4.01.23 Gasket for tank & cover:** All gasketed joints shall be designed, manufactured and assembled to ensure long-term leak proof and maintenance free operation. All gasketed joints shall preferably be O-ring and designed with gasket-in-groove arrangement. If gasket/O-rings are compressible, metallic stops/other suitable means shall be provided to prevent over- compression. All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. All matching flanges of gasket sealing joints should be machined (except curb joints). Gasket with intermediate stops is not acceptable. To the extent possible, the seamless gasket should be used for openings on tank/cover such as turrets, bushing, inspection covers etc. All tank gaskets/O-rings used shall be of NBR (Acrylonitrile Butadiene Rubber) suitable for temperature conditions expected to be encountered during operation. The gasket material and additives should be fully compatible with transformer insulating fluid/oil. The gasket should not contain oil soluble sulphur compounds. The properties of all the above gaskets/O-Rings shall comply with the requirements of type-IV rubber of IS-11149. Gaskets and O-rings shall be replaced every time whenever the joints are opened.

4.02 Foundation, Roller Assembly and Anti Earthquake Clamping Device.

4.02 Foundation, Roller Assembly and Anti Earthquake Clamping Device.

- 4.02.1 Transformer shall be placed on foundation either directly or on roller assembly.**
- 4.02.2** For transformer to be placed directly on foundation, one set of rollers shall be provided for movement within the yard. The rollers for transformer are to be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.
- 4.02.3 The rail track gauge shall be 1676 mm.**
- 4.02.4** To prevent movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation.
- 4.02.5** For foundation of separately mounted cooler bank of transformer, fixing of cooler support shall be through Anchor Fastener with chemical grouting and no pockets for bolting shall be provided.
- 4.02.6** For support of cooler pipes, Buchholz pipe (if required), Pre-fabricated metallic support from pit shall be provided which shall be further encased with concrete to prevent rusting.

- 4.02.7** All control cubicles shall be mounted at least one meter above Finished Ground Level (FGL) to take care of water logging during flooding. Suitable arrangement (ladder and platform) shall be provided for safe access to control cubicles.

4.03 Conservator

- 4.03.1** The conservator of main tank shall have **air cell type** constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture. Conservator shall be **fitted with magnetic oil level gauge with potential free high and low oil level alarm contacts and prismatic oil level gauge.**
- 4.03.2** **The conservator shall preferably be on the left side of the tank while viewing from HV side.**
- 4.03.3** Conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to top oil temperature of 100 deg C. The capacity of the conservator tank shall be such that the transformer shall be able to carry the specified overload without overflowing of oil.
- 4.03.4** The conservator shall be fitted with lifting lugs in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell and cleaning of the conservator as applicable.
- 4.03.5** The conservator shall be positioned so as not to obstruct any electrical connection to transformer.
- 4.03.6** Contact of the oil with atmosphere is prohibited by using a **flexible air cell of nitrile rubber reinforced with nylon cloth.** The temperature of oil in the conservator is likely to raise up to 100 Deg C during operation. As such air cell used shall be suitable for operating continuously at this temperature.
- 4.03.7** The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator. The main conservator tank shall be stenciled on its underside with the words **“Caution: Air cell fitted”**. Lettering of at least 150 mm size shall be used in such a way to ensure clear legibility from ground level when the transformer is fully installed. To prevent oil filling into the air cell, the oil filling aperture shall be clearly marked. The transformer rating and diagram plate shall bear a warning statement that the **“Main conservator is fitted with an air cell”**.
- 4.03.8** The transformer manual shall give clear instructions on the operation, maintenance, testing and replacement of the air cell. It shall also indicate shelf life, life expectancy in operation, and the recommended replacement intervals.
- 4.03.9** **The conservator tank and piping shall be designed for complete vacuum/filling of the main tank and conservator tank.** Provision must be made for equalizing the pressure in the conservator tank and the air cell during vacuum/filling operations to prevent rupturing of the air cell.

- 4.03.10** The contractor shall furnish the leakage rates of the rubber bag/ air cell for oxygen and moisture. It is preferred that the leakage rate for oxygen from the air cell into the oil will be low enough so that the oil will not generally become saturated with oxygen. Air cells with well proven long life characteristics shall be preferred.
- 4.03.11** **OLTC shall have conventional type conservator (without aircell) with magnetic oil level gauge with potential free oil level alarm contact and prismatic oil level gauge.**
- 4.03.12** **Conservator Protection Relay (CPR)/Air cell puncture detection relay (if required)** shall be externally installed on the top of conservator to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.

4.04 Piping works for conservator

- 4.04.1** Pipe work connections shall be of adequate size preferably short and direct. Only radiused elbows shall be used.
- 4.04.2** The feed pipe to the transformer tank shall enter the cover plate at its highest point and shall be straight for a distance not less than five times its internal diameter on the transformer side of the Buchholz relay, and straight for not less than three times that diameter on the conservator side of the relay. This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than 3 degrees. The feed pipe diameter for the main conservator shall be not less than 80mm. The Gas-venting pipes shall be connected to the final rising pipe between the transformer and Buchholz relay as near as possible in an axial direction and preferably not less than five times pipe diameters from the Buchholz relay.
- 4.04.3** No metal corrugated bellow (Flexible metal system) should be used in the feed pipe connecting main tank to conservator.
- 4.04.4** A double flange valve of preferably 50 mm and 25 mm size shall be provided to fully drain the oil from the main tank conservator and OLTC conservator tank respectively.
- 4.04.5** Pipe work shall neither obstruct the removal of tap changers for maintenance or the opening of inspection or manhole covers.

4.05 BREATHER:-

The main transformer tank/conservator and OLTC tank/ OLTC conservator both shall have breather whose technical specification is mentioned below:-

Technical specification of maintenance free breather for transformers for main tank and OLTC tank both

Objective and Principle of Working of the Breather:

Dehydrating breathers work according to the following principle. When the oil conservator succions in air (e.g., due to the reduced load), the air flows through a

filter made of high-grade steel wire mesh to the inside of the device. This filter and the dust cap filter dust, sand and other dirt particles from the air. The filtered air flows through the desiccant chamber filled with colorless, moisture adsorbing pellets and are dehydrated. The dehydrated air rises further via the pipe in the oil conservator. The dehydrating breather is mounted on the pipe to the oil conservator. A suitable counter-flange must be installed on the pipe to mount the dehydrating breather. The desiccant contained in the drying assembly is dehydrated using sensors controlled by the built-in heating unit, thus obviating the need for periodic desiccant replacement.

By providing the Maintenance Free Type of Breather the objective is to achieve reduced site inspections, Cost reduction by obviating the complete process of ordering, storage and replacement of the desiccant. It also leads to no pollution and disposal problem of the used up desiccant (which is associated with the conventional pigmented silica gel) is eliminated.

Specification:

1. The main Transformer tank conservator shall be fitted with a silica gel Breather of the Maintenance-Free type, in a convenient floor height at eye level.
2. Each Silica gel breather shall be equipped with a humidity sensor, a condition based microprocessor control unit to ensure that the regeneration of the silica gel is activated only when the transformer is exhaling.
3. A stainless steel filter at the bottom shall protect the silica gel chamber against external environment influences.
4. Insect Protection for the High Grade Filter is also to be provided.
5. This condition controlled application should be environmental friendly.
6. Material of External Construction of the Breather: All external parts must be suitable for mounting for outdoor use, resistant against transformer oil and ultraviolet rays. **Salt water resistance should be made available on request.** No plastic parts shall be used in the construction of the breather.
7. Ambient Temperature: The equipment must be suitable for ambient: 0 to + 80 Deg C.
8. Degree of Protection: Minimum IP55. If the Breather need to be installed in a location where there could be sub-zero temperatures, a filter heater must be provided.
9. The control unit on the breather must be equipped with suitable heater to prevent moisture condensation.
10. The breather should be provided with status LEDs for local display. Also suitable contacts must be provided to take the signal to a remote control room.
11. The moisture and temperature measurement system (sensor) installed should be modular making it easy to replace the same if at all the same is necessary during the

- service of breather. A self-diagnostic system must be provided with LED indication and remote signal through a relay should be provided.
12. To protect against overvoltage, a micro fuse and an additional built in line filter must be provided to avoid failures caused by high-frequency interference.
 13. The control unit in the breather must provide analogue output signal of 4-20mA and also should be equipped with a USB Port for data logging.
 14. Suitable Data Logger should be also provided in the control unit.
 15. The Breather should be equipped with an optional integrated test button. This should allow to carry out a self-test at any time and to check the functions, like the relay circuits, the heating or the signal transmission in the control room.
 16. Rated Insulation Voltage:
500VAC 50 Hz, 1min., voltage supply voltage: against ground;
500VAC 50 Hz, 1min., analog output against ground; 2.5kVAC 50/60Hz, 1 min., relay contact against ground
 17. **Necessary List of Type Test Conducted and Routine Test Certificate issued by the manufacturer of the maintenance free Breather used must be provided for each supply.**

The arrangement and placement of maintenance free breather shall be such that retrofitting with conventional type breather as described above for OLTC is possible with ease. The quantity of silica gel in maintenance free breather shall depend upon the size of transformer and volume of oil contained therein. The bidders are required to indicate this in their offer.

4.06 PRESSURE RELIEF DEVICE :

One PRD of 150 mm Diameter is required for every 30000 Litres of oil. However, at least two numbers PRDs **shall be provided. Its mounting should be either in vertical or horizontal orientation, preferably close to bushing turret or cover. PRD operating pressure selected shall be verified during design review.**

PRD shall be provided with special shroud to direct the hot oil in case of fault condition. It shall be provided with an outlet pipe which shall be taken right up to the soak pit of the transformer. The size (Diameter) of shroud shall be such that it should not restrict rapid release of any pressure that may be generated in the tank, which may result in damage to equipment. Oil shroud should be kept away from control

cubicle and clear of any operating position to avoid injury to personnel in the event of PRD operation.

The device shall maintain its oil tightness under static oil pressure equal to the static operating head of oil plus 20 kPa.

It shall be capable of withstanding full internal vacuum at mean sea level. It shall be mounted directly on the tank. Suitable canopy shall be provided to prevent ingress of rainwater. One set of potential free contacts (with plug & socket type arrangement) per device shall be provided for tripping. Following routine tests shall be conducted on PRD:

- a) Air pressure test
- b) Liquid pressure test
- c) Leakage test
- d) Contact operation test
- e) Dielectric test on contact terminals

4.07 BUCHHOLZ RELAY :

Double float, reed type Buchholz relay complying with IS:3637 shall be connected through pipe between the oil conservator and the transformer tank with minimum distance of five times pipe diameters between them. Any gas evolved in the transformer shall be collected in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling while the transformer in service. **Suitable canopy** shall be provided to prevent ingress of rain water. It shall be provided **with two potential free contacts** (Plug & socket type arrangement), **one for alarm/trip on gas accumulation and the other for tripping on sudden rise of pressure.**

The Buchholz relay shall not operate during starting/stopping of the transformer oil circulation under any oil temperature conditions. The pipe or relay aperture baffles shall not be used to decrease the sensitivity of the relay. The relay shall not mal-operate for through fault conditions or be influenced by the magnetic fields around the transformer during the external fault conditions. Pressurized water ingress test for Terminal Box (routine tests) shall be conducted on Buchholz relay.

4.08 TEMPERATURE INDICATOR :

4.08.1 Oil Temperature Indicator (OTI) :

The transformer shall be provided with a dial type thermometer of about 150mm diameter for top oil temperature indication with angular sweep of 270°. Range of temperature should be 0-150°C with accuracy of ±1.5% (or better) of full scale deflection. The instruments should be capable of withstanding high voltage of 2.5kV AC rms, 50Hz for 1 minute. The terminal provided for auxiliary wiring should be Press-fit type.

The thermometer shall have adjustable, potential free alarm and trip contacts besides that required for control of cooling equipment (if any), maximum reading pointer and resetting device, switch testing knob & anti-vibration mounting grommets (for projection mounting). Type of switch (NO/NC) shall be heavy duty micro switch of 5A at 240V AC/DC. Adjustable range shall be 20-90% of full scale range. The instruments case should be weather proof with epoxy coating at all sides.

Instruments should meet degree of protection of IP55 as per IS/IEC-60529. A temperature sensing bulb located in a thermometer pocket on tank cover should be provided to sense top oil. This shall be connected to the OTI instrument by means of flexible stainless steel armour to protect capillary tubing. Temperature indicator dials shall have linear gradations to clearly read at least every 2 deg C. The setting of alarm and tripping contacts shall be adjustable at site.

The OTI shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

In addition to the above, the following accessories shall be provided for remote indication of oil temperature:

Temperature transducer with PT100 sensor

RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at zero degrees centigrade. The PT100 temperature sensor shall have three wire ungrounded system. The calibration shall be as per IS 2848 or equivalent. The PT100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil for OTI system and shall provide dual output 4-20mA for SCADA system. The transducer shall be installed in the Individual Marshalling Box. Any special cable required for shielding purpose, for connection between PT100 temperature sensor and transducer, shall be in the scope of manufacturer. 4-20mA signal shall

be wired to Digital RTCC panel/BCU for further transfer data to SCADA through IS/IEC 61850 compliant communications.

4.08.2 Winding Temperature Indicator (WTI)

The transformer shall be provided with a dial type hot spot indicator of about 150mm diameter for measuring the hot spot temperature of each winding [HV & LV]. It shall have angular sweep of 270°. Range of temperature should be 0- 150°C with accuracy of ±1.5% (or better) of full scale deflection. The instruments should be capable of withstanding high voltage of 2.5kV AC rms, 50Hz for 1 minute. The terminal provided for auxiliary wiring should be Press-fit type.

The thermometer shall have adjustable, potential free alarm, trip contacts besides that required for control of cooling equipment, if any. Instrument should be provided with maximum reading pointer and resetting device, switch testing knob & anti-vibration mounting grommets (for projection mounting). Type of switch (NO/NC) shall be heavy duty micro switch of 5A at 240V AC/DC. Adjustable range shall be 20-90% of full scale range. The instruments case should be weather proof and epoxy coating at all sides. Instruments should meet degree of protection of IP55 as per IEC60529. A temperature sensing bulb located in a thermometer pocket on tank cover should be provided to sense top oil. This shall be connected to the WTI instrument by means of flexible stainless steel armour to protect capillary tubing. WTI shall have image coil and auxiliary CTs, if required to match the image coil mounted in local control box. The setting of alarm and tripping contacts shall be adjustable at site.

The WTI shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

In addition to the above, the following accessories shall be provided for remote indication of winding temperature:

Temperature transducer with PT100 sensor for each winding

RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at zero degree centigrade. The PT100 temperature sensor shall have three wire ungrounded system. The calibration shall be as per IS 2848 or equivalent. The PT100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil, Auxiliary CTs, if required to match the image coil, for WTI system and shall provide dual output 4-20mA for remote WTI and SCADA system

individually. The transducer and Auxiliary CT shall be installed in the Individual Marshaling Box. Any special cable required for shielding purpose, for connection between PT100 temperature sensor and transducer, shall be in the scope of Contractor. 4-20mA signal shall be wired to Digital RTCC / BCU panel for further transfer data to SCADA through IS/IEC 61850 compliant communications.

4.09 Fiber Optic System

The transformer shall be fitted with optical fiber temperature system for direct/ real time temperature monitoring and control. The technical specification for such system is mentioned below:

4.09.1 TECHNICAL SPECIFICATION OF FIBER OPTIC SYSTEM

Fiber Optic Temperature Sensors:

The transformer shall be equipped with fiber optic temperature sensors for monitoring direct hotspots into transformer windings, core, and oil temperature. 13 fiber optic sensors shall be installed for the following measurement points:

- One sensor each on the lateral winding of Primary and Secondary phases
- Two sensors each on the central windings of Primary and Secondary phases
- Two sensors for Top and bottom oil temperatures, preferably where the oil enters and exits center phase winding assembly
- Three sensors positioned to measure the hottest temperatures in the core, between the core and core clamping structure, and of the core clamping structure.

4.09.2 The locations of fiber optic sensors shall be proposed by the Manufacturer and locations finalized by agreement of the Purchaser.

4.09.3 Fiber Optic temperature Sensors shall be based on the proven zero-drift wavelength-shift Gallium Arsenide (GaAs) technology, suitable for all oil types, 200 μm all silica, Torlon disk, with a protection layer in radiant green colored PTFE Teflon protective spiral-wrap for improved visibility and mechanical strength. Sensors shall withstand exposure to hot kerosene vapor during the transformer insulation drying process.

4.09.4 Fiber Optic temperature sensor tips and tip/disk assemblies shall meet the following:

- i. The temperature measurement range should be between $-80\text{ }^{\circ}\text{C}$ to $+250\text{ }^{\circ}\text{C}$, with a total system accuracy of $\pm 1\text{ }^{\circ}\text{C}$.
- ii. No greater than 3pC (pico-Coulomb) partial discharge in mineral oil under 60 Hz AC stress per ASTM D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies and negative lightning impulse conditions per ASTM D3426, Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Material using Impulse Waves

- iii. Fiber optics sensors to withstand pull test of forces exceeding 60 N (~6 kg-F); 1 kg-f (kilogram-force) is about 10 N (Newton)
- iv. End interface ST connectors made of Zirconia for optimal light energy transfer

4.09.5 FO System Accessories:

- 4.09.5.1 The optical signal shall be brought out of the tank using a solder-glass optical feedthrough (without use of O-rings or seals), withstanding pressure in excess of 200 PSI. A 316L Stainless steel-based tank wall plate accommodating thirteen optical feedthroughs shall be installed on the tank.
- 4.09.5.2 The optical feedthroughs shall be assembled on the Tank Wall Plate and assembly shall be pressure-tested for the expected pressure inside transformer.
- 4.09.5.3 A protective 316L stainless steel-based interface box (I-Box) cover designed to mate with the wall plate shall be supplied. The box must be leak proof (IP66 rated), so that all optical feedthroughs and extension cables are protected from moisture and dust ingress.

4.10 EARTHING TERMINALS :-

- 4.10.1 **Two (2) earthing pads** (each complete with two (2) nos. holes, M16 bolts, plain and spring washers) **suitable for connection to 75 x 12 mm galvanised steel grounding flat** shall be provided each at **position close to earth of the two (2) diagonally opposite bottom corners of the tank.**
- 4.10.2 **Two earthing terminals** suitable for connection to **75 x 12 mm galvanised steel flat** shall also be provided **on each cooler, individual/common marshalling box and any other equipment mounted separately.** For the tank-mounted equipment like Optical Sensor Box etc., (if provided), double earthing shall be provided through the tank for which provision shall be made through tank and connected through two flexible insulated copper link.
- 4.10.3 **Equipotential flexible copper links** of suitable size shall be provided **between turret & tank, between tank & cover or between Bell & lower tank.** Other components like - pipes, conservator support etc. connected to tank may also be provided with equipotential flexible copper link.

4.11 CORE

- 4.11.1 **The core shall be constructed from non-ageing, Cold Rolled Grain Oriented (CRGO) silicon steel laminations. Indian transformer manufacturers shall use core material as per above specification with BIS certification.**
- 4.11.2 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating. The step-lap construction arrangement is preferred for better performance in respect of noise, no-load current and no-load loss.

- 4.11.3 The hot spot temperature and surface temperatures in the core shall be calculated for over voltage conditions specified in the document and it shall not exceed 125 deg C and 120 deg C respectively.**
- 4.11.4 Core and winding shall be capable of withstanding the shock during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.
- 4.11.5 All steel sections used for supporting the core shall be thoroughly sand/ shot blasted after cutting, drilling and welding.
- 4.11.6 Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.
- 4.11.7 The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.
- 4.11.8 Adequate lifting lugs shall be provided to enable lifting of active part (core & winding).
- 4.11.9 Core assembly shall be manufactured in such a way that lamination shall remain flat and finally assembled core shall be free from distortion.
- 4.11.10 **Single point core earthing should be ensured to avoid circulating current.** Core earth should be brought separately on the top of the tank to facilitate testing after installation on all transformers. The removable links shall have adequate sections to carry ground fault current. Separate identification nameplate/labels shall be provided for the 'Core' and 'Core clamp'. Cross section of Core earthing connection shall be of minimum size 80 sq.mm copper with exception of the connections inserted between laminations which may be reduced to a cross- sectional area of 20 sq. mm tinned copper where they are clamped between the laminations.
- 4.11.11 In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.
- 4.11.12 Insulation of core to clamp/frame shall be tested at 2.5 kV DC for 1 minute without breakdown after the transformer is filled with liquid and insulation resistance should be at least 500 Megohm for new transformer.**

4.13 WINDINGS

- 4.13.1 The manufacturer shall ensure that **windings of all transformers are made in clean, dust proof** (Cleanroom class ISO 9 or better as per ISO 14644-1), **humidity controlled environment with positive atmospheric pressure.**
- 4.13.2** The **conductors** shall be of **electrolytic grade copper** free from scales and burrs. Oxygen content shall be as per IS 12444.

- 4.13.3 Epoxy bonded Continuously Transposed Conductor (CTC) shall be used in main winding for rated current of 400 A or more.**
- 4.13.4 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalise the distribution of currents and temperature along the winding.
- 4.13.5 The conductor insulation shall be made from **high-density (at least 0.75 gm/cc)** paper having high mechanical strength. The characteristics for the paper will be reviewed at the time of design review.
- 4.13.6 The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and shall be non-catalytic and chemically inactive in transformer oil during service.
- 4.13.7 Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.
- 4.13.3 The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.
- 4.13.4 The windings shall be designed to withstand the dielectric tests specified. The type of winding used shall be of time tested. An analysis shall be made of the transient voltage distribution in the windings, and the clearances used to withstand the various voltages. Margins shall be used in recognition of manufacturing tolerances and considering the fact that the system will not always be in the new factory condition.
- 4.13.5 **The barrier insulation including spacers shall be made from high- density pre-compressed pressboard (1.15 gm/cc minimum for load bearing and 0.95 gm/cc minimum for non-load bearing) to minimize dimensional changes. Kraft insulating paper used on conductor should have density of >0.75 g/cc.**
- 4.13.6 Wherever required, electrostatic shield, made from material that will withstand the mechanical forces, will be used to shield the high voltage windings from the magnetic circuit.
- 4.13.7 All insulating materials and structures shall be protected from contamination and the effects of humidity during and after fabrication, and after receipt, by storing them in a separate, climate-controlled area. All blocks shall be installed such that the grain is oriented in the horizontal direction, perpendicular to the winding compressive forces.
- Aspect ratio of selected conductor shall be chosen suitably based on manufacturer experience to result in stable winding under normal and abnormal service condition after assembly.**
- 4.13.8 All winding insulation shall be processed to ensure that there will be no detrimental shrinkage after assembly. All windings shall be pre- sized

before being clamped.

4.13.9 Winding paper moisture shall be less than 0.5%.

4.13.10 Windings shall be provided with clamping arrangements which will distribute the clamping forces evenly over the ends of the winding.

4.13.11 **Either brazing/crimping type of connections are permitted for joints. It shall be time proven and safely withstand the cumulative effect of stress which may occur during handling, transportation, installation and service including line to line and line to ground faults/Short circuits. Manufacturer shall have system which allows only qualified personnel to make brazing or crimping joints.**

4.14 Current carrying connections

The mating faces of bolted connections shall be appropriately finished and prepared for achieving good long lasting, electrically stable and effective contacts. All lugs for crimping shall be of the correct size for the conductors. Connections shall be carefully designed to limit hot spots due to circulating eddy currents.

4.15 Winding terminations into bushings

4.15.1 Winding termination interfaces with bushings shall be designed to allow for repeatable and safe connection under site conditions to ensure the integrity of the transformer in service.

4.15.2 The winding end termination, insulation system and transport fixings shall be so designed that the integrity of the insulation system generally remains intact during repeated work in this area.

4.15.3 Allowances shall be made on the winding ends for accommodating tolerances on the axial dimensions of the set of bushings and also for the fact that bushings may have to be rotated to get oil level inspection gauges to face in a direction for ease of inspection from ground level.

4.15.4 In particular, rotation or straining of insulated connections shall be avoided during the fastening of conductor pads (or other methods) on the winding ends onto the termination surfaces of the bushing.

4.15.5 Suitable inspection and access facilities into the tank in the bushing oil-end area shall be provided to minimize the possibility of creating faults during the installation of bushings.

4.16 GAS AND OIL-ACTUATED RELAYS

4.16 GAS AND OIL-ACTUATED RELAYS

- 4.16.1** Each transformer shall be fitted with gas and oil-actuated relay equipment having alarm contacts, which close on collection of gas or low oil level, and tripping contacts which close following oil surge conditions. Separate relays shall be provided for on load tap changer.
- 4.16.2** Each gas and oil-actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay.
- 4.16.3** Each relay shall be fitted with a calibrated glass window for indication of gas volume.
- 4.16.4** To allow gas to be collected at ground level, a small bore pipe shall be connected to the gas release cock of the gas and oil-actuated relay and brought down to a point, approximately 1400 mm above ground level,. Where it shall be terminated by a cock, which shall have provision for locking to prevent unauthorized operation.
- 4.16.5** The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that mal-operation of the relay will not take place under normal service conditions, including starting or stopping of oil circulating pumps whether by manual or automatic control under all operating temperatures.
- 4.16.6** The pipe work shall be so arranged that all gas arising from the transformer will pass into the gas and oil-actuated relay. The oil circuit through the relay must not form a delivery path in parallel with any circulating oil pipe, nor is to be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided. For this reason, bushing turrets, if fitted shall have vent pipes, which will route any gas collection through the relay.
- 4.16.7** A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the expansion pipe and the cross level of the relay.
- 4.16.8** A straight run of pipe work shall be provided for a length of five times the internal diameter of the pipe on the conservator side of the gas and oil-actuated relay.
- 4.16.9** The surge float contacts shall close at a rate of steady oil flow between the following limits. As far as possible, the limits shall also be met when the relay is subjected to oil surge conditions, produced by rapid opening of a lever operated gate valve.
- 4.16.10** The relays shall be so located as to be easily accessible from the top of the tank. Oil Pipe Connection I.D. (mm) Operational Limits for Relay.
[Rising angles of 1° to 9°.]
700-1300
750 – 1400
900-1600

- 4.16.11** The gas collection contacts shall operate within the angle limits, specified for test:
- 4.16.12** When a transformer is provided with two conservators, the gas and oil - actuated relays shall be arranged as follows:
- (i) If the two conservators are connected to the transformer by a common oil pipe, one relay shall be installed in the common pipe.
 - (ii) If the two conservators are piped separately to the transformer, two relays shall be installed, one in each pipe connection.
- 4.16.12** The clearance between oil pipe work and live metal shall be not less than the minimum clearances as per standard practice.

4.17 INSULATING OIL :-

The insulating oil shall be unused inhibited (Type A, High Grade) conforming to IEC-60396-2020 & all parameters specified at Annexure–L, while tested at oil supplier's premises. The contractor shall furnish test certificates from the supplier against the acceptance norms as mentioned at Annexure–L, prior to despatch of oil from refinery to site. Under no circumstances, poor quality oil shall be filled into the transformer and thereafter be brought up to the specified parameter by circulation within the transformer. The Unused Insulating Oil parameters including parameters of oil used at manufacturer's works, processed oil, oil after filtration and settling are attached at Annexure–L. The oil test results shall form part of equipment test report.

A minimum of 10% of the oil quantity shall be supplied as spare (in addition to first filling) **for maintaining required oil level in case of leakage in tank, radiators, conservator etc.**

Oil used for first filling, testing and impregnation of active parts at manufacturer's works shall be of same type of oil which shall be supplied at site and shall meet parameters as per specification.

4.18 TAP CHANGING MECHANISM :

Main OLTC Gear Mechanism

4.18.1 Three phase transformer as specified in **Annexure-A** shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load. The OLTC shall conform to IS 8468/IEC 60214 (Part 1 & 2). The requirement of voltage regulation (on HV side), location (physical and electrical) of tap winding (end of common/ series winding or at neutral end), range of voltage variation, no. of steps etc. shall be as given in **Annexure-A**.

4.18.2 The **OLTC** shall be of **high speed transition resistor type**. OLTC shall be motor operated suitable for local as well as remote operation. The

diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment. The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer and the chamber shall be designed to withstand the vacuum. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contacts shall be replaceable.

4.18.3 The voltage class, maximum tapping current, step voltage of OLTC shall have adequate design margin for safe & reliable service life of both OLTC and transformer. OLTC shall have long contact life, quick & easy to disassemble diverter switch inserts, simple to adjust & control and easy to replace diverter's contacts etc.

4.18.4 Necessary safeguards shall be provided to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer.

4.18.5 The OLTC oil chamber shall have oil filling and drain valve, oil sampling valve, relief vent and level glass. Oil sampling valve, accessible from ground, shall be provided to take sample of oil from the OLTC chamber. It shall also be **fitted with an oil surge relay** which shall be connected **between OLTC oil chamber and OLTC conservator tank. Provision of a suitable device like tie-in-resistor has to be made, wherever required, to limit the recovery voltage to a safe value.** The use of tie-in-resistor (if used) shall be clearly marked in rating and diagram plate of the transformer. The whole of the driving mechanism shall be of robust design and capable of giving satisfactory service without undue maintenance.

4.18.6 Tap changer shall be so mounted that bell cover of transformer can be lifted without removing connections between windings and tap changer.

4.18.7 As an alternative to conventional OLTC with traditional diverter switch immersed in oil (where arcing takes place in oil), vacuum type OLTC (where arcing takes place in a hermetically sealed vacuum interrupter) may also be provided. However, provisions as specified above shall be followed as far as applicable.

Local OLTC Control Cabinet (Drive Mechanism Box)

4.18.8 OLTC shall be suitable for manual (handle operated) and electrical (motor operated) operation. For local manual operation from **Local OLTC Control cabinet (Drive Mechanism Box), an external handle shall be provided.**

4.18.9 OLTC's Local control cabinet shall be mounted on the tank in accessible position. The cranking device/handle for manual operation for OLTC gear shall be removable and suitable for operation by a man standing

at ground level (preferably at a height less than 1800mm). The mechanism shall be complete with the following:

- (a) Mechanical tap position indicator, which shall be clearly visible near the transformer.
- (b) A mechanical operation counter of at least five digits shall be fitted to indicate the number of operations completed and shall have no provision for resetting.
- (c) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.
- (d) The manual control, considered as back up to the motor operated on load tap changer control, shall be interlocked with the motor to block motor start-up during manual operation.
- (e) The manual operating mechanism shall be labelled to show the direction of operation for raising the voltage and vice-versa.
- (f) An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change, until the mechanism comes to rest and resets circuits for a fresh position.

4.18.20 For electrical operation from local as well as remote, motor operated mechanism shall be provided. It shall not be possible to operate the electric drive when the manual operating gear is in use. It shall not be possible for any two controls to be in operation at the same time. Transfer of source in the event of failure of operating AC supply shall not affect the tap changer. Thermal device or other means shall be provided to protect the motor and control circuit.

4.18.21 The Local OLTC Drive Mechanism Box shall house all necessary devices meant for OLTC control and indication. It shall be complete with the following:

- (a) A circuit breaker/contactors with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor
- (b) Emergency Push Button to stop OLTC operation
- (c) Cubicle light with door switch
- (d) Anti-condensation metal clad heaters to prevent condensation of moisture
- (e) Padlocking arrangement (or locking arrangement suitable for long term operation) for hinged door of cabinet
- (f) All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.
- (g) The cabinet shall be tested at least IP 55 protection class.

4.18.22 In case auxiliary power supply requirement for OLTC Drive Mechanism (DM) Box is different than station auxiliary AC supply, then all necessary converters shall be provided.

4.18.23 Operating mechanism for on load tap changer shall be designed to go through one step of tap change per command only, until the control switch is returned to the off position between successive operations/ repeat commands.

4.18.24 Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition. An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.

4.18.25 OLTC local control cabinet shall be provided with tap position indication for the transformer. Drive Mechanism shall be equipped with a fixed resistor network capable of providing discrete voltage steps or provide 4-20mA transducer outputs for tap position indication input to digital RTCC/relevant BCU (as applicable)/SCADA system. The tap position indicator shall also be provided in control room.

4.18.26 'Local-remote' selector switch shall be provided in the local OLTC control cabinet. In Local mode, all electrical commands from remote (digital RTCC, SCADA, SAS etc.) shall be cut- off/blocked. Electrical operations to change tap positions shall be possible by using raise/lower push buttons under local mode from Driving Mechanism (DM) Box. In remote mode electrical commands from digital RTCC/SCADA/SAS etc. shall be executed. The remote-local selector switch shall be having at-least two spare contacts per position.

4.18.27 For 3-phase transformer, the following minimum LED indications shall be provided in DM box:

- (a) INCOMPLETE STEP
- (b) OLTC motor overload protection operated
- (c) Supply to DM Motor fail
- (d) OLTC IN PROGRESS
- (e) Local / Remote Selector switch positions of DM
- (f) OLTC upper/lower limits reached
- (g) 415V Main AC supply ON
- (h) 415V Standby AC supply ON

4.18.28 The following minimum contacts shall be available in DM Box. For three phase unit, and these contacts shall be further wired to digital RTCC panel/relevant BCU (as applicable):

- (a) INCOMPLETE STEP which shall not operate for momentary loss of auxiliary power.
- (b) OLTC motor overload protection
- (c) Supply to DM Motor fail
- (d) OLTC IN PROGRESS

- (e) Local/Remote Selector switch position
- (f) OLTC upper/lower limits reached

4.18.29 All relays, switches, fuses etc. shall be mounted in the OLTC local control cabinet and shall be clearly marked/ labelled for the purpose of identification. Both ends of all the wires (control & power) connected to Drive Mechanism Box must be provided with proper ferrule nos. for tracing and maintenance.

4.18.30 A permanently legible lubrication chart and control circuit drawing shall be fitted within the OLTC local control cabinet.

4.18.31 Remote Control & Monitoring of OLTC (through Bay Control Unit/ Digital RTCC Relay, as applicable)

Requirement of digital RTCC relays may be specified by the utility for existing conventional substations as per its practice. For substations/ power plants having Substation Automation System, Control & monitoring of OLTC shall be carried out through Substation Automation System. All the functionalities specified for digital RTCC shall be realised in soft logic in Substation Automation System. All hardwire signals from/to OLTC shall be wired to Bay Control Units (BCUs) provided by the owner/contractor, as applicable. Wherever, digital RTCC relay is required following specification may be followed.

4.18.31.1 The digital RTCC relay shall have Automatic Tap Changer control and monitoring relay with Automatic Voltage Regulating features to remotely control and monitor OLTC.

4.18.31.2 Each digital RTCC relay shall be used to control 1 bank of transformers (i.e. 3 Nos. 1-Phase units or 1 No. 3-Phase unit). No. of relays including spare relay, if any, shall be specified by the utility as per requirement.

4.18.31.3 All digital relays can be housed in a single digital RTCC panel in control room or in the BCU panel in kiosks located in the switchyard.

~~4.18.32 For existing substations, the requirement of digital RTCC panel and relays shall be specified by the utility. However, availability of existing RTCC schemes /Digital RTCC relays need to be specified to finalise matching digital RTCC relays. The Digital RTCC relays envisaged for existing transformers shall be integrated for parallel operations. All required cables for the same shall be deemed to be included in the scope.~~

4.18.33 Digital RTCC relay shall be **microprocessor based** adopting the latest state of the art design & technology with **in-built large LCD** (or better) display for ease of programming and viewing. The unit supplied shall be field programmable so that in the event of change in transformer/location, it could be customized to suit site conditions without sending back to works. The programming shall be menu driven and easily configurable. If it is designed with draw out type modules, it should take care of shorting all CT inputs automatically while drawing out. The CT/VT ratio shall be field programmable and Relay shall display the actual HV Voltage and current considering suitable multiplying factors. The system

shall be self-sufficient and shall not require any additional devices like parallel balancing module etc.

4.18.34 The digital RTCC relay shall have Raise/Lower push buttons, Manual/ Automatic mode selection feature, Local/Remote selection feature, Master / Follower/ Independent/ Off mode selection feature for control of OLTC.

4.18.35 In Manual Mode: In this mode, power system voltage based automatic control from digital RTCC relay shall be blocked and commands shall be executed manually by raise/lower push buttons.

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

4.18.37 Master/Follower/Independent/Off mode

Master/Follower/Independent/Off mode is required in Digital RTCC relay for parallel/group operation of transformers. Master-follower scheme implies that controlled decision shall be taken by the Master and control actions (Raise/Lower tap position) shall be executed simultaneously by Master & Follower units. Same logic needs to be implemented in digital RTCC relays.

Master Position: If the digital RTCC relay is in master position, it shall be possible to control the OLTC units of other parallel operating transformers in the follower mode by operation from the master unit.

Follower Position: If the digital RTCC relay is in Follower position, control of OLTC shall be possible only from panel where master mode is selected.

Independent Position: In independent position of selector switch, control of OLTC shall be possible only from the panel where independent mode is selected.

Suitable interlock arrangement shall be provided to avoid unwanted/inconsistent operation of OLTC of the transformer

4.18.38 Raise/Lower control: The remote OLTC scheme offered shall have provision to raise or lower taps 3-Phase Transformer.

4.18.39 Digital RTCC relays shall communicate with SCADA using IS/IEC 61850 through fiber optic port to monitor, parameterise and control the OLTC. Any software required for this purpose shall be supplied. The supplied software shall not have restrictions in loading on multiple computers for downloading and analyzing the data. Software shall indicate the current overview of all measured parameters of the connected transformer in real time.

4.18.40 Communication between the Digital RTCC relays to execute the commands for parallel operation shall be implemented using required communication protocol. Suitable communication hardware shall be provided to communicate up to a distance of 1 km between digital RTCC relays. Scope shall also include communication cables between digital RTCC relays. Cables as required for parallel operation of OLTCs of all transformers (including existing transformers wherever required) from Digital RTCC relays shall be considered included in the scope.

4.18.41 The Digital RTCC relay shall have additional programmable Binary Inputs (minimum 7 Nos.) and Binary outputs (minimum 7 Nos.) for future use. It shall be possible to have additional module for Binary Input / output as well as Analogue input module depending upon requirement.

4.18.42 The relays shall ensure completion of lowering/raising of the OLTC tap, once the command is issued from the relay. "Step-by-Step" operation shall be ensured so that only one tap change from each tap changing pulse shall be effected. If the command remains in the "operate" position, lock-out of the mechanism is to be ensured.

4.18.43 The relay shall incorporate an under voltage / over voltage blocking facility which shall make the control inoperative if voltage falls/ rises by percentage value of set point value with automatic restoration of control when nominal voltage rises / falls to value.

4.18.44 The relay shall have facility to monitor operating hours of tap changer and register the tap changer statistics. In the statistics mode, the relay shall display the no. of tap changing operations occurred on each tap.

4.18.45 The relay shall have self-check of power on and shall continually monitor all functions and the validity of all input values to make sure the control system is in a healthy condition. Any monitoring system problem shall initiate the alarm.

4.18.46 Following minimum indications/alarms shall be provided in Digital RTCC relay either through relay display panel or through relay LEDs:

- (a) INCOMPLETE STEP alarm
- (b) OLTC motor overload protection alarm
- (c) Supply to DM Motor fail alarm
- (d) OLTC IN PROGRESS alarm
- (e) Local / Remote Selector switch positions in DM Box
- (f) OLTC upper/lower limits reached alarm
- (g) OLTC Tap position indications for transformer units
- (h) Independent-combined-remote selector switch positions of CMB (in case of single phase transformer)
 - (i) 415V, AC Main Supply Fail.
 - (j) 415V, AC Standby Supply Fail

4.18.47 ~~In case of parallel operation or 1-Phase Transformer unit banks, OLTC out of step alarm shall be generated in the digital RTCC relay for~~

discrepancy in the tap positions.

4.19 CONSTRUCTIONAL FEATURES OF COOLER CONTROL CABINET/ INDIVIDUAL MARSHALLING BOX/ COMMON MARSHALLING BOX/ OUTDOOR CUBICLE/DIGITAL RTCC PANEL

4.19.1 Each transformer unit shall be provided with local OCTC/OLTC Drive Mechanism Box (DMB), Cooler Control Cabinet/Individual Marshalling Box, Digital RTCC panel (as applicable).

4.19.2 Common marshalling box (for single phase unit) shall be of size not less than 1600mm (front) X 650mm (depth) X 1800mm (height). Individual **Marshalling Box (IMB) and Cooler Control Box** shall be **tank mounted** or ground mounted. All cabinets except CMB & Digital RTCC panel shall be tank mounted. All separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof for outdoor application. The gland plate shall be at least 450 mm above ground level.

4.19.3 The Cooler Control Cabinet (CCC)/Individual Marshalling Box (IMB), Common Marshalling Box (CMB), and **all other outdoor cubicles** (except OLTC Drive Mechanism box) shall be made of stainless steel sheet of minimum Grade SS 304 and of minimum thickness of 1.6 mm. Digital RTCC panel shall be made of CRCA sheet of minimum thickness of 2.0 mm and shall be painted suitably as mentioned in this specification.

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

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

4.19.6 All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired upto the terminal board in the Marshalling Box. All the CT secondary terminals in the Marshalling Box shall have provision for shorting to avoid CT open circuit while it is not in use. All the necessary terminations for remote connection to Purchaser's panel shall be wired up to the Common Marshalling Box.

4.19.7 Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh of brass. All the control cabinets shall be provided with suitable lifting arrangement. Thermostat controlled space heater and cubicle lighting with ON-OFF switch shall be provided in each

panel.

4.20 AUXILIARY POWER SUPPLY FOR OLTC, COOLER CONTROL AND POWER CIRCUIT

4.20.1 Two auxiliary power supplies of 415 volt, three phase four (4) wire shall be provided by the Purchaser at **Cooler Control Cabinet / Marshalling Box**. All loads shall be fed by one of the two sources through an electrically interlocked automatic transfer scheme housed in the Cooler Control Cabinet/Marshalling Box.

4.20.2 For each circuit, suitably rated power contactors, MCBs/MCCBs as required for entire auxiliary power supply distribution scheme including distribution to DM boxes, Online Gases and moisture monitoring system, Online drying system and Fibre optic sensor Box etc. (as applicable), shall be provided in cooler control cabinet/ Marshalling Box.

4.20.3 Auxiliary power supply distribution scheme shall be submitted for approval. Supply and laying of Power, Control and special cables from marshalling box to all accessories is in the scope of the manufacturer/contractor (as applicable). Further any special cable (if required) from MB to Owner's Control Panels/Digital RTCC panels is also in the scope of the manufacturer/contractor (as applicable).

4.20.4 All relays and operating devices shall operate correctly at any voltage within the limits specified below:

Normal Voltage	Variation in voltage	Frequency (in Hz)	Phase/Wire	Neutral connection
415 V	±10%	50±5%	3 Phase 4Wire	Solidly earthed
240 V	±10%	50±5%	1 Phase 2 Wire	Solidly earthed
220 V	190 V to 240 V	DC	Isolated 2 wire system	--
110 V	95 V to 120 V	DC	Isolated 2 wire system	--
48 V	--	DC	2 wire system (+) earthed	--

Combine variation of voltage and frequency shall be limited to ±10%.

4.20.5 Design features of the transfer scheme shall include the following:

- a) Provision for the selection of one of the feeder as normal source and other as standby.
- b) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.

- c) Indication to be provided at cooler control cabinet/Individual Marshalling Box/Common Marshalling Box for failure of normal source and for transfer to standby source and also for failure to transfer.
- d) Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.
- e) Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

4.20.6 For spare unit which is not connected through isolator switching arrangement, 415 volt, three phase four (4) wire AC supply shall be provided for heater,.

4.21 TRANSFORMER BUSHINGS :-

4.21.1 For various voltage class of transformer, type of bushings shall be as follows:

Voltage Rating	Bushing Type
145 kV, 245 kV and 420 kV bushings for 400 kV and below voltage class transformers	RIP/RIS
Bushings of 36 kV and below	Solid porcelain
Bushings of other rating	OIP/RIP/RIS

OIP: Oil Impregnated Paper (with porcelain/polymer housing); RIP: Resin Impregnated Paper (with polymer housing); RIS: Resin Impregnated Synthetic (with polymer housing)

4.21.1 Bushings shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout and movement along with the spare transformer with bushing erected and provided with proper support from one foundation to another foundation within the substation area. The electrical and mechanical characteristics of bushings shall be in accordance with IS/IEC: 60137. All details of the bushing shall be submitted for approval and design review.

4.21.2 Oil filled condenser type bushing shall be provided with at least following fittings:

- i. Oil level gauge.
- ii. Tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable
- iii. Oil filling plug & drain valve (if not hermetically sealed)

4.21.3 Porcelain used in bushing manufacture shall be homogenous, free from

lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

- 4.21.4 Bushing shall be provided **with tap for capacitance and tan delta test**. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable.
- 4.21.5 Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.
- 4.21.6 Bushings of **identical rating of different makes shall be interchangeable** to optimize the requirement of spares.
- 4.21.7 **Polymer insulator** shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have **silicon content of minimum 30% by weight**. It should protect the bushing against environmental influences, external pollution and humidity. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be finalized during finalization of MQP. The weather sheds of the insulators shall be of alternate shed profile as per IS 16683-3/IEC 60815-3. The weather sheds shall be vulcanized to the sheath (extrusion process) or moulded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams/ burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IS 9947. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The polymer insulator shall be capable of high pressure washing.
- 4.21.8 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.
- 4.21.9 The hollow silicone composite insulators shall comply with the requirements of IEC-61462 and the relevant parts of IEC-62217. The design of the composite insulators shall be tested and verified according to IEC-61462 (Type & Routine test).
- 4.21.10 Clamps and fittings shall be of hot dip galvanised/stainless steel except for Aluminium Clamps and connectors.

- 4.21.11 Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.
- 4.21.12 **No arcing horns** shall be provided on the bushings.
- 4.21.13 **Corona shield(whenever required or not, as per calculation at the time of bid) , shall be provided** at bushing terminal (air end) to minimize corona.
- 4.21.14 Bushing shall be specially packed to avoid any damage during transit and suitable for long storage, with non-returnable packing wooden boxes with hinged type cover. Without any gap between wooden planks. Packing Box opening cover with nails/screws type packing arrangement shall not be acceptable. Manufacturer shall submit drawing/ documents of packing for approval during detail engineering. Detail method for storage of bushing including accessories shall be brought out in the instruction manual.
- 4.21.15 Oil end portion of RIP/RIS type bushings shall be fitted with metal housing with positive dry air pressure and a suitable pressure monitoring device shall be fitted on the metal housing during storage to avoid direct contact with moisture with epoxy. The pressure of dry air need to be maintained in case of leakage.
- 4.21.16 The terminal marking and their physical position shall be as per IS 2026.
- 4.21.17 **Tan delta measurement at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (RIP/ RIS) at Transformer manufacturing works as routine test before despatch** and the result shall be compared at site during commissioning to verify the healthiness of the bushing.
- 4.21.18 **Tan δ value of RIP/RIS condenser bushing shall be 0.005 (max.) in the temperature range of 10°C to 40°C. If tan delta is measured at a temperature beyond above mentioned limit, necessary correction factor as per IEEE shall be applicable.**

4.22 **COOLING :-**

4.22.1 **Radiator based cooling for Power transformer**

The transformer shall be designed with cooler system as specified in Annexure-A and with following provisions, as applicable.

4.22.2 The cooler shall be designed using **tank mounted radiators**. Design of cooling system shall satisfy the performance requirements.

4.22.3 The radiator shall be of sheet steel complying with IS 513 and minimum thickness 1.2 mm. Each radiator bank shall be provided with the following accessories:

- (a) Cooling Fans, Oil Pumps, Oil Flow Indicator (as applicable)

- (b) Top and bottom shut off valve of at least 80mm size
- (c) Drain Valve and sampling valve
- (d) Top and bottom oil filling valves
- (e) Air release plug at top
- (f) Two grounding terminals suitable for termination of two (2) Nos. 75x12 mm galvanised steel flats.
- (g) Thermometer pockets fitted with captive screw caps at cooler inlet and outlet.
- (h) Lifting lugs

4.22.4 Each radiator bank shall be detachable and shall be provided with flanged inlet and outlet branches. Expansion joint (for separately/ ground mounted cooler banks) shall be provided on top and bottom cooler pipe connection.

4.22.5 One number standby fan shall be provided with each radiator bank.

4.22.6 Cooling fans shall not be directly mounted on radiator. The supporting frames for the cooling fans shall be fixed preferably on separate support or to the main tank in such a manner that the fan vibration does not affect the performance of the radiators and its valves. Fans shall be located so as to prevent ingress of rain water. Each fan shall be suitably protected by galvanised wire guard. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.

4.22.7 Cooling fans shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall be of premium efficiency **class IE3 conforming to IS: 12615**. Each cooling fan shall be provided with starter, thermal overload and short circuit protection. The motor winding insulation shall be conventional **class 'B' type**. Motors shall have hose proof enclosure equivalent to **IP: 55** as per IS/IEC 60034-5.

4.22.8 The cooler pipes, support structure including radiators and its accessories shall be hot dip galvanised or corrosion resistant paint should be applied to external surface of it.

4.22.9 Air release device and oil plug shall be provided on oil pipe connections. Drain valves shall be provided in order that each section of pipe work can be drained independently.

4.22.10 Automatic operation control of fans shall be provided (with temperature change) from contacts of winding temperature indicator. The manufacturer shall recommend the setting of WTI for automatic changeover of cooler control over the entire operating range depending on types of cooling system like ONAN/ONAF. The setting shall be such that hunting i.e. frequent start-up operations for small temperature differential do not occur.

4.22.11 Suitable manual control facility for cooler fans shall be provided. Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans manually.

4.22.12 Following lamp indications shall be provided in cooler control cabinet:

- a) Cooler Supply failure (main)
- b) Cooler supply changeover
- c) Cooler Supply failure (standby)
- d) Control Supply failure
- e) Cooling fan supply failure for each bank
- f) Common thermal overload trip
- g) Thermal overload trip for each fan
- h) Stand by fan

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet and for single phase unit connection shall be extended further to Common Marshalling Box.

4.22.13 The Cooler Control Cabinet/ Individual Marshalling Box shall have all necessary devices meant for cooler control and local temperature indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired up to the terminal board in the Cooler Control Cabinet/Individual Marshalling Box. All the CT secondary terminals in the Cooler Control Cabinet shall have provision for shorting to avoid CT open circuit while it is not in use.

4.22.14 All the necessary terminations for remote connection to Purchaser's panel shall be wired upto the Marshalling Box (3-Ph unit).

4.22.15 AC power for Cooler Control Circuitry shall be derived from the AC feeder. In case auxiliary power supply requirement for Cooler Control Mechanism is different than station auxiliary AC supply, then all necessary converters shall be provided.

4.23 CLEANING AND PAINTING :-

4.23.1 Before painting or filling with oil or compound, all ungalvanised parts shall be completely cleaned and made free from rust, scale and grease and all external rough surfaces in castings, shall be filled by metal deposition. The interior of all transformer tanks and other oil filled chambers and internal structural steel work shall be cleaned of all scale and rust by sand blasting or other approved method. These surfaces shall be painted with an oil resisting varnish or paint Unexposed welds not be painted.

4.23.2 PAINTING PROCEDURE

PAINTING	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	Total Dry Film Thickness (DFT)	Colour shade
External surfaces: Main tank, pipes, conservator tank, oil storage tank & Driving Mechanism (DM) Box etc. ()	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40µm)	Epoxy high build Micaceous iron oxide (HB MIO) (75µm)	Aliphatic polyurethane (PU) (Minimum 50µm)	Minimum 155µm	RAL 7035
Internal surfaces: Main tank, pipes (above 80 # NB), conservator tank, oil storage tank & DM Box etc. ()	Shot Blast cleaning Sa 2 ½*	Hot oil resistant, non-corrosive paint, low viscosity varnish or epoxy	--	--	Minimum 30µm	Glossy white for paint
Radiator (external surfaces)	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40µm)	Epoxy base Zinc primer (30-40µm)	PU paint (Minimum 50µm)	Minimum 100µm	Matching shade of tank/ different shade aesthetically matching to tank
Manufacturer may also offer Radiators with hot dip galvanised (in place of painting) with minimum thickness of 40µm (min)						
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish or Hot oil resistant, non-corrosive	--	--	--	--

		Paint				
Digital RTCC Panel	Seven tank process as per IS:3618 & IS:6005	Zinc chromate primer (two coats)	--	EPOXY paint with PU top coat or POWDER coated	Minimum 80 μm / for powder coated minimum 100 μm	RAL 7035 shade for exterior and Glossy white for interior
Control cabinet / Marshalling Box - No painting is required.						

Note:

***indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1. #NB: Nominal Bore**

5.0 QUALITY ASSURANCE PROGRAMME

5.01 INTRODUCTION

The Quality Assurance programme shall be generally in line with latest ISO-9001 (Quality Management System), ISO-14001 (Environmental Management System) and OHSAS 18001 (Occupational Health and Safety Management System). A Quality Assurance Programme of the manufacturer shall generally cover the following:

- a) Organization structure for the management and implementation of the proposed Quality Assurance Programme
- b) Quality System Manual
- c) Design Control System
- d) Documentation Control System
- e) Qualification and experience data for key Personnel
- f) The procedure for purchase of materials, parts, components and selection of sub-supplier's services including vendor analysis, source inspection, incoming raw material inspection, verification of materials purchased etc.
- g) List of manufacturing facilities available
- h) Level of automation achieved and list of areas where manual processing exists
- i) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- j) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls
- k) System for Control of non-conforming items and for corrective & preventive actions based on customers' feedback.
- l) Inspection and test procedure both for manufacture and field activities
- m) System for Control of calibration of testing and measuring equipment and the indications of calibration status on the instrument
- n) System for Quality Audits
- o) System for indication and appraisal of inspection status
- p) System for authorising release of manufactured product to the Purchaser
- q) System for handling storage and delivery
- r) System for maintenance of records
- s) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component
- t) System of various field activities i.e. unloading, receipt at site, proper storage, erection, testing & commissioning

The manufacturer shall use state-of-the-art technology and dirt, dust and humidity controlled environment during various processes of manufacturing and testing to ensure that end product is of good quality and will provide uninterrupted service for the intended life period. All manufacturers are expected to develop their manufacturing facility at par with the leading manufacturers with best global practices. An indicative list for facilities needed to be available at manufacturer's works has been provided at *Annexure-G*. In case the manufacturers do not have the required facilities as given in *Annexure-G*, it may be ensured by the manufacturers that the same shall be made available and put into use within two years of release of this document.

5.02 GENERAL REQUIREMENTS - QUALITY ASSURANCE

- 5.02.1 All materials, components and equipment required for transformer manufacturing shall be procured, manufactured, erected, commissioned and tested at all stages, as per a comprehensive Quality Assurance Programme, the detailed Quality Plans for manufacturing and field activities shall be drawn up by the manufacturer/ contractor (as applicable) and will be submitted to Purchaser for approval.
- 5.02.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of purchaser specification and standards mentioned therein and quality practices and procedures followed by Manufacturer's/Sub-supplier's/Sub-supplier's Quality Control Organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted to purchaser, for review and approval. **Typical Manufacturing Quality Plan (MQP) is provided at Annexure-E** for reference. Any change in practice or acceptance norms (with reference to various tests / parameters in respective National / International standard) would be suitably incorporated by manufacturer from time to time and submit the same for approval of purchaser / utility.
- 5.02.3 List of testing equipment available with the manufacturer for stage/final testing of transformer and test plant limitation, if any, for the acceptance and routine tests specified in the relevant standards shall be furnished by the manufacturer. These limitations shall be very clearly brought out in 'The schedule of deviations' for specified test requirements.
- 5.02.4 The transformer manufacturer, along with Quality Plans, shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Purchaser's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Purchaser shall identify Customer Hold Points (CHP), i.e. test/checks which shall be carried out in presence of the Purchaser's authorized representative and the work will not

proceed without consent of Purchaser in writing. All deviations to approved quality plans and applicable standards must be documented and referred to Purchaser along with technical justification for approval and dispositioning.

- 5.02.5 All material used for equipment manufacture shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure, if any and actually followed shall be recorded on certificates and time temperature chart, as applicable. Tests shall be carried out as per applicable material standards and/or agreed details.
- 5.02.6 No material shall be dispatched from the manufacturer's works before the same is accepted, subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Purchaser's authorized representative and duly authorized for dispatch.
- 5.02.7 The manufacturer shall list out all major items/equipment/components to be manufactured in house as well as procured from sub-supplier. All the sub-suppliers proposed by the manufacturer for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the manufacturer and finalized with the Purchaser and shall be subject to Purchaser's approval. The manufacturer's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, quality systems followed, experience list, etc. along with his own technical evaluation for identified sub-suppliers enclosed and shall be submitted to the Purchaser for approval in sufficient time so as not to impede the progress of work on the facilities.
- 5.02.8 For components/equipment procured by the manufacturer for the purpose of the contract, after obtaining the written approval of the Purchaser, the manufacturer's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-suppliers shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organization, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalized with the Purchaser and such approved Quality Plans shall form a part of the purchase order/contract between the manufacturer and sub-suppliers.
- 5.02.9 Purchaser reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the manufacturer's or their sub-supplier's quality management and control activities. The manufacturer shall provide all necessary assistance to enable the Purchaser carry out such audit and surveillance.
- 5.02.10 The manufacturer shall carry out an inspection and testing programme during manufacturing in his work and that of his sub-supplier and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all

materials parts and equipment. Manufacturer shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

- 5.02.11 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Purchaser to reject the equipment if it does not comply with the specification, when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the manufacturer in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings (approved by the Purchaser), and minutes of various meetings with customer / Purchaser etc.
- 5.02.12 Any repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Purchaser/authorized representative.
- 5.02.13 The Manufacturer / Sub-suppliers shall carry out routine test on 100% item at manufacturer / sub-supplier's works. The quantum of check / test for routine & acceptance test by purchaser shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.
- 5.02.14 The manufacturer/ contractor (as applicable) shall submit to the Purchaser Field Welding Schedule for field welding activities (if applicable) along with all supporting documents, like welding procedures, heat treatment procedures, Non-Destructive Test (NDT) procedures etc. before schedule start of erection work at site.
- 5.02.15 **Transformer manufacturer shall also provide Field Quality Plans** that will detail out for all the equipment, the quality practices and procedures etc. to be followed by the manufacturer's representative or authorized agency, during various stages of site activities starting from receipt of materials/equipment at site till commissioning.
- 5.02.16 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Purchaser. All welding / brazing procedures adopted/used at shop will be made available to purchaser during audit / inspection. Procedures to be adopted at site will be submitted to purchaser for approval.
- 5.02.17 All brazers, welders and welding operators employed on any part of the contract either in Manufacturer's/his sub- supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Purchaser.
- 5.02.18 Any of the offered software, if applicable shall not of β -version and be also free from all known bugs and should be with cyber security certificate.

5.03 QUALITY ASSURANCE DOCUMENTS

5.03.1 The manufacturer shall be required to submit the QA Documentation in hard copies and DVD ROMs/Pen Drive containing soft copy, as identified in respective quality plan.

5.03.2 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document. The QA Documentation file shall be progressively completed by the manufacturer's sub-supplier to allow regular reviews by all parties during the manufacturing.

5.03.3 Typical contents of QA Documentation is as below:-

- a) Quality Plan for various components and accessories. A typical quality plan for key components of transformer is provided at **Annexure-E**.
- b) Material mill test reports on components as specified by the specification and approved Quality Plans.
- c) Manufacturer's works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- d) Non-destructive examination results/reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- e) Heat Treatment Certificate/Record (Time- temperature Chart), if any.
- f) All the accepted Non-conformance Reports (Major/Minor)/deviation, including complete technical details **/repair procedure**.
- g) Customer Hold Points (CHP)/Inspection reports duly signed by the Inspector of the Purchaser and Manufacturer for the agreed Customer Hold Points.
- h) Certificate of Conformance (COC) wherever applicable.

5.03.4 Similarly, the manufacturer/contractor (as applicable) shall be required to submit hard copies and DVD/ Pen Drive containing soft copy, containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning.

5.03.5 Before offering for Factory Acceptance Test of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

Note:- The word 'Inspector' shall mean the authorized representative and to inspect and examine the materials and workmanship of the works during its manufacture or erection.

5.04 QUALITY DURING INSPECTION & TESTING (including virtual inspection) AND INSPECTION CERTIFICATES

5.04.1 Inspection, audit, assessment, test measurement and comparison all describe the same phenomena of examining carefully to some established criteria. Inspector should be prepared with the following documents:

- a) Contract documents together with technical specifications
- b) Basic guideline regarding the scope of inspection
- c) Approved drawings and reference standards (ISS/IEC/BS etc.)
- d) Previous inspection reports of transformers of similar rating (if available)
- e) Type test certificates (if already conducted).

5.04.2 The Inspector shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Manufacturer shall obtain for the Inspector permission to inspect as if the works were manufactured or assembled on the Manufacturer's own premises or works.

5.04.2 The Manufacturer shall give the Inspector ten (10) days written notice of any material being ready for testing. Such tests shall be to the Manufacturer's account.

5.05 Virtual Stage inspection & Factory Acceptance Test (FAT)

5.05.1 The conventional practice of witnessing Stage inspection and Factory Acceptance Test (FAT) of transformers as per technical specification of the utility/purchaser requires physical presence of utility's/purchaser's representative/inspector at manufacturer's works and involves considerable co-ordination efforts and planning by both utility/purchaser and manufacturers, especially in special situations like Covid-19 pandemic. The self-certification/waiver of FAT is not desirable. Under the situation like Covid-19 or if there is mutual agreement between the manufacturer & the utility/purchaser, the manufacturer can offer virtual stage inspection or FAT or both, with similar experience/confidence as on-site witness, as an alternative to conventional methods.

5.05.2 The resources required for virtual inspection/testing:

The following resources should form part of virtual inspection/testing:

- (a) High speed Wi-Fi Internet
- (b) Necessary electronic devices like Mobiles, Tabs or iPads, portable cameras, computers for test equipment or instruments, Conference call setup with laptop, cameras in test lab and test bay for clear view of the test bay as well as transformer under test, connection leads and measuring equipment etc. For better clarity and transparency, wherever possible, screens of computers for test equipment or instruments should be paralleled for direct view of the customer. Example – Loss Measurement

system, PD test System, HV Test System etc.

(Note: Issues of screen blinking may be observed during chopped wave lightning impulse due to earthing issues and should be ignored)

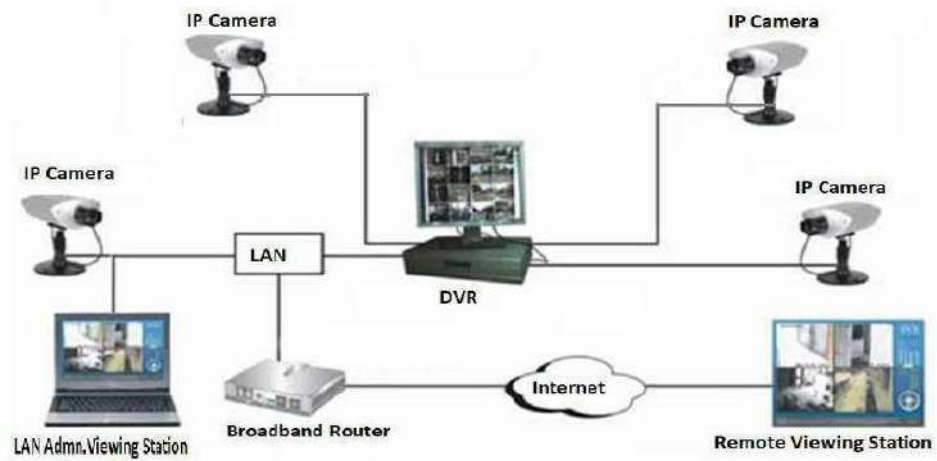
- (c) Qualified engineers well-conversant with technology shall be deployed to effectively handle online stage inspection/FAT.
- (d) Online applications like Microsoft Teams, Skype, Google meet, Google hangout, WhatsApp, etc.
- (e) Measuring Instruments with valid calibration certificates
- (f) Recording facility of all the activities performed during stage inspection/FAT as well as photography of recording of important readings should form part of the Stage/Final inspection reports of the product.
- (g) The manufacturer shall nominate a nodal officer, who shall be responsible for coordinating with the utility/purchaser and camera operators for visual arrangement/facilities spread across different locations within the manufacturer's works.
- (h) Different sections like Core - coil assembly area, winding area, tank inspection area etc. shall be provided with adequate no. of cameras or portable cameras can be used for clear and proper visualization of the test object.
- (i) During stage inspection/FAT, the position of cameras (with zoom in/out facility) shall be done in such a way that the test object, measuring instruments and test equipment are clearly visible.

Procedure for virtual inspection / testing:

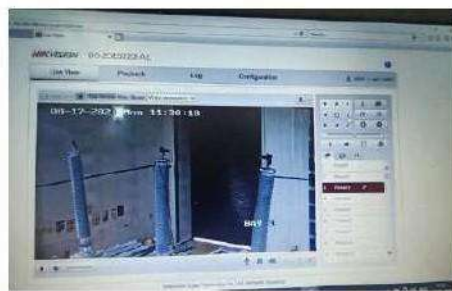
- (a) Manufacturer's QA/QC in-charge will plan, verify the process checklist and ensure that the Stage inspection/Routine/FAT are conducted as per approved quality plan in line with the Technical Specification.
- (b) Manufacturer will submit soft copies of Photographs and Calibration Certificates with a proper index sheet duly certified from their end in order to demonstrate readiness of the Transformer for inspection/testing.
- (c) The Date and time and arrangement for online stage inspection/FAT shall be finalized in consultation with the utility/purchaser.
- (d) Online inspection/FAT shall be done through online application platforms like – Microsoft Teams, Skype, Google meet, Google hangout, WhatsApp, etc., considering the system compatibility and security in consultation with the utility/purchaser. Online recording facility of the activities performed or witnessed must be available at manufacturer's end at all time for customer's reference/review/record.

- (e) Utility's/purchaser's approval shall be taken in advance for the virtual stage inspection/FAT including the specific online application platform that will be used.
- (f) Whenever required the Mock trial may be carried out at manufacturer's work to get hands on experience before offering to customer.
- (g) All issues must be discussed and resolved before commencement of inspection/tests.
- (h) The Test circuits and Test procedure shall be shared with utility's/purchaser's inspector for clarity & better understanding.
- (i) Application link and security password shall be shared with the utilities's/purchaser's inspecting officer on the same day of inspection and password must be secured to maintain the confidentiality.
- (j) While conducting remote FAT, due care must be taken to keep the data safe while transmitting from factory to utility's/ purchaser's inspector through a web-based application. There are various Cybersecurity requirements and InfoSec protocols, which should be adhered to for safety like Database Security, Strong Password Policy, Access Control, Restricted Access via 2-Factor Authentication for utility/purchaser, Single Session or Timed Sessions, Resetting Passwords, Password Expiry Policy, Validations for 3rd Party participants, Authentication for users/test engineers etc.
- (k) All tests shall be conducted as per relevant latest standards/procedures mentioned in the Technical Specification. The readings recorded in each test will be shown to remote-end inspector live for witness/acceptance. At the end of each test, either side shall discuss the summary of test results to avoid ambiguity at later stage. During Temperature Rise test, the HOT resistance has to be measured at the time of shutdown of power supply to Transformer. The camera position shall be suitably placed, so that the readings are visible without any obstruction by the working personnel. As far as possible, resistance measurement should be done inside the Control Room to avoid any obstructions or interfere of personnel.
- (l) During testing, one camera shall always be focused towards test bay area where the transformer is under test for online overview of connections. If one camera is not enough to see both transformer and test leads, more no. of cameras shall be deployed. This will enable complete testing connection overview to inspecting officer all the time.
- (m) The camera must be operated by the authorized person of the manufacturer as per the direction of the inspection team [representatives of utility/purchaser]. The inspection team should have the facility to communicate directly with the manufacturer's representative for a thorough & effective inspection including the physical verification of the dimension, surface defect etc.

- (n) The image quality shall be good enough for assessment of the condition of the transformer which may affect the quality & performance of transformer. The factors affecting image quality include:
- Poor image resolution.
 - Image out of focus.
 - Inadequate lighting /Glare from strong light source/shadows
 - Frequent loss of connectivity between the Inspection team and the onsite Video monitors.
- (o) The Two-way Audio-Video communication Scheme for stage inspection/FAT of transformer through web shall be as follows:



- (p) The camera should be focused for continuous visibility of the test values in the meters so that the utility's/purchaser's inspector can see the test values throughout the Inspection.



- (q) During the stage Inspection/FAT, test results/readings & test connections shall be recorded and mailed to the utility's/ purchaser's inspector.
- (r) The manufacturer has to prepare test report on daily basis during testing period by the end of each day. Test Reports must be issued by the testing in charge of manufacturer indicating list of Tests carried out and the test results.
- (s) For long duration tests (Temperature rise and partial discharge and impulse), manufacturer shall ensure that Cameras shall be provided near transformer under test and the Power analyser or equipment's computer so that the readings can be seen simultaneously.
- (t) After completion of inspection, OEMs representative should sign off from the application.
- (u) After getting stage inspection Clearance from utility/purchaser, the transformer may be moved to next stage of manufacturing process and after getting FAT Clearance from utility/purchaser.

- (v) All video recording of the inspection shall be done and it shall be shared with the utility / purchaser and also to be maintained by manufacturer/OEM for future reference.
- (w) The MoM of the stage inspection/FAT shall be prepared by the manufacturer/OEM and all points discussed & agreed including rectification/punch points, completion date etc. shall be communicated to the utility/purchaser.
- (x) Final Stage inspection report/FAT reports, supporting documents and photographs should be submitted to utility / purchaser for their future reference and record.

The online virtual inspection & testing process at manufacturer's/OEM's premises will benefit both manufacturer and the utility/purchaser in terms of time, money & manpower/human resources and would be easier and faster.

5.05.3 The Inspector shall within ten (10) days from the date of inspection as defined herein give notice in writing to the Manufacturer, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The manufacturer shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

5.05.4 Deleted

5.05.5 In all cases where the contract provides for tests whether at the premises or works of the Manufacturer or any sub-suppliers, the Manufacturer, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Inspector to carry out effectively such tests on the equipment in accordance with the Manufacturer and shall give facilities to the Inspector to accomplish testing.

5.05.6 The inspection by the Inspector and issue of **Joint Inspection report thereon shall in no way limit the liabilities and responsibilities of the manufacturer in respect of the agreed Quality Assurance Programme forming a part of the contract.**

5.05.7 All inspection, measuring and test equipment used by manufacturer shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The manufacturer shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by purchaser. In case repair is carried out in the measuring and test equipment it should be compulsorily re- calibrated. All calibrated measuring and test equipment must be properly sealed after calibration to stop any kind of manipulation with the equipment. Wherever mutually agreed between manufacturer & Purchaser, the manufacturer shall re-calibrate the measuring/test equipment in the presence of the Inspector.

5.05.8 Preparation of inspection report is the concluding part of inspection. Every inspection agency has its own style of preparation of inspection report. However, since it is a quality document, we must ensure that all relevant information and enclosures are made available along with the report. The inspection report has mainly three parts:

- a) The first part contains details of equipment, contract detail, quantity offered, sampling, observation noted during inspection, remark on test results etc.
- b) The second part contains reports on physical verification.
- c) The third part of the report contains the routine test results of the inspected transformers, temperature rise test results, if carried-out, and few demonstrative sample calculations e.g. Load Loss calculation at normal and extreme taps, Temperature rise calculation, Noise level calculation etc.
- d) Calibration certificates for all the testing equipments, test certificates of raw materials etc.

6.0 INSPECTION AND TESTING

The inspection envisaged by the purchaser is given below. However, the manufacturer shall draw up and carry out a comprehensive inspection and testing programme in the form of detailed quality plan duly approved by Purchaser for necessary implementation during manufacture of the equipment. All accessories and components of transformer shall be purchased from source, approved by the purchaser. All process tests, critical raw material tests and witness/ inspection of these testing shall be carried out as per approved Manufacturing Quality Plan (MQP) by the purchaser.

6.1 Factory Tests

- 6.1.1 The manufacturer shall carry out all type & routine tests specified in “**Annexure-D** and **Annexure-E**”. All tests shall be done in line with latest IS: 2026/IEC 60076 or as per procedure specified in this document. Complete test report shall be submitted to purchaser after proper scrutiny and signing on each page by the test engineer of the manufacturer.
- 6.1.2 The manufacturer shall be fully equipped to perform all the required tests as specified. He shall confirm the capabilities of the proposed manufacturing plant in this regard. Any limitations shall be clearly stated.
- 6.1.3 The manufacturer shall bear all additional costs related to tests which are not possible to carry out at their own works.
- 6.1.4 In case, any failure observed during factory testing involving winding/ winding shield/ static shield ring, then affected winding of all phases shall be replaced by new one mutually agreed between manufacturer & Purchaser.

6.2 Tank Tests

(A) Oil Leakage Test

All tanks and oil filled compartments shall be completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure equal to normal head of oil plus 35 kN/sq.m (5 psi) measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours for oil and 1 hour for air during which no leakage shall occur.

B) Vacuum Test

All transformer tanks shall be subjected to the specified vacuum. The tank designed for full vacuum (760 mm of mercury at sea level) shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length of flat plate (in mm)	Permanent deflection (in mm)
Up to And including 750	5.0
751 To 1250	6.5
1251 To 1750	8.0
1751 To 2000	9.5
2001 To 2250	11.0
2251 To 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

C) Pressure Test

All transformer tanks, its radiator, conservator and other fittings together or separately shall be subjected to a **pressure corresponding to twice the normal head of oil or normal oil head pressure plus 35 KN/ sq.m whichever is lower, measured at the base of the tank and maintained for eight hours.** The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

6.3 Stage Inspection

- 6.3.1 **Stage inspection** will be carried out by the Inspector **on Core, Winding, core-coil assembly & Tank during the manufacturing stages** of the transformer. The manufacturer will have to call for the stage inspection and shall arrange the inspection at manufacturer's premises or manufacturer's sub-supplier's premises, as applicable, free of cost.
- 6.3.2 **Stage inspection will be carried out on at least one Transformer (at the discretion of purchaser)** against an offer of minimum 50% of the ordered

quantity as mentioned in delivery schedule. On the basis of satisfactory stage inspection, manufacturer will proceed further.

6.3.3 The manufacturer will offer the core for stage inspection and get approval from purchaser during manufacturing stage. **The BIS certified prime core materials are only to be used.** The manufacturer has to produce following documents at the time of stage inspection for confirmation of use of prime core materials.

1. Invoice of supplier
2. Mills' approved test certificates
3. Packing list
4. Bill of lading
5. Bill of entry certificate by custom.
6. Description of material, electrical analysis, physical inspection, certificate for surface defects, chemical composition certificate, thickness and width of the materials
7. Place of cutting of core materials

6.3.4 To avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, **the imported packed slit coils of CRGO materials shall be opened in the presence of the Inspector. Only after the inspection and approval from purchaser, the core material will be cut in-house or sent to external agency for cutting individual laminations.** In case the core is sent to external agency for cutting, the Inspector will have full access to visit such agency for the inspection of the cutting of core. Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

6.3.5 Typical example for calculation of flux density, core quantity, no-load loss and weight of copper during stage inspection shall be as per "Standard Specifications and technical Parameters for Transformers and Reactors (66 kV & above voltage class)" of CEA.

6.4 Type Tests on fittings

Following fittings shall conform to type tests and the type test reports shall be furnished along with drawing of the equipment/fittings.

- a) Bushing (Type test as per IS/IEC:60137)
- b) OLTC (Test as per IS 8468/IEC:60214 and degree of protection test for IP-55 on Driving mechanism box)
- c) Buchholz relay
- d) OTI and WTI
- e) Pressure Relief Device (including degree of protection test for IP 55 in terminal box)
- f) Sudden Pressure Relay (including degree of protection test for IP 55 in terminal box)
- g) Magnetic Oil Level gauge & Terminal Box degree of protection test for IP-55.
- h) Air Cell (Flexible air separator) - Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per IS: 3400/ BS: 903/ IS: 7016

- i) Marshalling & common marshalling box and other outdoor cubicle (IP-55 test)
- j) Bus post Insulators
- k) Oil pump
- l) Cooling fan & motor assembly
- m) RTCC Panel (IP-43 test)

6.5 Pre-shipment Checks at Manufacturer's Works

The following pre-shipment checks shall be done at manufacturer's works:

6.5.1 Check for inter-changeability of components of similar transformers for mounting dimensions.

6.5.2 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, Buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

6.5.3 Ensure following setting of impact recorder at the time of installation with transformer unit before despatch from factory:

1g: Start recording

2g: Warning

3g: Alarm

Further, drop-out setting shall be 1g and threshold setting shall be in the range of 5g to 10g.

6.5.4 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

6.5.5 Gas tightness test to confirm tightness and record of dew point of dry air inside the tank. Derivation of leakage rate and ensure the adequate reserve dry air capacity.

6.5.6 Due security arrangements to be ensured during transportation to avoid pilferage and tempering with the valves and other accessories used while dry air filling.

7.0 UNLOADING OF TRANSFORMERS INCLUDING HANDLING AND PLACEMENT ON PLINTH, ERECTION, TESTING & COMMISSIONING OF TRANSFORMERS AT SITE:

The supplier shall have to do unloading of transformers including handling and placement on plinth, erection, testing & commissioning of the transformers at site supplied by them. They shall quote charges accordingly in the schedule of price. Such quoted rates shall be considered for tender evaluation.

The charge for deputation of their service engineer on per day basis shall also be quoted in the price bid. This will not be considered for tender evaluation.

Upon the transformer having successfully erected & completed the required site tests and commissioned, the purchaser or its authorized engineer, after satisfying that the equipment is in full and satisfactory working condition, will issue a Job completion certificate which will form basis for payment of their service bills.

8.0 SPARE PARTS & MAINTENANCE EQUIPMENTS:

The tenders shall quote separately for mandatory spares as specified in the schedule. The make and type of such spares offered shall be same as those offered along with the main transformer and interchangeable with the similar items. The prices offered for supply of these spares shall be taken into consideration for the purpose of bid evaluation.

The tenderers shall also indicate in their proposal and quote their rates for any other spares recommended for the trouble free operation of the equipment for five years. The prices of these optional spares shall not be taken into consideration for the purpose of bid evaluation. The purchaser shall decide the actual quantities of spare parts to be included in the order on the basis of this list and the item-wise prices of spare parts.

9.0 ERECTION AND MAINTENANCE TOOLS:

The tenderers shall separately list out in their tender the sets of tools required for initial erection and subsequent maintenance for the power transformer and the associated equipment. The prices quoted for such tools shall not be taken into consideration for the purpose of bid evaluation.

10.0 VENDOR SELECTION FOR MOUNTING ACCESSORIES:

S. No.	Item Description	Proposed make
1.	Core	Core materials to be procured directly from authorized dealer of CRGO manufacturer as following:
		POSCO, Korea
		NIPPON, Japan
		JFE, Japan
2.	Winding	HINDALCO
		Hindustan Copper
		Sterlite
	CTC Conversion	Asta India, Vadodara
		KSH International, Chakan
		Precision Wires, Silvassa
		Sri Cables & Conductors (P) Ltd., Bhopal
	3.	Transformer Oil
4.	Paper Insulation for Conductor	Weidman Electrical, Switzerland
		Smurift Munksjo, Sweden

5.	Pre-compressed Board	ABB, Sweden
		H Weidman, Switzerland
		Senapathy Whiteley, Bangalore
		Raman Boards, Mysore
6.	Un-impregnated Densified Wood	Permali Wallace, Bhopal
		Western India Plywood, Cannanore
7.	Bushing CT	Mahindra Electricals, Mumbai
		BHEL, Bhopal
		Pragati Electricals Pvt. Ltd., Thane
		A.U. Electric Machines, Allahabad
8.	Tank	Self manufacturing as well as outsourced
	Sheet	SAIL, RINL, TISCO, IISCO
	Tank fabricator	Satyam Industries, Bhopal
		Allahabad Enterprises, Allahabad
		Jyoti Fabricator, Naini
9.	OIP Bushing	Alstom
		CGL, Nasik/Aurangabad
		ABB
9.	RIP/ RIS Bushing	ABB
		GE GRID SOLUTIONS
		YASH HIGHVOLTAGE LTD, VADODARA
10.	Porcelain Bushing Insulator	CJI, Khurja
		W S Industries, Chennai
		Jayashree Insulators, Halol
		BHEL, Bangalore
11.	Rubber Gasket	Nu Cork Products, Bhiwadi
		Bombay Oil Seal Mfg Co., Mumbai
12.	Marshalling Box	BHEL, Bhopal
		Pyrotech, Udaipur
		C&S, Noida
		United Industrial Components Co., Navi Mumbai
		Ashoka Electronic, Bhopal
		Own make subject to valid type test report
13.	Terminal Connector	Nootan, Vadodara
		Milind Engineering, Mumbai
14.	Bucholz Relay	EMB, Germany
		Sukrut Electric, Pune
15.	OTI/WTI	Perfect Control, Chennai

		Precimeasure, Bangalore
16.	OLTC	BHEL, Bhopal
		CTR, Pune
		ABB, Sweden
		Easun MR, Chennai
17.	Radiators	CTR, Pune
		Transpares, Ahmedabad
		Hi Tech Radiators, Mumbai
		Thermal Transfer, Bangalore
		Gururaj Radiators Pvt. Ltd., Naini
18	Silicagel Breather (Maintenance free)	MESSKO
19.	Fibre Optic Sensor	Rugged Monitoring Inc, Canada
20.	Valves	Leader Valves, Jalandhar
		VIAT INSTRUMENTS PVT. LTD., AHMEDABAD
		GG Valves Ltd, Udaipur
		Petson Valves, Coimbatore
		APEX PIPING SYSTEM PVT. LTD., JALANDHAR
21.	PRV (Pressure Release Valve)	Sukrut, Pune
		Qualitrol Company, USA
		MESSKO, Germany
		VIAT INSTRUMENTS PVT. LTD., AHMEDABAD
22.	Cooling fan	Marathon, Kolkata
		Khaitan, Kolkata
		CGL
23.	MOG	MESSKO,
		SUKRUT ELECTRIC CO. LTD, CHAKAN
		VIAT INSTRUMENTS PVT. LTD., AHMEDABAD

ANNEXURE -A-1**GTP for 50 MVA 132/33 kV, 3-Phase Power Transformer**

S. No.	Description	Unit	TECHNICAL PARAMETERS
1.	Voltage ratio (Line-to-Line)	kV	132/33
2.	Rated capacity (HV and LV)	MVA	50
3.	No of phases		3 (Three)
4.	Vector Group		YNyn0
5.	Type of transformer		Power Transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Cooling type		ONAN/ONAF
8.	Rating at different cooling	%	60 / 100
9.	Cooler Bank Arrangement		2 X 50%
10.	Frequency	Hz	50
11.	Tap changer		
i)	Type		On-load tap changer (CFVV)
ii)	Tapping range and steps		-15% to +5% in steps of 1.25% for HV variation
iii)	Location of tap changer		On HV neutral end
12.	HV-LV Impedance at 75 °C, at highest MVA base		
i)	Max. Voltage tap	%	13.2
ii)	Principal tap	%	12.5
iii)	Min. Voltage tap	%	11.8
13.	Tolerance on Impedance	%	No negative Tolerance on Principal Tap
14.	Service		Outdoor
15.	Duty		Continuous
16.	Overload Capacity		IEC 60076-7
17.	Temperature rise over 50°C ambient temp.		

i)	Top oil measured by thermometer	°C	45
ii)	Average winding measured by resistance method	°C	50
18.	Winding hot spot rise over yearly weighted temperature of 32 °C	°C	61
19.	Tank hot spot temperature	°C	110
20.	Maximum design ambient temperature	°C	50
21.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	650 (132 kV)
	LV	kVp	170
	HV Neutral	kVp	95
	LV Neutral	kVp	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	715 (132 kV)
	LV	kVp	187
iii)	Switching Impulse withstand Voltage		
	HV	kVp	540 (132 kV)
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	275 (132 kV)
	LV	kVrms	70
	HV Neutral	kVp	38
	LV Neutral	kVp	70
v)	Neutral Grounding (HV and LV)		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤0.5%
22.	Bushings		

i)	Rated voltage		
	HV	kV	145
	LV, LV Neutral & HV Neutral	kV	36
ii)	Rated current (Min.)		
	HV	A	1250
	LV	A	1250
	HV Neutral & LV Neutral	A	1250
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	650
	LV, HV Neutral and LV Neutral	kVp	170
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	305
	LV, HV Neutral and LV Neutral	kVrms	77
v)	Tan delta of bushing at ambient Temperature	%	≤ 0.5
vi)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	mm	4495
	LV, HV Neutral and LV Neutral	mm	1116
	Maximum Partial discharge level at Um on HV	pC	10
23.	Maximum Partial discharge level at $1.58 \cdot U_r / \sqrt{3}$	pC	100
24.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	75 for 50 MVA
25.	Maximum Permissible Losses of Transformers		
i)	Max. No Load Loss at rated voltage and frequency	kW	25
ii)	Max. Load Loss at rated current and frequency and at 75°C at principal tap between HV & LV	kW	125
iii)	Max. $I^2 R$ Loss at rated current and frequency and at 75°C at principal tap between HV & LV	kW	105
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	3

ANNEXURE –B-1 DETAILS OF BUSHING CT AND NEUTRAL CT

Bushing C.T. parameters (on each phase connection):-

<u>a) Ratio</u>	<u>H.V. side</u>	<u>HV Neutral</u>	<u>LV side</u>	<u>LV Neutral</u>
Core -I	400/1	400/1	1000/1	1000/1
Core -II	300/1	-	1000/1	-
<u>b) Minimum knee point voltage-</u>				
Core -I	800V	800V	1000V	1000V
<u>c) Accuracy class</u>				
Core-I	Class- PX	Class-PX	Class- PX	Class- PX
Core-II	0.2s Class ISF≤5	-	0.2s Class ISF≤5	-
<u>d) Burden</u>				
Core-I	30 VA	-	30 VA	-
<u>e) Application</u>				
Core I	REF	REF	REF	REF
Near the winding				
Core II	Metering		Metering	
<u>f) Max. magnetizing current at knee point voltage at core-I</u>				
Core-I	100 mA	100 mA	100 mA	100 mA
Core-II	-	-	-	-
<u>g) Maxim C.T Resistance</u>				
Core-I	1.5 Ohms	1.5 Ohms	1.5 Ohms	1.5 Ohms
Core-II	-	-	-	-

Note:

- i) Parameters of WTI CT for each winding shall be provided by the contractor.
- ii) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.
- iii) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.
- iv) Class (for the relevant protection & duties) as per IEC 185.

ANNEXURE -A-2

GTP for 160 MVA 220/132 kV, 3-Phase Auto Transformer

S. No.	Description	Unit	TECHNICAL PARAMETERS
1.	Voltage ratio (Line-to-Line)	kV	220/132
2.	Rated capacity (HV and LV)	MVA	160
3.	No of phases		3 (Three)
4.	Vector Group		YNa0
5.	Type of transformer		Auto Transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Cooling type		ONAN/ONAF/OFAF
8.	Rating at different cooling	%	60 /80/ 100
9.	Cooler Bank Arrangement		2 X 50%
10.	Frequency	Hz	50
11.	Tap changer		
i)	Type		On-load tap changer
ii)	Tapping range and steps		-10% to +10% in steps of 1.25% for HV variation
iii)	Location of tap changer		On HV neutral end
12.	HV-LV Impedance at 75 °C, at highest MVA base		
i)	Max. Voltage tap	%	10.3
ii)	Principal tap	%	12.5 (No negative tolerance)
iii)	Min. Voltage tap	%	15.4
13.	Tolerance on Impedance	%	As per IEC with no negative tolerance
14.	Service		Outdoor
15.	Duty		Continuous
16.	Overload Capacity		IEC 60076-7
17.	Temperature rise over 50°C ambient temp.		

i)	Top oil measured by thermometer	°C	45
ii)	Average winding measured by resistance method	°C	50
18.	Winding hot spot rise over yearly weighted temperature of 32 °C	°C	61
19.	Tank hot spot temperature	°C	110
20.	Maximum design ambient temperature	°C	50
21.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	950
	LV	kVp	650
	Neutral	kVp	95
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	1045
	LV	kVp	715
iii)	Switching Impulse withstand Voltage		
	HV	kVp	750
	LV	kVp	540
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	395
	LV	kVrms	275
	Neutral	kVp	38
v)	Neutral Grounding (HV and LV)		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤0.5%
22.	Bushings		

i)	Rated voltage		
	HV	kV	245
	LV	kV	145
	Neutral		36
ii)	Rated current (Min.)		
	HV	A	1250
	LV	A	1250
	Neutral	A	2000
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	1050
	LV	kVp	650
	Neutral	kVp	170
iv)	Switching Impulse withstand voltage on HV	kVp	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	505
	LV	kVrms	305
	Neutral	kVrms	77
v)	Tan delta of bushing at ambient Temperature	%	≤ 0.5
vi)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV		7595
	LV	mm	4495
	Neutral	mm	1116
vii)	Maximum Partial discharge level at Um on HV & LV	pC	10
23.	Maximum Partial discharge level at $1.58 \cdot U_r / \sqrt{3}$	pC	100
24.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	75
25.	Maximum Permissible Losses of Transformers		
i)	Max. No Load Loss at rated voltage and frequency	kW	30
ii)	Max. Load Loss at rated current and frequency and at 75°C at principal tap for HV & LV	kW	200
iii)	$\frac{2}{2}$ Max. I ² R Loss at rated current and frequency and at 75°C at principal tap for	kW	145

	HV & LV		
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	6

ANNEXURE – B-2 – DETAILS OF BUSHING CT AND NEUTRAL CT for 160 MVA Transformer

Description	Current Transformer Parameters (Transformer)		
	HV Side	IV Side	Neutral Side
(a) Ratio			
CORE 1	1000/1	1000/1	1000/1
CORE 2	600/1	1000/1	-
(b) Minimum knee point voltage or burden and accuracy class			
CORE 1	1000V, PX / PS	1000V, PX / PS	1000V, PX / PS
CORE 2	0.2S Class 15VA ISF ≤ 5	0.2S Class 15VA ISF ≤ 5	-
(c) Maximum CT Secondary Resistance			
CORE 1	1.5 Ohm	1.5 Ohm	1.5 Ohm
CORE 2	-	-	-
(d) Application			
CORE 1	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault
CORE 2	Metering	Metering	-
(e) Maximum magnetization current (at knee point voltage)			
CORE 1	100 mA	100 mA	100 mA
CORE 2	-	-	-

Note:

- i) **Parameters of WTI CT for each winding shall be provided by the contractor and finalized at the time of approval.**
- ii) **For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.**
- iii) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.
- iv) Class (for the relevant protection & duties) as per IEC 185.

ANNEXURE-C GUARANTEED AND OTHER TECHNICAL PARTICULARS FOR POWER TRANSFORMER

(To be filled in by the manufacturer)

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufacturer
1.	General Information i) Supplier ii) Name of Manufacturer iii) Place of Manufacture (Country & City) iv) Type of transformer (Core/Shell)			
2.	Applications i) Indoor/Outdoor ii) 2wdg/3wdg/Auto iii) GT/Step-down/ICT/Station Start-up/ Auxiliary/ Rail Trackside Supply iv) Bi directional			
3.	Corrosion Level at Site i) Light ii) Medium iii) Heavy iv) Very Heavy			
4.	Site altitude above mean sea level	m		--
5.	Seismic zone and ground acceleration at site (both in horizontal & vertical direction)			--
6.	Maximum and minimum ambient temperature at site			
7.	Applicable Standards i) IEC: 60076 ii) IS : 2026 iii) Any other, please specify			
8.	Rated Capacity / Full load rating (HV/LV)	MVA		
9.	3-Phase/Bank of Three Single Phase (A,B,C)			
10.	Rated No Load Voltages (HV /LV)	kV		
11.	Currents at normal tap (HV /LV)	Amp		
12.	Rated Frequency	Hz		
13.	Connections and phase displacement symbols (Vector Group)			
14.	Weight Schedules (Minimum with no negative tolerance)			

	i) Active part (Core + coil)	kg		
	ii) Insulating Oil (excluding mass of extra oil)	kg		
	iii) Tank and Fittings	kg		
	iii) Total weight	kg		
	iv) Transportaion Weight	kg		
	v) Overall dimensions L x B x H	mm		
	vi) Size of heaviest package L x B x H	mm		
	vii) Weight of heaviest package	kg		
	viii) Weight of 10% extra oil	kg		
	ix) Weight of core	Kg		
	x) Weight of copper (HV/LV/ Regulating)	kg		

	xi) Insulating Oil volume (excluding 10% extra oil)	Ltrs		
	xii) Quantity of oil in OLTC	Ltrs		
15.	Transport limitation			
16.	LV Winding i) Stabilizing tertiary (Yes/No) ii) Loaded (Yes/No)			
17.	Tappings i) Type (OLTC/OCTC) and make of tap changer ii) Position of Tapping on the winding iii) Variation on iv) Range of variation v) No. of Steps vi) Whether control suitable for : • Remote/local operation • Auto/manual operation vi) Parallel Operation Requirements	%		
18.	Impedance and Losses			
	i) Guaranteed No load loss at rated voltage and frequency	kW		
	Tolerance (to be considered for loss evaluation)	%		
	ii) Guranteed I ² R Loss at rated current & frequency (at 75 ⁰ C) at principal tap	kW		
	Tolerance (to be considered for loss evaluation)	%		
	iii) Eddy current and stray loss at rated current & frequency (at 75 ⁰ C) at principal tap	kW		

	iv) Load Loss(I^2R +Eddy and Stray) at rated current & frequency (at 75 ⁰ C) at principal tap	kW		
	v) Guaranteed Auxiliary loss at rated voltage and frequency	kW		
	Tolerance (to be considered for loss evaluation)	%		
	vi) Calculated Fan Loss	kW		
	vii) Calculated Pump Loss	kW		
	viii) Air core reactance of HV winding	%		
	ix) Guaranteed Impedance (at Highest MVA base)	%		
	(a) HV-LV(at Principle tap)			
	Tolerance			
	x) Impedance at extreme tappings at Highest MVA base [for HV-LV for two winding transformer] a) Max. Voltage tap b) Min. Voltage tap	%		
	Tolerance	%		
	xi) Zero sequence impedance at principal tap (for 3-phase transformers)			
19.	Capacitance to earth for HV/LV	pF		
20.	Regulation at full load at 75 ⁰ C winding temperature at: a. upf b. 0.8 pf			
21.	Guaranteed maximum Magnetizing Current at rated Voltage	%		

22.	Efficiency : At 100% load upf 0.8 lead 0.8 lag At 75% load upf 0.8 lead 0.8 lag At 50% load upf 0.8 lead 0.8 lag	%		
23.	Load at Maximum efficiency	%		
24.	Any limitations in carrying out the required test? If Yes, State limitations			
25.	Fault level of system (in kA) and its duration (in sec)	kA (sec)		

26.	Calculated short Circuit current (in kA) withstand capability for 2 seconds without exceeding temperature limit (i.e. Thermal ability to withstand SC current)	kA		
27.	Test current (in kA) and duration (in ms) for short Circuit current test (i.e. Dynamic ability to withstand SC)	kA & msec		
28.	Over fluxing withstand time (due to combined voltage & frequency fluctuations): 110% 125% 140% 150% 170%	msec		
29.	Free space required above the tank top for removal of core			
30.	Maximum Partial discharge level at $1.58 U_r/\sqrt{3}$	pC		

A. MAGNETIC SYSTEM

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufa-cturer
1.	Core Type: i) 3 Phase 3 Limb (3 wound limbs) ii) 3 Phase 5 Limb (3 wound limbs) iii)1 Phase 2 Limb (2 wound limbs) iv)1 Phase 3 Limb (1 wound limb) v) 1 Phase 4 Limb (2 wound limbs) vi)1 Phase 5 Limb (3 wound Limbs)			
2.	Type of Core Joint: i) Mitred ii) Step Lap			
3.	CRGO : i) Make & Country of Origin ii) Thickness, mm iii) Max. Specific loss at 1.7 T, 50Hz, in Watts/kg iv) Grade of core as per BIS v) Insulation between core lamination vi) BIS certified (Yes/No)			

4.	Minimum Gross & Net Area of: i) Core ii) Limb iii) Yoke iv) Unwound limb (May be verified during manufacturing stage – at the discretion of buyer)	cm ²	
5.	Stacking Factor	%	
6.	Voltage per turn	V	

7.	Apparent Core Density for Weight Calculation			
8.	Minimum Net Weight of Silicon Steel Lamination CRGO (may be verified during manufacturing stage by calculation)	kg		
9.	Maximum Flux density at 90%, 100% and 110% voltage and frequency (may be verified during manufacturing stage by calculation)	T		
10.	W/kg at working flux density			
11.	Building Factor Considered			
12.	Calculated No Load Loss at rated voltage and Frequency (Net Weight x W/kg x Building factor)	kW		
13.	Magnetizing inrush current	Amp		
14.	No load current at normal ratio and frequency for : 85% of rated voltage 100% of rated voltage 105% of rated voltage	Amp		
15.	Core Isolation test	kV		
16.	Core bolt in limb / yoke	Yes/No		
17.	Core bolt insulation withstand voltage for one minute	kV		
18.	Maximum temperature rise of any part of core or its support structure in contact with oil	°C		

B. CONDUCTING SYSTEM

Sl. No.	Description	Unit	Offered by manufacturer			
			HV	IV	LV	Regulating

1.	Type of Winding Helical/Disc/Layer/interwound					
----	---	--	--	--	--	--

2.	Type of Conductor PICC/CTC/CTCE/CTCEN/BPICC					
3.	Minimum Yield Strength of Conductor for 0.2% elongation	N/mm ²				
4.	Maximum Current density at CMR and conductor area at any tap: i) HV ii) LV	A/mm ² & sq. mm				
5.	Maximum current density under short circuit: i) HV ii) LV	A/mm ²				
6.	Bare Weight of copper without paper insulation and lead (Minimum)	Kg				
7.	Per Phase Maximum resistance of winding at rated tap at 75 °C	ohm				
8.	Number of Turns/Phase					
9.	Insulating material used for HV/LV winding					
10.	Insulating material used between : i) HV and LV winding ii) Regulating winding and adjacent winding/core					
11.	Details of special arrangement					

12.	Dielectric Shielding used: i) Interleaved winding ii) Wound in Shield iii) Others					
13.	Magnetic Shielding used: i) Yoke Shunt on core clamp ii) Magnetic shunt on tank iii) Electromagnetic (Copper/Aluminum) shield on tank iv) Others					
14.	Noise level when energized at normal voltage and frequency without load	dB				

C. COOLING SYSTEM

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufacturer
1.	Type of Cooling [ONAN (or) ONAN/ONAF (or) ONAN / ONAF / OFAF (or) ONAN / ONAF/ ODAF (or) ONAN / ONAF1 / ONAF2 etc.]			
2.	Percentage Rating Corresponding to Cooling Stages (HV/LV)			
3.	No. of Cooler banks (2x50% / 2x100% / 1x100% etc.)			
4.	Temperature gradient between windings and oil			
5.	Time in minutes for which the transformer can run at full load without exceeding temperature when supply to fans and / or pumps is cut off	min		

6.	Guaranteed Maximum Temperature rise at 1000 mts. altitude and at actual altitude at site at ambient temperature at cooling specified at sl. No. 1: i) Top Oil by thermometer ii) Average Winding by resistance iii) Winding hot spot	°C		
7.	Type of Cooler: i) Radiator Bank ii) Oil to Air Heat Exchanger (Unit Cooler) iii) Oil to Water Cooler (Single Tube) iv) Oil to Water Cooler (Double Tube) v) Tank Mounted vi) Header Mounted vii) Separately Mounted viii) Degree of Protection of terminal box			

8.	<p>Cooling Fans:</p> <ul style="list-style-type: none"> i) Type ii) Size iii) Rating (kW) iv) Supply voltage v) Quantity (Running + Standby) per cooler bank vi) Whether fans are suitable for continuous operation at 85% of their rated voltage calculated time constant: <ul style="list-style-type: none"> ● natural cooling ● forced air cooling vii) Degree of Protection of terminal box 			
9.	<p>Oil Pumps:</p> <ul style="list-style-type: none"> i) Type ii) Size iii) Rating (lpm and kW) iv) Supply voltage v) Quantity (Running + Standby) per cooler bank vi) Efficiency of motor at full load vii) Temperature rise of motor at full load viii) BHP of driven equipment 			
10.	<p>Coolers (Oil to Air):</p> <ul style="list-style-type: none"> i) Quantity (Running + Standby) ii) Type and Rating 			
11.	<p>Coolers (Oil to Water):</p> <ul style="list-style-type: none"> i) Quantity (Running + Standby) ii) Type and Rating iii) Oil flow rate (lpm) iv) Water flow rate (lpm) v) Nominal Cooling rate (kW) vi) Material of tube 			
12.	<p>Radiators:</p> <ul style="list-style-type: none"> i) Width of elements (mm) ii) Thickness (mm) iii) Length (mm) iv) Numbers 			
13.	Cooler loss at rated output, normal ratio, rated voltage, rated frequency at ambient temperature of 50°C	kW		

D. DIELECTRIC SYSTEM

Sl. No.	Description	Unit	Offered by manufacturer				
1.	Geometric Arrangement of winding with respect to core e.g: Core-LVHV-Reg Coarse-Reg Fine						
2.	Regulating Winding: i) Body Tap ii) Separate						
3.	HV Line Exit point in winding: i) Top ii) Center						
4.	Varistors used across Windings If yes, Details	Yes/No					
5.	Insulation Levels of windings		HV	IV	LV	HV-N	IV-N
	i) Lightning Impulse withstand voltage (1.2/50 μ s)	kV _p					
	ii) Chopped wave Lightning Impulse withstand voltage	kV _p					
	iii) Switching Impulse withstand voltage (250/2500 μ s)	kV _p					
	iv) Power frequency withstand voltage	kV _{rms}					

	(one minute / 5 minutes)						
6.	Tan delta of windings at ambient temperature	%					

E. ACCESSORIES

Sl. No.	Description	Unit	Offered by manufacturer	Specified by Buyer
1.	Tap Changers			
	i) Control a-Manual b-Automatic c-Remote d-Local			
	ii) Voltage Class and Current Rating of Tap Changers			
	iii) Make and Model			
	iv) Make and Type of Automatic Voltage Regulator (AVR)			
	v) Tie-in resistor requirement (to limit the recovery voltage to a safe value) and its value			
	vi) OLTC control and monitoring to be carried out through Substation Automation System	Y/N		
	vii) Power Supply for control motor (No. of Phases/Voltage/Frequency)			
	viii) Rated Voltage for control circuit (No. of Phases/Voltage/Frequency)	V		
2.	Tank			
	i) Tank Cover: Conventional/Bell/Bottom Plate			
	ii) Material of plate for tank			
	iii) Plate thickness : side, bottom, cover	mm		
	iv) Rail Gauge	mm		
	v) Minimum Clearance height from rail for lifting Active Part	mm		
	vi) Wheels : Numbers/Plane/Flanged/Uni-Directional/Bi-Directional/Locking Details			
	vii) Vacuum withstand Capability (a) Tank (b) Radiators/Conservator/Accessories	mm of Hg		

	viii) High Pressure withstand Capability (a) Tank (b) Radiators/Conservator/Accessories	mm of Hg				
	ix) Radiator fins/ conservator plate thickness	mm				
	x) Tank Hot spot temperature	°C				
3.	Bushings:		HV	IV	LV	HV-N LV-N
	i) Termination Type a-Outdoor b-Cable Box (oil/Air/SF ₆) c-Plug in Type					
	ii) Type of Bushing: OIP/RIP/RIS/oil communicating					
	iii) Bushing housing - Porcelain / polymer					
	iv) Rated Voltage Class	kV				
	v) Rated Current	A				
	vi) Lightning Impulse withstand voltage (1.2/50µs)	kV _p				

	vii) Switching Impulse withstand voltage (250/2500µs)	kV _p				
	viii) One minute Power frequency withstand voltage (dry & wet)	kV _{rms}				
	ix) Minimum Creepage Distance	mm				
	x) Quantity of oil in bushing and specification of oil used					
	xi) Make and Model					
	xii) Tan delta of bushings	%				
	xiii) Max Partial discharge level at U _m	pC				
	xiv) Terminal Pad details					
	xv) Weight of assembled bushings	kg				
	xvi) Whether terminal connector for all bushings included in the scope of supply					
4.	Minimum clearances between bushings (for HV, IV and LV) (a) Phase to phase (b) Phase to ground					

5.	Indicator / Relay			
	i) Winding temperature thermometer/ indicator: Range Accuracy			
	iii) Oil temperature thermometer/ indicator: Range Accuracy			
	iii) Temperature sensors by fiber optic			
	iv) Oil actuated/gas operated relay			

	v) Oil level Indicators: Main Conservator OLTC Conservator			
	vi) Oil Sight Window: Main Tank Main Conservator OLTC Conservator			
6.	Conservator: i) Total volume ii) Volume between highest and lowest visible oil levels			
7.	Conservator Bag (air cell) i) Material of air cell ii) Continuous temperature withstand capacity of air cell			
8.	Air cell rupture relay provided	Yes / No		
9.	Pressure Relief Device: i) Number of PRDs provided ii) Location on the tank iii) Operating pressure of relief device			
10.	Sudden Pressure Relay / Rapid Pressure rise relay provided; if yes, i) Location on the tank ii) Operating pressure	Y/N		
11.	Dehydrating Breathers(Type & No. of breathers) (a) For main Conservator tank (b) For OLTC conservator			
12.	Flow sensitive Conservator Isolation valve Provided	Y/N		
13.	Tap Changer protective device			
14.	Type and material of gaskets used at gasketed joints			

15.	Bushing CTs: (HV side and LV side) i) Voltage class ii) No. of cores iii) Ratio iv) Accuracy class v) Burden vi) Accuracy limit factor vii) Maximum resistance of secondary winding viii) Knee point voltage ix) Current rating of secondaries	kV VA Ω V A		
16.	Neutral CTs: i) Voltage class ii) No. of cores iii) Ratio iv) Accuracy class v) Burden vi) Accuracy limit factor vii) Maximum resistance of secondary winding viii) Knee point voltage ix) Current rating of secondaries	kV VA Ω V A		
17.	Transformer Oil i) IS 335 / IEC60296 / as per specification ii) Inhibited/ un-inhibited iii) Mineral / Natural Ester / Synthetic Ester iv) Spare oil as percentage of first filling v) Manufacturer vi) Quantity of oil (before filling and before commissioning) vii) Moisture content (mg/L or ppm) viii) Tan delta (Dielectric Dissipation Factor) at 90°C ix) Resistivity (Ω -cm)			
	x) Breakdown Voltage (before and after treatment) (kV) xi) Interfacial tension at 20 °C (N/m) xi) Pour point (°C) xii) Flash point(°C) xiii) Acidity (mg KOH/gm) xiv) Inhibitors (for inhibited oil) (%) xv) Oxidation Stability			
18.	Press Board: i) Make ii) type			

19.	<p>Conductor Insulating Paper</p> <ul style="list-style-type: none"> i) Kraft paper ii) Thermally upgraded Kraft paper iii) Nomex 			
20.	Provision for fire protection system (as per spec), if yes, provide details	Y/N		
21.	Insulation of core bolts, washers, end plates etc.			
22.	<p>Weights and Dimensions:</p> <ul style="list-style-type: none"> i) Weights: <ul style="list-style-type: none"> a. Core b. Windings c. Tank d. Fittings e. Oil f. Total weights of complete transformers with oil and fittings ii) Dimensions; <ul style="list-style-type: none"> a. Overall Height above track b. Overall length 			

	<p>c. Overall breadth</p> <p>iii) Minimum bay width required for installation of the transformer</p> <p>iv) Weight of the heaviest package of the transformer arranged for transportation</p>			
23.	<p>Lifting Jacks</p> <p>i) Number of jacks included</p> <p>ii) Type and Make</p> <p>iii) Capacity iv) Pitch</p> <p>v) Lift</p> <p>vi) Height in close position</p>			
24.	<p>Rail Track gauges</p> <p>i) 2 Rails or 3 rails or 4 rails</p> <p>ii) Distance between adjacent rails on shorter axis</p> <p>iii) Distance between adjacent rails on longer axis</p>			

ANNEXURE-D TEST PLAN AND PROCEDURES

Tests for Transformers

No.	Test	Um ≤ 170kV	Um > 170kV
1.	Measurement of winding resistance at all taps	Routine	Routine
2.	Measurement of voltage ratio at all taps	Routine	Routine
3.	Check of phase displacement and vector group	Routine	Routine
4.	Measurement of no-load loss and current measurement at 90%, 100% & 110% of rated voltage and rated frequency	Routine	Routine
5.	Magnetic balance test (for three phase Transformer only) and measurement of magnetizing current	Routine	Routine
6.	Short Circuit Impedance and load loss measurement at principal tap and extreme taps	Routine	Routine
7.	Measurement of insulation resistance & Polarization Index	Routine	Routine
8.	Measurement of insulation power factor and capacitance between winding to earth and between windings	Routine	Routine
9.	Measurement of insulation power factor and capacitance of bushings	Routine	Routine
10.	Tan delta of bushing at variable frequency (Frequency Domain Spectroscopy)	Routine	Routine
11.	Full wave lightning impulse test for the line terminals (LI)	Type (for Um≤72.5kV) Routine (for 72.5kV< Um≤170 kV)	-
12.	Chopped wave lightning impulse test for the line terminals (LIC)	Type	Routine
13.	Lightning impulse test for the neutral terminals (LIN)	Type	Type
14.	Switching impulse test for the line terminal (SI) (Not applicable for Um≤72.5 kV)	Type	Routine
15.	Applied voltage test (AV)	Routine	Routine
16.	Line terminal AC withstand voltage test (LTAC) (Not applicable for Um≤72.5 kV)	Routine	Type
17.	Induced voltage withstand test (IVW)	Routine	-

18.	Induced voltage test with PD measurement (IVPD)	Routine*	Routine
19.	Measurement of transferred surge on Tertiary due to HV lightning impulse and LV lightning impulse	-	Type
20.	Measurement of transferred surge on Tertiary due to HV Switching impulse and LV Switching impulse	-	Type
21.	Test on On-load tap changer (Tap changer fully assembled on the transformer)	Routine	Routine
22.	Measurement of dissolved gasses in dielectric liquid	Routine	Routine
23.	Check of core and frame insulation	Routine	Routine
24.	Leak testing with pressure for liquid immersed transformers (tightness test)	Routine	Routine
25.	Appearance, construction and dimension check	Routine	Routine
26.	Measurement of no load current & Short circuit Impedance with 415 V, 50 Hz AC.	Routine	Routine
27.	Frequency Response analysis (Soft copy of test report to be submitted to site along with test reports)	Routine	Routine
28.	High voltage withstand test on auxiliary equipment and wiring after assembly	Routine	Routine
29.	Tank vacuum test	Routine	Routine
30.	Tank pressure test	Routine	Routine
31.	Check of the ratio and polarity of built-in current transformers	Routine	Routine
32.	Temperature rise test	Type	Type
33.	Overload testing in short-circuit method (applicable for 765 kV transformer only)	-	Type
34.	Short duration heat run test (Not Applicable for unit on which temperature rise test is performed)	Routine	Routine
35.	Over excitation test (applicable for 765 kV transformer only)	-	Routine
36.	Measurement of Zero seq. reactance (for three phase Transformer only)	Type	Type
37.	Measurement of harmonic level in no load current	Type	Type
38.	Determination of acoustic sound level	Type	Type
39.	Measurement of power taken by fans and liquid pump motors (Not applicable for ONAN)	Type	Type
40.	Dynamic Short circuit withstand test	As specified in the specification	

***The requirements of the IVW test can be incorporated in the IVPD test so that only one test is required.**

Test Procedures (for Transformer)

General

Tests shall be carried out as per following procedure. However, IS 2026/IEC 60076 (with latest amendments) shall be followed in general for other tests. Manufacturer shall offer the transformer unit for type testing with all major fittings including radiator bank, Marshalling Box, Common Marshalling Box, RTCC (as applicable) assembled.

1. Core assembly dielectric and earthing continuity test

After assembly each core shall be tested for 1 minute at 2000 Volts between all yoke clamps, side plates and structural steel work (core to frame, frame to tank & core to tank).

The insulation of core to tank, core to yoke clamp (frame) and yoke clamp (frame) to tank shall be able to withstand a voltage of 2 kV (DC) for 1 minute. Insulation resistance shall be minimum 1 G Ω for all cases mentioned above.

2. Measurement of winding resistance

After the transformer has been under liquid without excitation for at least 3 h, the average liquid temperature shall be determined and the temperature of the winding shall be deemed to be the same as the average liquid temperature. The average liquid temperature is taken as the mean of the top and bottom liquid temperatures. Measurement of all the windings including compensating (in case terminal is available at outside) at normal and extreme taps.

In measuring the cold resistance for the purpose of temperature-rise determination, special efforts shall be made to determine the average winding temperature accurately. Thus, the difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by a pump.

3. No-load loss and current measurement

As per IEC 60076-1:2011 clause 11.5

4. Measurement of short-circuit impedance and load loss

The short-circuit impedance and load loss for a pair of windings shall be measured at rated current & frequency with voltage applied to the terminals of one winding, with the terminals of the other winding short-circuited, and with possible other windings open circuited. The difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by a pump. Loss measurement for all combinations whichever applicable (HV-IV, HV-LV, IV-LV or otherwise and at Normal and extreme taps).

5. Short term heat run test (Not Applicable for unit on which temperature rise test is performed)

In addition to the type test for temperature rise conducted on one unit, each cooling combination shall routinely be subjected to a short term heat run test to confirm the performance of the cooling system and the absence of manufacturing defect such as major oil flow leaks that may bypass the windings or core.

DGA samples shall be taken at intervals to confirm the gas evolution.

This test is applicable for the Transformer without Pump also (ONAN or ONAF rating). For such type of transformer test may be carried out with the following sequence:

Arrangement shall be required with pump of suitable capacity (considering the oil velocity) without cooler bank.

- Raise the oil temperature 20-25 deg C above ambient.
- Stop power input and pumps for 6 minutes and observe cooling down trend.
- Restart pumps and observe increased cooling trend due to forced oil flow.

6. Temp. Rise Test as per IEC: 60076 (as applicable)

Headspace extraction and Gas chromatographic analysis on oil shall also be conducted before, during and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567.

The temperature rise test shall be conducted at a tap for the worst combination of loading (3-Winding Loss) for the Top oil of the transformer.

3-Winding Loss = HV (Max MVA) + IV (Max MVA).+ LV (Max MVA).

The Contractor before carrying out such test shall submit detailed calculations showing losses on various taps and for the three types of ratings of the transformer and shall recommend the combination that result in highest temperature rise for the test.

The Temperature rise type test results shall serve as a “fingerprint” for the units to be tested only with short term heat run test.

Headspace extraction and Gas chromatographic analysis on oil shall also be conducted before, during and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567.

Oil sample shall be drawn before and after heat run test and shall be tested for dissolved gas analysis. Oil sampling to be done 2 hours prior to commencement of temperature rise test. Keep the pumps running for 2 hours before and after the heat run test. Take oil samples during this period. For ONAN/ONAF cooled transformers, sample shall not be taken earlier than 2 hours after shut down. The acceptance norms with reference to various gas generation rates shall be as per IEC 61181.

The DGA results shall generally conform to IEC/IEEE/CIGRE guidelines.

i. Test conditions for temperature rise test:

- This test shall be generally carried out in accordance with IEC 60076-2
- For each cooling combination with cooler bank, tests shall be done on the maximum current tap for a minimum of 12 hours for ONAN/ONAF or ONAF1 and 24 hours for ODAF or OFAF or ONAF2 with saturated temperature for at least 4 hours while the appropriate power and current for core and load losses are supplied.
- The total testing time, including ONAN heating up period, steady period and winding resistance measurements is expected to be about 48 hours.
- DGA tests shall be performed before and after heat run test and DGA results shall generally conform to IEC/IEEE/CIGRE guidelines.

ii. Test records:

Full details of the test arrangements, procedures and conditions shall be furnished with the test certificates and shall include at least the following.

iii. General:

- Purchaser's order number and transformer site designation.
- Manufacturer's name and transformer serial number.
- Rating of transformer
- MVA
- Voltages and tapping range
- Number of phases
- Frequency
- Rated currents for each winding
- Vector Group
- Cooling Type
- Measured no-load losses and load losses at 75° C.
- Altitude of test bay.
- Designation of terminals supplied and terminals strapped.

iv. Top oil temperature rise test:

A log of the following quantities taken at a minimum of 30 minute intervals:

- Time
- Voltage between phases
- Current in each phase and total power
- Power in each phase and total power
- Ambient temperature
- Top oil temperature
- Cooler inlet and outlet oil temperatures
- Hot spot temperatures (make use of probes) (if applicable)

ANNEXURE-E MANUFACTURING QUALITY PLAN

* Category of Responsibility: P - Actual Test Performance V - Verify and Accept W - Witness Actual testing, verify and accept

TC --- Test PD- Perpendicular CD- Cross MD- Machine PICC-Paper Insulated

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/Standard	Acceptable Value	Category of Responsibility*		
						Sub-Vendor	Manufacturer	Customer
A.	Raw Material & Components							
1.	Winding Conductor (PICC)/ (CTC)/ Lead wires	(a) Visual & Dimensional check of Conductor: Thickness & width of bare conductor, thickness of paper, surface covering, no. of conductors, finish of conductor and finish of PICC/CTC	One sample per type per lot	IS 1897 IS 13730 As per approved drawing	Bare conductor: Width(mm) Tolerance (in \pm mm) Up to 3.15 - 0.03 3.16 to 6.30 - 0.05 6.31 to 12.5 - 0.07 12.51 to 16 - 0.10 > 16 - 0.13	P	V	W/V
					Thickness (mm) Tolerance (in mm) For Width (mm) (2-16) (16-40) 0.8 to 3.15 - 0.03 0.05 3.15 to 6.30 - 0.05 0.07 6.30 to 10 - 0.07 0.09			
					Insulated conductor: Paper Covering Tolerance (%) Thickness (mm) 0.25 to 0.5 - 10 Over 0.5 to 1.3 - 7.5 Over 1.3 - 5			

		(b) Resistivity at 20 deg.C		IS 13730	For annealed conductor: $0.01727 \frac{\text{ohm}}{\text{mm}^2} / \text{m} \text{ (max)}$	P	V	W/V
					For half hard conductor: $0.01777 \frac{\text{ohm-mm}}{\text{m}^2} \text{ (max)}$			
		(c) Insulation test for bunched conductor/ between strands of CTC (if applicable)		IS 13730	Maximum Charging current	P	V	W/V
		(d) Elongation test for annealed conductors (if applicable)		IS 7404 IS 13730	Thickness Elongation (mm)% Up to 2.5 30 (min.) >2.5-5.6 32 (min.)	P	V	-
		(e) Proof strength of work hardened conductor		IS 7404 IS 13730	As per design requirement	P	V	-

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value	Category of Responsibility*			
						Sub-Vendor	Manufacturer	Customer	
		(f) Radius of corner of bare conductor		IS 7404 IS 13730	Thickness (mm) Up to 1.0 1.01 to 1.60 - 1.61 to 2.24 - 2.25 to 3.55 - 3.56 to 5.60 - (Tolerance $\pm 25\%$)	Corner Radius (mm) 0.50 x nominal thickness 0.50 0.65 0.80 1.00	P	V	V
		(g) Copper purity		As per plant standard	OEM Standard		V	V	V
		(h) Oxygen Content		As per plant standard	OEM Standard		V	V	V
		(i) Epoxy Bonding Strength (Bonded CTC)		As per plant standard	As per plant standard		P	V	V
2.	Kraft Insulating Paper (for covering of PICC/CTC)	(a) Visual check & Measurement	One sample per type per lot	IEC 60554-3-1 IEC 60554-3-5 IEC 60554-	Paper to be smooth, unglazed surface, free from dust particles and no surface defect Thickness tolerance within specified value $\pm 10\%$		P	V	--
		(b) Density		60554-	Nominal value ± 0.05 gm/cm ³				

	(c) Substance (grammage)	2, Methods	Thickness(μm) Sub(g/m ²) 50 40 65 52 75 60 90 72 Tolerance: For material ≤ 45 g/m² $\pm 10\%$ For material > 45 g/ m² $\pm 5\%$			
	(d) Moisture Content		8 % max			
	(e) Tensile Index (Machine Direction)		93 NM/gm (min)			
	(f) Tensile Index (Cross-machine Direction)		34 NM/gm (min)			
	(g) Elongation at Break (MD)		As per IEC 60554-3-1			
	(h) Elongation at Break (CD)		As per IEC 60554-3-1			
	(i) Electric Strength in Air		As per IEC 60554-3-1			
	(j) Ash Content		1 % max			
	(k) PH of Aqueous extract		6 to 8			
	(l) Conductivity of Aqueous extract		10 mS/m (max)			
	(m) Air Permeability		0.5 to 1.0 $\mu\text{m}/\text{Pa.s}$			
	(n) Tear Index (MD)		5 mN m ² /g (min)			
	(o) Tear Index (CD)		6 mN m ² /g (min)			
	(p) Water Absorption (Klemn Method)		10 %			

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value	Category of Responsibility*		
						Sub- Vendor	Manufacturer	
		(q) Heat Stability i) Reduction of ii) Reduction of Bursting Strength iii) Increase of Conductivity of Aqueous extract.			Type test report			
		(r) DP Value			As per IEC 60554/Manufacturer's practice			
		(s) Storage Period			As per Manufacturer's std. practice			
		(t) Storage in controlled Environment			As per Manufacturer's std. practice			
3.	Thermally	Manufacturer's std. practice			As per Manufacturer's std. practice			

4.	(i) CRGO Mother coil	Check following documents (a) Invoice of Supplier (b) Mill's Test certificate (c) Packing List (d) Bill of Lading (e) Bill of Entry (f) manufacturer's	Each Lot (100% coils)	IS 3024 IS 649 IEC 60404 ASTM 4343	As per approved design	P	V	V
		Check points:						
		(a) Visual check, check for coil width & thickness from nameplate	10% of coils		Visually defect free, as per design requirement			
		(b) Cutting Burr	One sample per lot		Less than 20 micron burr/ As per IS/ mutual agreement while ordering			
		(c) Bend / Ductility test			As per IS 649/IS 3024 Completion of one 160o bend without fracture			
		(d) Surface insulation resistivity check			Average value: 10 Ω cm ² (min.) Individual value: 05 Ω cm ² (min.)			
		(e) Accelerated Aging test (type test)			4% (max.) increase in measured specific total loss			
		(f) Test on stacking factor			As per table no. 4 of IS 3024			
		(g) Test for specific Watt loss test	One sample from offered lot	IS 3024	As per table no. 2 of IS 3024	--	P	V
		(h) Magnetic Polarisation		IS 3024	As per appropriate tables of IS 3024	--	P	V
(i) Grade of CRGO		Approved	Approved	P	V	V		

	(j) Permeability at 800 A/m	drawing/ Document	Drawing/Docum ent/ Manufacturer standard	P	V	V
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Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
				Test Method IS 3024/ IS 649	
		(k) Compliance to Quality Control Order of DHI		IS 3024	
5.	Pre-compressed Press Board/ Laminated pre-compressed pressboard	(a) Visual & dimensional check, thickness, width and length	One sample of each size (thickness) per lot of pressboard	IEC 60641-3-1 IEC60763-3-1 IEC 60641-2, IEC60763-2 Methods of Test	No surface defects
	(b) Apparent Density (g/cm ³)	Up to 1.6 mm TK - >1.6-3 mm - >3-3.6 mm - >6-8 mm -			- - -
	(c) Compressibility in air (C) (in %)	Up to 1.6 TK- >1.6-3 mm - >3-3.6 mm - >6-8 mm -			10 % 7.5 % 5 % 4 %
	(d) Reversible part Compressibility in air (Crev) (in %)	Up to 1.6 TK- >1.6-3 mm - >3-3.6 mm - >6-8 mm -			45 %; 50 % 50 %; 50 %
	(e) Oil Absorption	Up to 1.6 mm TK - > 1.6-3 mm - > 3 - 3.6 mm - > 6-8 mm -			1 9 n 7 m 7 n

	(f) Moisture Content	6% max. / As per r Manufacturer's std. practice
	(g) Shrinkage in air (MD, CD & PD)	MD - 0.5 % max, CD- 0.7 % max
	(h)pH of aqueous extract	6-9 for solid boards
	(i) Conductivity of aqueous extract	Up to 1.6 - 5 max () > 1.6-3 mm- 6 max, > 3-3.6 mm - 8 max > 6-8 mm TK - 8-10 max
	(j) Dielectric Strength in Air	Up to 1.6 - 12 kV/ > 1.6-3 mm - 11 kV/mm > 3-3.6 mm - 10 kV / mm > 6-8 mm TK - 9 kV/mm
	(k) Dielectric Strength in Oil	Up to 1.6 - 40 kV > 1.6-3 mm - 35 kV

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
					> 3-3.6 mm - 30 kV > 6-8 mm TK - kV/mm
		(l) Ash Content (%)			1 % maximum
		(m) Elongation (MD, CD)			MD Up to 1.6 - 3 % >1.6-3 mm - 3 % >3-3.6 mm - 3 % >6-8 mm TK - 3 %
		(n)Tensile strength (MD, CD)			As per relevant std./ Manufact practice

		<p>(o) Internal Ply Bond strength (for laminated pre compressed boards)</p> <ul style="list-style-type: none"> • Dried (tested at 23°C) • Dried (tested at 120°C retention) • Oil impregnated (tested at 23°C) • Aged for 1 week at 120°C in oil (tested at 23°C retention) 			As per relevant std./ Manufact practice													
		(p) Flexural strength (MD, CD) (for Laminated pre compressed Boards) (MPa)			As per relevant std./ Manufact practice													
		<p>(q) Contamination Dielectric Liquids (for laminated pre compressed press boards)</p> <ul style="list-style-type: none"> • Neutralization value (mg KOH/g) • Sludge content (mg/l) • Dissipation factor 			As per relevant std./ Manufact practice													
6.	Perma-wood	(a) Visual & dimensional check, thickness, width & length	One sample of size each per lot	IS 3513 IS 1708 IS 1736 IS 1998 IEC 61061 Approved document	Shall be free from surface defe													
		(b) Density			0.8 to 1.3 gm/cc													
		(c) Moisture content			IS 3513/IS 1708													
		(d) Oil Absorption at 90 °C			Min 5%													
		(e) Dielectric Strength at 90 °C			Min 60 KV													
		(f) Tensile strength			Min for LD - 700 KV /cm2													
		(g) Compressive strength test			Min for LD - 1400 KV /cm2													
		(h) Shear strength age-wise			Min for LD - 450 KV /cm2													
		(i) Thickness			<table border="0"> <tr> <td>Thickness (mm)</td> <td></td> <td>Toler</td> </tr> <tr> <td></td> <td></td> <td>(±n</td> </tr> <tr> <td>10 to 25</td> <td>-</td> <td>1.4</td> </tr> <tr> <td>26 to 50</td> <td>-</td> <td>2.0</td> </tr> <tr> <td>51 to 150</td> <td>-</td> <td></td> </tr> </table>	Thickness (mm)		Toler			(±n	10 to 25	-	1.4	26 to 50	-	2.0	51 to 150
Thickness (mm)		Toler																
		(±n																
10 to 25	-	1.4																
26 to 50	-	2.0																
51 to 150	-																	

	(j) Shrinkage (MD, CD)		IEC 61061/Plant standard
	(k) pH Value		

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/Standard	Acceptable Value
		(l) Breakdown voltage, parallel to the laminations			
7.	Porcelain Bushings (Hollow)	(a) Visual & dimensional check.	10% Sample per lot As per IS/ IEC	IS 3347 IS 8603 IEC 60137	As per approved 3347/IS 8603
		(b) Power frequency voltage withstand test			As per IS 3347/IS 60137
8.	Polyester Resin Impregnated Glass Fiber Tape	(a) Visual Check	One sample per lot per size	IS 15208	Free from visual defect
		(b) Verification of shelf life			To be used within self-life per used after expiry of period
		(c) Dimensional Check ● Thickness ● Width			● 0.25 to 0.35 mm (\pm 0.0 manufacturer's design ● 20 to 50 mm (\pm 2)
		(d) Tensile Strength			200 N/mm (min)
		(e) Resin Content			27 (\pm 3%)
		(f) Softening point of resin			Max 200 °C
		(g) Storage Condition			As per cl. 15.3 of IS 15208
		(h) Elongation			4% (Max)
9.	Lacquer (in case it is used)	Manufacturer's std. practice			As per Manufacturer's std. pr
10.	Condenser Bushing (OIP/RIP/RIS)	Routine Test	100%	IEC 60137	
		(a) Visual and Dimensional check			No visible damage
		(b) Lightning impulse withstand test (if			As per IEC 60137

		applicable)			
		(c) Measurement of dielectric dissipation factor and capacitance at room temperature			Tan Delta - 0.5%
		(d) Dry power frequency voltage withstand test			As per approved GTP
		(e) Measurement of Partial Discharge (PD)			As per IEC - No flash-over/ p
		(f) Pressure Test (for OIP condenser bushing)			No leakage
		(g) Test tap insulation test			As per IEC 60137

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
		(h) Tightness test (i) Creepage distance (j) Test of oil before carrying out routine test on bushing (for OIP bushing) <ul style="list-style-type: none"> ● BDV ● Water content ● Tan delta at 90°C ● IFT at 27°C 			No leakage As per approved GTP <ul style="list-style-type: none"> ● BDV: Min 70 kV ● Water content: Max 5 ppm ● Tan Delta at 90°C Max:0.0 ● IFT at 27°C: Min 0.04 N/m
11.	Buchholz Relay	Routine test (a) Type & make (b) Porosity (c) High voltage (d) Insulation resistance (e) Element test (f) Gas volume test at 5° ascending towards conservator (g) Loss of oil & Surge test	100%	IS 3637	As per bushing manufacturer guideline As per approved drawing No leakage 2 KV for 1 min. withstand Minimum 10 MΩ by 500 V D No leakage at 1.75 KV pressure for 15 mins GOR - 1: 90 to 165 CC GOR - 2: 175 to 225 CC GOR - 3: 200 to 300 CC GOR - 1: 70 to 130 CC GOR - 2: 75 to 140 CC GOR - 3: 90 to 160 CC

12.	Bimetallic Terminal Connector	Routine test	100%	IS 5561		
		(a) Dimensional				As per approved drawing
		(b) Visual check				Free form defects
		(c) Tensile strength				As per type test report
		(d) Resistance				As per type test report
(e) Galvanizing test (if required)	As per type test report					
13.	Marshalling Box/ Cooler Control Cabinet	(a) Dimensional & Visual check (workmanship, clearances, ferruling, labeling, accessories, earthing terminals, mounting/ lifting details, 20% spare TBs etc.)	100%	Approved drawing and specification	As per approved drawing	
		(b) Verification of paint shade, thickness & adhesion			As per approved drawing	
		(c) All Functional Check at max & min rated operating voltage, electrical control			As per approved drawing	
Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value	

		operations, alarms, interlocks and sequential operations				
		(d) BOM check for Component type, make & rating				As per approved drawing
		(e) DOP check by thin paper insertion method				As per technical specification
		(f) Degree of Protection (IP Class)				As per type test report / appro

		verification			
		(g) Check for sealing gasket (EPDM rubber for outdoor/ neoprene rubber for indoor)			Free form defects
		Routine test			
		a. HV test at 2kV (for 1 min) for auxiliary winding			1 min withstand
		b. Verification of wiring and its routing			Firm and aesthetic
		c. IR test at 500 V for 1 min			1 min withstand
14.	Remote Control Tap Changer Panel (if applicable)	(a) Dimension & Visual Check	100%	Approved drawing and specification	As per approved drawing
		(b) 2kV test for Auxiliary wiring			1 min withstand
		(c) Paint shade & Thickness			As per approved drawing
		(d) Wiring routing check			Firm and aesthetic
		(e) Functional Check			As per approved drawing
		(f) Verification of BOQ			As per approved drawing
15.	Air cell (Flexi Air Separator)	Make, Visual check of surface finish of complete air cell & Dimensions	100%	IS 3400	No surface defects. As per approved drawing
		Routine test			
		(a) Pressure test at 0.105 Kg /cm ² (10Kpa) for 24 hrs			No leakage for 24 hours
		(b) 10 times inflation and deflation test at 0.105 Kg /cm ²			No deformation
		Type tests on basic fabric i. Oil side coating compound ii. Air side inner/outer coating iii. Rubber coating (inner/outer) iv. Coated fabric	One sample per lot of raw material		Tensile strength & elongation 1421 Tear resistance: ISO 4674-1 Coating adhesion: ISO 2411 Gas permeability: ISO 7229

16.	Roller Assembly	(a) Visual & Dimensions.	One sample per lot	IS 5517 IS 2004	Free from surface defect
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Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
		(b) Mechanical Properties & Chemical composition of raw material used for shaft & roller forging	One sample per melt/heat treatment batch	IS 28 IS 2026	For shaft as per MS EN8, BS wheel of cast iron IS 210 For Cast steel IS 1030
17.	Oil & Winding Temperature Indicator	(a) Type & make (b) Accuracy (c) HV test at 2kV for 1 min between all terminals & earth (d) Switch contact operation test (e) Contact Rating	100%	--	As per approved drawing ± 1.5% of FSD Withstand for 1 min Operation within ± 2.5° C of s As per Manufacturer's std.
18.	Pressure Relief Device	(a) Type & Make (b) Air Pressure Test (c) Liquid Pressure Test (d) Switch/contact testing (e) Leakage test at 75% operating pressure (f) HV test (g) Functional test/Calibration (h) Contact Rating	100%	As per specification	As per approved drawing & fr Operate at Specified pressure Satisfactory operation at press No leakage for 24 hrs 2 kV withstand for 1 min As per Manufacturer's std.
19.	Magnetic Oil Level Gauge (MOG)	(a) Type & make (b) Dial Calibration for level (c) 2kV HV test for 1 min between all	100%	--	As per approved drawing & t defect Check pointer position for Ma center (within tolerance as per specif Withstand for 1 minute

		terminal & earth			
		(d) Leak test with air for 6 Hours			No leakage at 4 kg /cm2
		(e) Switch/contact operation test			Operate at Min level indicatio
		(f) Contact Rating			As per Manufacturer's std.
20.	Valves (Gate, Globe & Butterfly)	(a) Type, make & visual check for material of valve body, gate wedge, spindle and gland	100%	IS 778	As per approved drawing & no
		(b) Dimension check			
		(c) For Gate & Globe Valve: (i) Body test at 1.5 MPa (2 minutes) (ii) Seat test at 1.0 MPa (2 minutes) (iii) Seepage test at 2 kg/cm2 for 12 hrs.			No leakage

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
		(d) For Butterfly valve: (i) Pressure test through body and spindle (ii) Pressure test for diaphragm (iii) Oil seepage test (oil 105± 5 °C, pressure of 1.5 kg/cm ² for 24 hrs.)			(i) No leakage at 5 kg/cm ² (ii) Max 6 drops/min at 1.5 (iii) No leak in body and spi Max 6 drops/min through
21.	Transformer Oil	Routine Test	100%	IS: 335 IEC 60296 IS 6855	As per technical specification
22.	Tank, Tank-cover, Turret, Conservator & Accessories	(a) Visual check of welding joints including earthing connection, matching of tank with cover & Dimensional check after final welding (b) Visual Check for a fit up for butt welds on tank walls, base & cover (c) DP test on Butt welds after fit up & load bearing welds (lifting logs, bollards, jacking pads) (d) Air leakage test on assembled tank with turrets & on conservator (e) Visual check of paint shade, paint film thickness (inside & outside) & film adhesion, primer application	100% per One design	CBIP Manual Transformer 2013	Free from defect Check for proper welding Check for proper welding No leakage Paint thickness Outside: 155 micron Inside: 30 micron No peel-off Or As per approved drawin

		(f) WPS (Weld procedure specification) approval			Details to be furnished As per Specification/ASME Sec IX
		(g) PQR (Process Qualification Record)			Details to be furnished As per Specification/ASME Sec IX
		(h) Welders Qualification			Details to be furnished As per Specification/ASME Sec IX
		(i) UT (Ultrasonic test) of tank MS Plate of thickness >12mm.			Details to be furnished As per Specification/ASME Sec IX
		(j) RT (Radiography test) of butt weld in bottom plate of tank after fit up (if any)			Details to be furnished As per Specification/ASME Sec IX
		(k) Verification of PWHT (Post weld heat treatment)			Details to be furnished As per Specification/ASME Sec IX
		(l) Surface cleaning by Shot/sand blasting			Details to be furnished as per
		(m) Tank - i. Pressure test (PT)			i. Withstand-Twice head of oil or normal head

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
		ii. Vacuum test (VT) iii. Adhesion test iv. Visual Inspection inside transformer tank before PT & VT test (n) Chemical composition & mechanical property of steel (for tank, tank-cover, conservator, turrets and accessories)		IS 2062 BS 4360	KN/m ² whichever is low base of bank for 8 hrs. ii. Withstand- 3.33 KN/ m ² f iii. Details to be furnished a manufacturer's standard. iv. Inputs required specification As per relevant standards
23.	Radiators	(a) Chemical composition & mechanical property of raw material (b) DP test on lifting lugs welds (c) Surface cleaning of header support and bracing details by sand/shot blasting (d) Air pressure test on elements (e) Dimensional check after final welding (f) Air pressure test on radiator assembly by water dipping method (g) Visual check of paint shade, paint film thickness & film adhesion (h) WPS (Weld Procedure Specification) approval (i) PQR (Process Qualification Record)	100%	BS EN 50216-1 IS513 Manufacturer's drawing	As per relevant standards No welding defect Free from surface defect As per relevant standards /CB As per approved drawing 2 kg /cm ² for 30 m leakage As per tech spec, coating thick 70 micron Details to be furnished, if appl Specification/ASME Sec IX Details to be furnished, if appl Specification/ASME Sec IX

		(j) Welders Qualification			As applicable As per Specifica IX
24.	OLTC (as applicable)	(a) HV test on Auxiliary circuit (2kV for 1min).	100%	IS 8468 IEC 60214	To Withstand for 1 min
		(b) Operational test of complete OLTC including functional check of driving mechanism			Satisfactory operation
		(c) Pressure test on diverter switch oil compartment			No leakage at 10 Psi for 1 hou
		(d) Mechanical Operation test of diverter switch (endurance test)			No defect after 5000 operation
		(e) Mechanical test of tap selector motor drive			500 satisfactory operations be taps
		(f) Sequence test			Switching time within permiss
		(g) Visual & Dimensional check			Free from defects, dimensions

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
		(h) Operational test on Surge relay (i) Milli volt drop/contact resistance measurement after Mechanical test. (j) Condition of Silver plating on contacts (k) Measurement of Tan delta (l) Helium Test (barrier board leakage test)- For externally mounted OLTC			Satisfactory working of trip & As per standard Good condition To be provided (value to benchmark) as per standard To be provided as per manufa standard
25.	Digital RTCC Relay/ Automatic Voltage Regulating Relay (AVR) (if applicable)	(a) Check of Binary input and output signal along with HMI display nomenclature (b) Check availability of spare binary input and output terminal (c) Check communication interface (d) Test for complete function include tap position indication, raise and lower command execution	100%		as per specification/ma standard
26.	Cooling Fans & motor	(a) Type, Make & visual check (b) Power consumption, rating test (c) HV test (3kV Power frequency withstand test for 1 min)	100%	IS 2312	As per approved drawing, no defect As per approved drawing Should withstand

		(d) Insulation resistance value			2 MΩ (minimum) with megger
27.	Nitrile Rubber Gasket	(a) Visual check	1 sample/ Lot	ISO 7619-1 ISO 815 ISO 37 ISO 3865 IS 11149	Free from cracks and pin hole
		(b) Dimensions			Within tolerance
		(c) Shore Hardness			70 ± 5 IRHD
		(d) Tensile Strength			12.5 N/mm ² min
		(e) Compression set test			35% (max) at 70 ± 1° C
		(f) Elongation at break			250% min
		(g) Accelerated aging in air (at 100 ± 2° C for 72 hours)			Change in harness: ±15 IRHD strength change: 20% (max) Elongation change: max +10
		(h) Accelerated aging in oil (at 100 ± 2° C for 72 hours)			Change in hardness: ± Tensile strength change: 35% change: +20%/ -8%
		(i) Time period between manufacturing of gasket and its use			To be used within self-life period used after expiry period
28.		(a) Visual Check		IS 11149	Free from cracks & pinholes

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/ Standard	Acceptable Value
	EPDM Gasket for Marshalling Box	(b) Dimensional check (Thickness & Width)	1 sample/ Lot		Within tolerance
		(c) Tensile Strength			As per IS 11149
		(d) Elongation at break			As per IS 11149
		(e) Shore Hardness check as per DIN-53505			As per IS 11149
		(f) Compression test (in air) as per DIN, ISO 815			As per IS 11149
29.	Bushing CT	Dimensions (Visual check for ID/OD, thickness)	100%	IS 16227 IEC 61869-2	As per approved drawing
		Routine test			
		(a) Verification of terminal marking & polarity			As per IS 16227/ IEC 61869-
		(b) Overvoltage inter-turn test			Rated current withstand for 1
		(c) Determination of error			As per IS 16227/ IEC 61869-
		(d) HV Test (Dry power frequency withstand test on secondary winding)			3 kV AC for 1 min withstand
		(e) Accuracy Ratio			As per IS 16227/ IEC 61869-
		(f) Secondary winding resistance for PS/PX class			As per IS 16227/ IEC 61869-
		(g) Knee point voltage & excitation current for PS/PX class			
30.	Oil circulating pump (as	(a) Visual check	100%	IS 9137	no visual damage/ defect

	applicable)	(b) No load running test (rpm, input power and current) (c)			Satisfactory performance & no within limit
		(d) HV test (2kV power frequency withstand voltage test for 1 min)			Should withstand
		(e) Oil pressure test on pumps at 5kg/cm ² for 30 min			No leakage
		(f) Locked rotor test			Satisfactory operation of prote
31.	Oil flow Indicator (as applicable)	(a) Type, Make & Visual check (b) Dial & Calibration (c) Contact Rating (d) Dielectric Test between terminals and earth (e) Leak test at 7 kg/cm ² for 2 min (f) Alarm & trip operation check (g) Full flow check	100%	--	(a) As per standard docume damage/defect (b) As per standard docume (c) As per standard docume (d) Shall withstand 2 kV fo (e) No leak
32.	Power/Control Cable	Review of Supplier's TC for physical & electrical tests as per specification/drawing.	Random	--	As per standard document

Sr. No.	Item/Components	List of Tests	Sampling rate	Reference/Standard	Acceptable Value

33.	Silica Gel Breather	(a) Dimension, Type and model check (b) Check of healthiness & colour of Silica gel (c) Pressure test by blanking oil cup end	100%	-	(a) Within tolerance, Type drg (b) No visible d Gel colour is blue/Oran (c) No leak at 0.35 kg/cm ² (for 30 Min)
34.	Drum for insulating oil	(a) Visual check of inside cleanliness and outside coat	100%	IS 1783 –1	As per specifications/ IS 178
		(b) Dimensional check (thickness, height & diameter)			
		(c) Leakage test on drum			
		(d) Drop test			
		(e) Hydraulic test			

Sr. No.	Item/Process	Sampling rate	Reference / Standard	Acceptable Value	S
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B. IN-PROCESS INSPECTION					
I	CRGO Lamination for core				
	1. Visual check, check length & slitting dimension	One sample of each lot of CRGO	IS 3024	Prime CRGO and Free from defect	-
	2. Dimensional check			As per design Drawings	-
	3. Check for burr			Less than 20 micron	-
	4. Check for Edge bow			As per IS 3024 L < 250mm, H <= 2mm L >= 250 mm, H <= 3mm	-
II	Core Building				
	1. Visual check (frame assembly, arrangement of insulation, bonding of polyester tape)	100%	--	Free from defect	-

	2. Measurement of Total stack height		As per design drawings	within specified tolerance of design	-
	3. Core Diameter			within specified tolerance of design	-
	4. Check window width, window height and diagonal of frame			within specified tolerance of design	-
	5. Assembly of limb Insulation & plates			As per design	-
	6. Rectangularity of Core Assembly			As per design	-
	7. Check for Overlaps & air gap at joints			As per design	-
	8. Check leaning/ inclination of Core			No leaning	-
	9. Earthing of Core (check of insulation resistance between CC-CL, CC-Yoke bolt, CL-Yoke Bolt by 2kV megger)			Proper connection	-
	10. Limb Clamping & Binding			As per design drawings	-
	11. Insulation test between core & core clamp / frame		As per specification	shall withstand 2.5 kV DC for 1 min.	-
	12. Yoke Bolt Tightness		Design drawing	As per design	-
	13. Loss measurement on built up core assembly OR validation by software		As per specification/GTP	Within limit as per GTP	-
	14. Built-up core sample collection for watt loss verification	1 sample per design	To be furnished	As per declared/offered value of Watt loss value	-
III	Winding/coil				
	1. Nos. of discs	100%	As per approved drawings / Factory drawing	As per Factory drawing	-

Sr. No.	Item/Process	Sampling rate	Reference / Standard	Acceptable Value	
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2. No of turns / disc	100%	As per approved drawings/Factory drawing	As per Factory drawing		
3. Dimensional checks i) Outer diameter ii) Inner diameter iii) Unshrunk height iv) Radial thickness	100%	As per approved drawings/ Factory drawing	As per Factory drawing		
4. Brazing procedure and brazer's qualification	--	Customer approval	As per approval		
5. Visual inspection of brazed joints	100%	As per brazing procedure	As per approval		
6. Visual check for transposition	100%	As per design drawings	As per design		
7. Visual check for terminal marking & length	100%	As per design drawings	As per design		
8. Insulation arrangement including end insulation	100%	As per design drawings	As per design		
9. Lead & coil identification & marking	100%	As per design drawings	As per design		
10. Continuity test (testing of winding continuity/ brazing test)	100%	--	No breaking of continuity		
11. Coil clamping for shrinking & shrunk coil height and clamping force	100%	As per design drawings	As per design		
12. Check arrangement of fiber optic sensor (FOS) (if applicable)	100%	As per design drawings	As per design		
13. Inter-turn Insulation	100%	As per design drawings	As per design		

IV	Core Coil Assembly			
	1. Visual Check of level of bottom yoke (bearing beam)	100%	--	As per design
	2. Visual Check assembly of the magnetic shields (if applicable)		--	As per design
	3. Visual Check strip barrier assembly on all limbs		--	As per design
	4. Visual Check position of lead take out of HV		--	As per design
	5. Visual Check clamping of upper yoke		--	As per design
	6. Visual Check torque/ pressure of tensile bolt		--	As per design
	7. Visual Check insulation resistance between cooling duct by 500 V megger		--	As per design
8. Check IR between core and frame at 2 kV by Megger.	--		As per design	

Sr. No.	Item/Process	Sampling rate	Reference / Standard	Acceptable Value	S
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	Check of insulation resistance between CC-CL, CC-Yoke Bolt, CL-Yoke Bolt-2kV Megger				
	9. Visual check for inter-coil insulation		--	As per design	
	10. Lead & coil identification & marking		--	As per design	
	11. Brazing / Crimping of Joints		--	Shall be smooth and no sharped age	
	12. Visual check for completeness, cleanliness, clearance of live parts, absence of sharp edges, placement of lead support assembly		--	Complete assembly shall be free from dust / particles	

	13. Ratio test		As per IS 2026 / IEC 60076	Tolerance as per standards	
	14. Magnetic balance test		As per IS 2026 / IEC 60076	Tolerance as per standards	
	15. Magnetizing current test, polarity & vector group		As per IS 2026 / IEC 60076	Tolerance as per standards	
	16. Alignment of Spacers/Blocks		--	Aligned	
	17. HV test		Manufacturer's standard	10kV for 1 min withstand	
V	DRYING OF ACTIVE PART: Vapor Phase Drying (VPD) Validation				
	1. Check of temp of Evaporator	100%	Manufacturer's standards/drawings /checklist	Manufacturer's standards/drawings/ checklist	Graph of Vacuum Vs Time and Temperature Vs time to be submitted for review
	2. Check temp of Main heating				
	3. Check temp of Sprayed Kerosene				
	4. Check Vacuum Pressure (mbar) of VPD				
	5. Check Vacuum Pressure (mbar) of Fine vacuum				
	6. Check Water Extraction (g / Hr / Ton of Insulation) / Process Termination parameters				
	7. Check total process time (Hrs.)				
	8. Check Oil characteristics before impregnation a. Electric strength b. Water content c. Tan delta at 90°C d. Resistivity at 90°C(For Information)				
	As per Annexure-L of the document				
Sr. No.	Item/Process	Sampling rate	Reference / Standard	Acceptable Value	S

	e. IFT at room temperature				
VI	Connections and checks before tanking				
	1. OLTC fitting & connections	100%	Manufacturer standard	Manufacturer standard	
	2. Check for cable sizes	100%	As per design drawings	As per design	
	3. Check for clearance from tank walls	100%	As per design drawings	As per design	
	4. Visual checks for crimped joint	100%	--	Shall be smooth and no sharped age	
	5. Visual checks for bushing CT assembly tightness	100%	--	Assembly tightness	
	6. Ratio test	100%	As per IS 2026 / IEC 60076	Tolerance as per standards	
VII	Tank				
	1. Thickness of walls	100%	As per approved drawings	As per approved drawings	
	2. Dimensions	100%	As per approved drawings	As per approved drawings	
	3. Visual internal Inspection	100%	As per approved drawings	As per approved drawings	
	4. Pressure test	100%	As per specification	To withstand, permanent deflection shall not exceed as per specification	
	5. Vacuum test	100%	As per specification	To withstand, permanent deflection shall not exceed as per specification	
VIII	Opening, Tanking and Oil filling				

	1. Drying	100%	Manufacturer standard	Low voltage tan delta and PI values shall be checked periodically and after achieving the satisfactory values the process will be declared complete
	2. Checks for complete tightness before taking (a) Tightness of all joints / screws (b) Application of thread locking adhesive (c) Padding of top yoke (d) Pressing of active parts (e) Fitting of wall shunts & packing (f) Electrical clearance of core/coil assembly after completion of terminal gear connections.	100%	Manufacturer standard	As per design

Sr. No.	Item/Process	Sampling rate	Reference / Standard	Acceptable Value	S
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	3. Cleanliness of tank before tanking	100%	Manufacturer standard	Shall be clean.
	4. Tanking of active parts and check for clearance including clearance of the leads from tank walls & Core/frame earthing.	100%	As per design drawings	As per design
	5. 2kV HV test between (a) Core & end frame (b) Core & yoke bolts (c) End frame and yoke bolts	100%	As per specification	To withstand 2kV for 1 min

	6. Check for oil quality before impregnation	100%	As per specification	As per specification
	7. Proper scarfing of insulation during tapping of terminal gear joints, position of leads.	100%	Manufacturer standard	Manufacturer standard
	8. Oil filling & Air release	100%	Manufacturer standard	Manufacturer standard
	9. Impregnation process	100%	Manufacturer standard	Sufficient impregnation time shall be given before conducting the electrical test on the transformer

* Category of Responsibility: P - Actual Test accept

Performance

V - Verify and Accept

W - Witness Actual testing, verify and

Sr. No.	Test	Sampling rate	Reference / Standard	Acceptable Value
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C.	Acceptance Tests		100%	Specification IS: 2026 IEC 60076 other applicable standard	As per approved drawings
	<u>For Transformers:</u>				
	1.	Appearance, construction and dimension check as assembled for testing			
2.	Check validity of calibration of all test equipment and measuring instruments (e.g. HV test equipment, Loss measurement kit, Partial Discharge kit, impulse units etc.)		As per Specification/ IS: 2026/ IEC 60076/ other applicable standard		

3.	Measurement of winding resistance at all taps
4.	Measurement of voltage ratio at all taps
5.	Check of phase displacement and vector group
6.	Measurement of no-load loss and current measurement at 90%, 100% & 110% of rated voltage and rated frequency
7.	Magnetic balance test (for three phase Transformer only) and measurement of magnetizing current
8.	Short Circuit Impedance and load loss measurement at principal tap and extreme taps
9.	Measurement of insulation resistance (IR) & Polarization Index (PI)
10.	Measurement of insulation power factor and capacitance between winding to earth and between windings
11.	Measurement of insulation power factor and capacitance of bushings
12.	Tan delta of bushing at variable frequency (Dielectric frequency response)

	13.	Full wave lightning impulse test for the line terminals (LI) (for 72.5kV < Um ≤ 170 kV)			
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Sr. No.	Test	Sampling rate	Reference / Standard	Acceptable Value
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TC --- Test PD- Perpendicular CD- Cross MD- Machine

PICC-Paper Insulated Copper Conductor CTC-

* Category of Responsibility: P - Actual Test Performance V - Verify and Accept

	14.	Chopped wave lightning impulse test for the line terminals (LIC) (for transformers with Um > 170 kV)			
	15.	Switching impulse test for the line terminal (SI) (for transformers with Um > 170 kV)			
	16.	Applied voltage test (AV)			
	17.	Line Terminal AC withstand voltage test (LTAC) (for transformer with 72.5 kV < Um ≤ 170 kV)			
	18.	Induced voltage withstand test (IVW) (for transformers with Um ≤ 170 kV)			
	19.	Induced voltage test with PD measurement (IVPD)			

	20.	Test on On-load tap changer (Ten complete cycle before LV test) and other tests such as One complete operating cycle at 85 % of auxiliary supply voltage ,one complete operating cycle with Transformer energized at rated voltage and frequency at no load .Ten tap change operation with +/- 2 steps of principal tap with as far as possible the rated current of Transformer with one winding short circuited etc. as per IS 2026			
	21.	Measurement of dissolved gasses in dielectric liquid from each separate oil compartment except diverter switch compartment.			
	22.	Check of core and frame insulation			
	23.	Leak testing with pressure for liquid immersed transformers (tightness test)			
	24.	Measurement of no load current & Short circuit Impedance with 415 V, 50 Hz AC.			
	25.	Frequency Response analysis after completion of test for max, min &			

Sr. No.	Test	Sampling rate	Reference / Standard	Acceptable Value	Category of Responsibility*	
					Manufacturer	Customer

		normal tap (Soft copy of test report to be submitted to site along with test reports)					
	26.	High voltage withstand test assembly				P	W
	27.	Tank vacuum test (at tank supplier premises during tank manufacturing)				P	W
	28.	Tank pressure test (at tank supplier premises during tank manufacturing)				P	W
	29.	Check of the ratio and polarity of built-in current transformers				P	W
	30.	Short duration heat run test (Not Applicable for temperature rise test is performed)				P	W
	31.	Over excitation test (applicable for 765 kV transformer only)					

D.	Type Tests/Special test		One from Lot	Specification/ IS:2026 60076/other applicable standard	Specification/		
	<u>For Transformers:</u>						
	1.	Measurement of transferred surge on Tertiary due to HV lightning impulse and IV lightning impulse				P	W

Sr. No.	Test	Sampling rate	Reference / Standard	Acceptable Value	Category of Responsibility*	
					Manufacturer	Customer

	2.	Measurement of transferred surge on Tertiary due to HV switching impulse and IV switching impulse					
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3.	Full wave lightning impulse test for the line terminals (LI) (for $U_m \leq 72.5 \text{ kV}$)			
4.	Chopped wave lightning impulse test for the line terminals (LIC) (for transformer with $U_m \leq 170 \text{ kV}$)			
5.	Lightning impulse test for the neutral terminals (LIN)			
6.	Switching impulse test for the line terminal (SI) (applicable for $U_m > 72.5 \text{ kV} \ \& \ \leq 170 \text{ kV}$)			
7.	Temperature rise test			
8.	Measurement of Zero seq. reactance (for three phase Transformer only)			
9.	Measurement of harmonic level in no load current			
10.	Determination of sound level			
11.	Measurement of power taken by fans and liquid pump motors (Not applicable for ONAN)			
12.	Short circuit withstand capability test (Dynamic)			

Annexure-G BASIC MANUFACTURING FACILITY & MANUFACTURING ENVIRONMENT

Customer/Purchaser always desires that the transformer manufactured and delivered is of good quality and must perform trouble free service for its “Specified Design Life”. The consistency in quality of material used & manufacturing process are the main cause for variation in quality of transformer. It is also equally very important that the transformer is manufactured in a clean dust free and humidity controlled environment. Any compromise on this aspect will have an adverse effect on the expected design life of the transformer, however good is the quality of material used. A broad list of facilities the transformer manufacturers should have are given below:

Basic manufacturing facility

Following manufacturing facility should be available for use with transformer manufacturer:

1. EOT Crane for main manufacturing bay and other shops (With Load Cell).
2. Vapor Phase Drying Oven (adequately sized to accommodate the offered transformer and have facility to record temperature, vacuum, moisture etc.)
3. Air Casters for material handling
4. Core cutting line (if applicable)
5. Vacuum autoclaves
6. Air oven
7. Adjustable Horizontal and vertical winding machine
8. Winding Mandrels
9. Hydraulic Press
10. Brazing equipment
11. Mechanical platform
12. Tools and fixtures
13. Mechanical power press
14. Welding machines
15. Crimping tools
16. Faraday’s cage
17. Motor Generator Set/ Static Power System Set
18. Testing transformer
19. Capacitor bank
20. Impulse voltage generator
21. Capacitance & Tan delta bridge
22. Power Analyzer

23. Current & Voltage transformer
24. Partial Discharge (PD) measuring kit (for all manufacturers) & PD Diagnostic Kit (for 400 kV & above voltage class Transformer manufacturer)
25. Temperature data logger
26. Noise measurement kit
27. Thermo vision camera
28. Loss measurement kit
29. Insulation tester
30. Winding resistance meter
31. Turn ratio meter
32. Transformer oil test lab
33. Dissolved Gas Analysis (DGA) test kit
34. Sweep Frequency Response Analyzer (SFRA) kit
35. Frequency Domain Spectroscopy (FDS) kit
36. **NABL Accredited laboratory for testing**
37. Oil Storage tanks
38. Oil filter plant with requisite level of vacuum and filter
39. Tensometer for Oil Surface tension
40. Particle Count Kit (for 400 kV & above Transformer)
41. Multimeters

Manufacturing environment (Clean, dust free and humidity controlled environment)

A. Transformer must be manufactured in a bay having positive pressure w.r.t. external environment. Winding shall be manufactured in a clean, dust free and humidity controlled environment. The dust particle shall be monitored regularly in the manufacturing areas. Further, there shall be positive atmospheric pressure, clean, dust free and humidity controlled environment for following:

1. Insulation storage
2. Core storage
3. Glue stacking area
4. Core cutting line
5. Winding manufacturing bay
6. Core building area
7. Core coil assembly area
8. Testing lab
9. Packing & dispatch area

B. Following accessories to be kept in clean and covered location:

1. Piping
2. Radiator
3. Tank
4. Bushing (as per manufacturer's guideline)
5. Marshalling box
6. Turret
7. Conservator
8. Insulating oil

Annexure-J

CRITERIA FOR SELECTION OF SIMILAR REFERENCE TRANSFORMER FOR DYNAMIC SHORT CIRCUIT WITHSTAND TEST

A transformer is considered similar to another transformer taken as a reference if it has the following characteristics in common with the latter:

- Same type of operation, for example generator step-up unit, distribution, interconnection transformer;
- Same conceptual design, for example dry type, oil-immersed type, core type with concentric windings, sandwich type, shell type, circular coils, non-circular coils;
- Same arrangement and geometrical sequence of the main windings;
- Same type of winding conductors, for example aluminium, aluminium alloy, annealed or work-hardened copper, metal foil, wire, flat conductor, continuously transposed conductors and epoxy bonding, if used;
- Same type of main windings, for example helical-, disc-, layer-type, pancake coils;
- Absorbed power at short circuit (rated power/per unit short-circuit impedance) between 70% and 130% of that relating to the reference transformer;**
- Axial forces and winding stresses occurring at short circuit not exceeding 120 % of those relating to the reference transformer;
- Same manufacturing processes;
- Same clamping and winding support arrangement.

(Note:-A format for comparison of characteristics as given above of successfully type tested reference transformer and of transformer short circuit strength of which shall be evaluated (offered transformer) shall be as per “Standard Specifications and technical Parameters for Transformers and Reactors (66 kV & above voltage class)” by CEA.

Annexure-L UNUSED INHIBITED HIGH GRADE INSULATING OIL PARAMETERS

Sl. No.	Property	Test Method	Limits
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A	Function		
1a.	Kinematic Viscosity at 40 °C	IS 1448 Part 25 or ISO 3104 or ASTM D7042	12 mm ² /s (Max.)
1b.	Kinematic Viscosity at -30 °C		1800 mm ² /s (Max.)
2.	Appearance	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent and free from suspended matter or sediment
3.	Pour point	IS 1448 Part 10/Sec 2 or ISO 3016	-40 °C (Max.)
4.	Water content a) for bulk supply b) for delivery in drums	IEC 60814	30 mg/kg (Max.) 40 mg/kg (Max.)
5.	Electric strength (breakdown voltage)	IS 6792 or IEC 60156	Minimum 30 kV (new unfiltered oil) / 70 kV (after treatment)
6.	Density at 20 °C	IS 1448 Part 16 or ISO 12185 or ISO 3675 or ASTM D7042	895 kg/m ³ (Max.)
7.	Dielectric dissipation factor (tan delta) at 90 °C	IS 16086 or IEC 60247 or IEC 61620	0.0025 (Max.)
8.	Negative impulse testing KVp @ 25 °C	ASTM D3300	145 (Min.)
9.	Carbon type composition (% of Aromatic, Paraffins and Naphthenic compounds)	IEC 60590 and IS 13155 or ASTM D2140	Maximum Aromatic : 4 to12 % Paraffins : <50% & balance shall be Naphthenic compounds.
B	Refining/Stability		
1.	Colour	ISO 2049	L0.5 (less than 0.5)

2.	Appearance	–	Clear, free from sediment and suspended matter
3.	Neutralization Value (Total Acidity)	IEC 62021-1 or IEC 62021-2	0.01 mg KOH/g (Max.)
4.	Interfacial tension at 27°C	IEC 62961 or ASTM D971	0.043 N/m (Min.)
5.	Total sulphur content	ISO 14596 or ISO 8754	0.05 % (Max.) (before oxidation test)
6.	Corrosive sulphur	DIN 51353	Not Corrosive
7.	Potentially corrosive sulphur	IEC 62535	Not Corrosive
8.	Presence of oxidation inhibitor	IS 13631 or IEC 60666	0.08% (Min.) to 0.4% (Max.)
9.	DBDS	IEC 62697-1	Not detectable (<5 mg/kg)
10.	Metal passivator additives	IEC 60666	Not detectable (<5 mg/kg)
11.	2-Furfural and related compound content	IS 15668 or IEC 61198	Not detectable (<0.05 mg/kg) for each individual compound
12.	Stray gassing under thermo-oxidative stress	Procedure in Clause A.4 of IEC 60296- 2020 (oil saturated with air) in the presence of copper	Non stray gassing: < 50 µl/l of hydrogen (H ₂) and < 50 µl/l methane (CH ₄) and < 50 µl/l ethane (C ₂ H ₆)
C Performance			
1.	Oxidation stability	IEC 61125 (method c) Test duration: 500 hours	
	-Total acidity*	4.8.4 of IEC 61125:2018	0.3 mg KOH/g (Max.)
	-Sludge*	4.8.1 of IEC 61125:2018	0.05 % (Max.)
	-Dielectric Dissipation Factor* (tan delta) at 90 °C	4.8.5 of IEC 61125:2018	0.05 (Max.)
*values at the end of oxidation stability test			
D Health, safety and environment (HSE)			

1.	Flash point	IS 1448 Part 21 or ISO 2719	135 °C(Min.)
2.	Poly Aromatic Cyclic (PCA) content	IP 346	<3%
3.	Poly Chlorinated Biphenyl (PCB) content	IS 16082 or IEC 61619	Not detectable (< 2 mg/kg)

Note: Supplier shall declare the chemical family and function of all additives and the concentrations in the cases of inhibitors, antioxidants and passivators.

**TECHNICAL SPECIFICATION
FOR 80 MVA,
132/33 KV POWER TRANSFORMER**

**TECHNICAL SPECIFICATION FOR POWER TRANSFORMER AND ASSOCIATED
EQUIPMENT:**

1.000 EQUIPMENT REQUIRED:

The equipment to be supplied and works to be executed under this specification are indicated below. The 'Design Criteria' for the following transformers shall be guided by 'Annexure-D' of this specification.

Equipment Details:

- A. i)** 80 MVA, 132KV / 33KV (145Class), 50 Hz, YNyn0 , Star (Earthed neutral), ONAN / ONAF / OFAF, losses as per latest CEA guidelines, outdoor type, switch yard transformer with separately mounted cooler bank and On Load Tap Changer(HV side) of – 15% to + 5% Variation, with terminal connectors, CC cabinet, RTCC Panel, fiber optic temperature monitoring system, maintenance free breather along with all fittings and accessories.

The above transformers shall be complete with all necessary and as applicable fittings, Accessories, auxiliaries and devices including but not limited to those specified against clause No.7.000 below. The transformers shall be complete with oil for first filling and 10% extra.

- ii)** Complete set of equipment for Fire Prevention & Extinguishing System by Nitrogen (N₂) Injection method as per technical specification for above Transformers. The above transformers shall be complete with all fittings, which are necessary for efficient operation of the transformers & supply of all necessary equipment for Fire Prevention & Extinguishing System by Nitrogen (N₂) Injection method complete. Such parts shall be deemed to be within the scope of the supply whether specifically mentioned or not.
- iii)** Set of spares as per clause 7.010

2.000 GENERAL SITE INFORMATION:

The general site information shall be as per 'Annexure-'A' of this tender specification.

3.000 REFERENCE STANDARDS:

The equipment covered by this specification shall, unless otherwise stated be designed and tested in accordance with the latest revisions of relevant Indian standard specification and Indian Electricity Rules. The relevant IEC/ISS numbers have been furnished in 'Annexure-'F' of this specification.

In case of controversy reference may be made to relevant International Electrotechnical Commission (IEC) Publications, British Standard specification (BSS) ASA, CBIP and NEMA standards as required. In such case, the bidder shall clearly indicate the standard adopted and furnish copy of the English version of that standard along with the tender. **SHOULD THERE BE ANY DISPUTE AMONG VARIOUS STANDARDS AND THIS SPECIFICATION REQUIREMENT, THE MOST STRINGENT STIPULATIONS SHALL BE FOLLOWED.**

IF ANY SPECIFICATION IS NOT MENTIONED IN THIS SPECIFICATION THAN CEA GUIDELINE FOR TRANSFORMER SHALL BE FOLLOWED.

THE SCOPE OF SUPPLY INCLUDES THE PROVISION OF ONE OFFICIAL COPY OF EACH OF THE STANDARDS, IDENTIFIED IN CLAUSE-2 OF THIS TECHNICAL SPECIFICATION WITHOUT ANY EXTRA COST TO BSPTCL.

4.000 AUX. SUPPLY SYSTEM DATA:

The auxiliary supply system data shall be as indicated in the 'Annexure-B' of this specification.

5.000 GENERAL FITTINGS REQUIRED FOR TRANSFORMER:

1. Air cell bag type main conservator along with its supporting bracket to be mounted on tank or independent structures, as the case may be (in case of independent structure mounting, the structure shall be within the scope of transformer supplier). Main conservator shall have air cell type constant oil pressure system to prevent oxidation as well as contamination of oil due to contact with moisture. The conservator tank shall have adequate capacity with highest and lowest visible level to meet the requirement of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temp to 90 deg. Cent. Suitable provision is to be kept for replacement of Air cell, if applicable. Connection of Air cell to the top of the conservator is by Air proof seal preventing entry of air into the conservator.
2. Conservator filling hole with cap (removable).
3. Conservator drain valve with flanged pipe terminal.
4. Isolating valve for conservator / Buchholtz relay.
5. OLTC conservator Drain valve.
6. OLTC Conservator isolating valve.
7. Prismatic oil gauge for OLTC conservator.
8. Buchholtz relay / oil surge relay for OLTC, double float type with two sets of contacts for alarm & trip. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper / stainless steel tube shall be connected from the gas collector to a valve located about 1400mm above ground to facilitate collection / sampling of gas while transformer is in service.
9. Oil filling hole on OLTC Conservator.
10. Dehydrating breather for OLTC Conservator.
11. Magnetic oil level gauge with minimum two (2) sets of alarm contacts (for remote annunciation) on one side and built-in oil level coloured gauge (with minimum level marking) on the other side of the conservator. Current rating of alarm contacts shall be 1 (one) amp. At $250 \pm 10\%$ D.C. contacts are to be wired up to the marshalling kiosk outgoing terminal block.
12. The main transformer tank/conservator **and OLTC tank / conservator** shall have maintenance free breather whose technical specification is mentioned below:

Technical specification of maintenance free breather for transformers

Objective and Principle of Working of the Breather:

Dehydrating breathers work according to the following principle. When the oil conservator sucks in air (e.g., due to the reduced load), the air flows through a filter made of high-grade steel wire mesh to the inside of the device. This filter and the dust cap filter dust, sand and other dirt particles from the air. The filtered air flows through the desiccant chamber filled with colorless, moisture adsorbing pellets and are dehydrated. The dehydrated air rises further via the pipe in the oil conservator. The dehydrating breather is mounted on the pipe to the oil conservator. A suitable counter-flange must be installed on

the pipe to mount the dehydrating breather. The desiccant contained in the drying assembly is dehydrated using sensor controlled by the built-in heating unit, thus obviating the need for periodic desiccant replacement.

By providing the Maintenance Free Type of Breather the objective is to achieve reduced site inspections, Cost reduction by obviating the complete process of ordering, storage and replacement of the desiccant. It also leads to no pollution and disposal problem of the used up desiccant (which is associated with the conventional pigmented silica gel) is eliminated.

Specification:

1. The main Transformer tank conservator shall be fitted with a silica gel Breather of the Maintenance- Free type, in a convenient floor height at eye level.
 2. Each Silica gel breather shall be equipped with a humidity sensor, a condition based microprocessor control unit to ensure that the regeneration of the silica gel is activated only when the transformer is exhaling.
 3. A stainless steel filter at the bottom shall protect the silica gel chamber against external environment influences.
 4. Insect Protection for the High Grade Filter is also to be provided.
 5. This condition controlled application should be environmental friendly.
 6. Material of External Construction of the Breather: All external parts must be suitable for mounting for outdoor use, resistant against transformer oil and ultraviolet rays. Salt water resistance should be made available on request. No plastic parts shall be used in the construction of the breather.
 7. Ambient Temperature: The equipment must be suitable for ambient: 0 to + 80 Deg C.
 8. Degree of Protection: Minimum IP55. If the Breather need to be installed in a location where there could be sub-zero temperatures, a filter heater must be provided.
 9. The control unit on the breather must be equipped with suitable heater to prevent moisture condensation.
 10. The breather should be provided with status LEDs for local display. Also suitable contacts must be provided to take the signal to a remote control room.
 11. The moisture and temperature measurement system (sensor) installed should be modular making it easy to replace the same if at all the same is necessary during the service of breather. A self-diagnostic system must be provided with LED indication and remote signal through a relay should be provided.
 12. To protect against overvoltage, a micro fuse and an additional built in line filter must be provided to avoid failures caused by high-frequency interference.
 13. The control unit in the breather must provide analogue output signal of 4-20mA and also should be equipped with a USB Port for data logging.
 14. Suitable Data Logger should be also provided in the control unit.
 15. The Breather should be equipped with an optional integrated test button. This should allow to carry out a self-test at any time and to check the functions, like the relay circuits, the heating or the signal transmission in the control room.
 16. Rated Insulation Voltage:
500VAC 50 Hz, 1min., voltage supply voltage: against ground;
500VAC 50 Hz, 1min., analog output against ground; 2.5kVAC 50/60Hz, 1 min., relay contact against ground
 17. Necessary List of Type Test Conducted and Routine Test Certificate issued by the manufacturer of the Breather used must be provided for each supply.
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However, the conservator tank of OLTC shall be fitted with a dehydrating filter breather.

It shall be so designed that:

- a) Passage of air is through a dust filter and silica gel.
- b) Silica gel is isolated from atmosphere by an oil seal.
- c) Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.
- d) Breather is mounted not more than 1400 mm above rail top level.
- e) Minimum quantity of silica gel to be 1 kg for every 3500 Lts. of oil in the tank.
- f) To minimize the ingress of moisture three breathers (of identical size) shall be connected in series for main tank conservator. Contractor shall provide flexible connection pipes to be used during replacement of any silica gel breather.
- g) To minimize the ingress of moisture, two in series of identical size shall be connected to OLTC Conservator. Contractor shall provide flexible connection pipes to be used during replacement of any silica gel breather.

The arrangement and placement of maintenance free breather shall be such that retrofitting with maintenance free breather as described above for OLTC is possible with ease

13. Pressure relief device with self-sealing arrangement and oil collecting device. Adequate no. of Pressure relief device, having sufficient size for rapid release of any pressure that may be generated inside transformer tank without damage to the transformer, shall be provided at suitable locations directly on the tank. These PRD shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. Proper provision shall be provided for taking discharge of PRD to a place away from transformer through pipes etc. thus preventing spray on the tank. One set of electrically insulated contacts shall be provided for Alarm / tripping.

Following 'Routine test' shall be conducted on the PRD and submitted to BSPTCL.

- i) Air pressure test. ii) Liquid pressure test. iii) Leakage test. iv) Dielectric & Contact test.
14. For oil conservator oil head, if required, at the HV / LV bushing ends oil pressure shall maintain Seal arrangements. The oil connections shall however be tapped from the tank to conservator oil piping on the tank and on the lower side of the Buchholtz relay through suitable isolating valves.
 15. Inspection covers / access holes on tank cover and tank, with bolted covers for access to inner ends of the bushings, on-load-tap changing gear, and oil immersed current transformers for winding temperature indicator etc. (i.e. areas required for inspection).
 16. Lifting eyes for cover only.
 17. Lifting eyes for core and winding.
 18. Lifting lugs for whole transformer.
 19. Jacking pads with hauling hole.
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20. Skid arrangement welded with tank base.
 21. Transport lugs with hauling holes.
 22. Locking arrangement (Yoke Clamp Assy. With tank cover).
 23. Air release plugs at the top of cover and bushing turrets.
 24. Upper filter valve (50mm dia) suitably baffled to reduce aeration of oil, flanged to seal 35mm IPS threaded adopter for oil filter m/c pipe connection)
 25. Bottom filter valve (50mm dia) flanged to send 35mm IPS threaded adopter (for oil filter m/c pipe connection).
 26. Drain valve (100mm dia) flanged and 15mm dia oil sampling valve.
 27. Under carriage with flanged bi-directional wheels for i) 1676 mm on minor (shorter) axis. ii) 1676 mm & 2438 mm on major axis i.e. provision for fixing the wheels at two different points as indicated above shall be kept.
 28. Drain plug on Tank (1" BSP).
 29. Tank & A-Frame earthing terminals - minimum two (2) Nos. each.
 30. Ladder with safety device for inspection and testing of Buchholtz relay and other tank mounted devices.
 31. Pocket at suitable places for inserting alcohol thermometer for oil temperature indication along with necessary alcohol thermometer.
 32. Pocket for WTI.
 33. Pocket for OTI. With thermometer.
 34. Pocket for RTD.
 35. Double float Buchholtz relay with one (1) set of alarm contacts (suitable) for minimum one ampere current rating at $250 \pm 10\%$ V. DC and one(1) set of trip contacts (suitable) for minimum one ampere current rating at $250 \pm 10\%$ V, DC. The relay contacts shall be wired up to the outgoing terminal block of marshalling kiosk. Shut off valves shall be provided on both sides of the Buchholtz relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample—**A copper /stainless steel tube shall be connected from the gas collector to a valve located about 1400mm above ground to facilitate collection / sampling of gas while transformer is inservice.**
 36. Winding temperature (Hot spot) indicating devices complete with current transformers, heater elements bellow resistance arm bridge, rectifier unit etc. as required with local dial thermometer and one no. loose repeater dial (to be installed in remote control panel). The local dial thermometer located in the transformer marshalling kiosk shall have at least two (2) sets of trip and one (1) set of alarm contacts other than those required for cooler control. The contact rating shall be minimum one (1) amp. At $250 \pm 10\%$ V. D.C. The W.T.I. contact along with connections required for remote repeater dial shall be wired up to the Marshalling Kiosk outgoing terminal block. The accuracy class of the WTI shall be $\pm 1.5\%$ or better. In addition to the above, the following equipment shall be provided for remote indication of winding temperature: i) **Signal transmitter:** Signal transmitter shall have additional facilities to transmit signal for recording winding temperature at Data acquisition system. For this purpose a separate
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duplex Platinum RTD with nominal resistance (as per SAMA, USA std.) shall be placed in the pocket containing temperature sensing element and image coil for WTI system which will be used both for Remote WTI and DAS. All necessary equipment (except cable for remote connection) required for sending the signal to remote WTI & DAS shall be provided.

37. CT terminal box on HV turret for (WTI & RTD).
38. Dial thermometer for oil temperature indication complete with two (2) sets of trip and one (1) set of alarm contacts. The contacts rating shall be minimum one (1) ampere at $250 \pm 10\%$ V, DC. The dial thermometer shall be located in the Marshalling Kiosk. The contacts shall be wired up to the Marshalling Kiosk of outgoing terminal block. The accuracy class of the OTI shall be $\pm 1.5\%$ or better.

39. Rating plate and Diagram plate as per IEC/IS 2026 and also danger plate.

40. For transformer, on-load-tap changing gear on H.V. winding for a voltage variation range of $- 15\%$ to $+ 5\%$ in steps of 1.25% (percent), total no. of taps, shall be 17 (seventeen) nos. including normal tap. Tap changer shall be suitable for operation locally and also from remote tap changer panel. In addition to local tap position indicator, remote tap position indicator shall also be supplied in remote tap changer panel. OLTC shall be suitable for both independent & master follower operation. OLTC shall have separate oil chamber / conservator with oil surge relay and oil level gauge. The relay and the oil level switch shall have two (2) sets of contact for each. Each contact rating shall be minimum one (1) amp. at $250 \pm 10\%$ V, DC. All the contacts shall be wired up to marshalling Kiosk outgoing terminals.

As such, the design, manufacturing and testing of complete OLTC unit should strictly conform to IEC as amended up to date. No deviation in any regard shall be acceptable.

41. Marshalling Kiosk for mounting of local indicating instruments and terminal connections for all transformers mounted equipment relays & devices. Marshalling Kiosk shall have degree of protection IP-55 (weather proof) by enclosure with sheet steel (CRCA) thickness of 2.5 mm (Min.).
42. OLTC local control cabinet. The OLTC control schemes equipment along with local control and indicating devices as per purchaser's approved scheme shall be provided in LCC. The LCC shall be designed for IP-55 (weather proof) degree of protection by enclosure with sheet steel (CRCA) thickness of 2.5 mm (Min.).

43. COOLING EQUIPMENT:

Separately supported/ body mounted (shall be decided during detailed engineering) pressed steel radiator stacks (necessary supporting structures shall be within the scope of the transformer supplier / manufacturer having two (each of 50%) radiator stacks shall be complete with following fittings:-

- (i) Oil service valves (25mm dia) on the Transformer tank, one in the top head and other in the bottom header flanged for bolted connection to the radiator stack. Each radiator fin
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shall be detachable from top and bottom header and connected to headers through shut off valves.

- (ii) One oil drain plug in the radiator and its pipe work including ($\frac{3}{4}$ " BSP) bottom header of the radiator stack.
 - (iii) Lifting lugs for the stack.
 - (iv) Air release plugs in the top header & bottom header.
 - (v) Thermometer pocket on top & bottom header.
 - (vi) Oil inlet and outlet valves (150mm dia.).
 - (vii) Filter valves (25mm dia) on pipe works.
 - (viii) AC motor driven cooling fans/ blowers built on the radiator stacks. [The motors shall be squirrel cage induction motor, suitable for $415 \pm 10\%$ V, 3ph, $50 \pm 3\%$ Hz AC supply for both fan & pump].
 - (ix) Oil pump and motor.
 - (x) Necessary oil strainers.
 - (xi) Oil service pipelines with steel supports, if required.
 - xii) Wheels for hand operation with all valves.
 - (xiii) Oil flow indicators each with two sets of contacts for alarm and remote indication of stoppage of oil flow.
 - (xiv) For Transformer- Outdoor cooler control cabinet (IP-55 weather proof degree of protection as per IS-13947) for housing control, protection and indicating devices for above cooling fans or blowers as per purchaser's approved scheme. The facility shall be, therefore, normal and auto-change over of duplicate A.C. supplies (415V, 3-phase) manual and auto-control of fans & pumps. There shall also be facility of both local and remote control and indication. Necessary potential free contacts of rating 1(one) ampere at $250 \pm 10\%$ V. D.C shall be provided for annunciating all the fault conditions of cooling system as a whole in remote tap changer control panel (separate cooler control cabinet may not be required if all the equipment required for the purpose are accommodated in the marshalling Kiosk).
2.5 mm (min.) thick sheet steel (CRCA) as per IS - 513 and Frame, load bearing support / structure, relay / meter etc. mounted sheet shall be 2.5 / 3mm sheet steel (CRCA). Front door may be glass with steel frame -- as per approved drawing.
- 44 Gas pressure cylinder with testing valve and pressure gauge if the transformer is shipped filled with inert/N₂ gas.
- 45 Neutral bushing current transformers as per details given in 'item'27' of "Annexure-D" of this specification. The CTs shall be housed in weatherproof enclosure with suitable terminal boxes. The CT terminal shall be wired up to Marshalling Kiosk terminal box
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terminals with proper heat resistant cables. Each CT lead shall be wired up to Marshalling Kiosk through two nos 2.5 mm² copper conductors cabling.

- 46 CT terminal Box tank wall for HV-n Housing.
- 47 Termination arrangement for transformer shall be as specified in “Item 22” ‘Annexure-D’ of this specification. Expansion type terminal connector suitable both for horizontal & vertical take off for HV, LV, HV-n bushings to be connected to purchaser’s ACSR double Moose Conductor / 2.5" IPS Al Tube (for HV & LV) and 50mm X 6 mm G.I. Flat /Al. However, terminal arrangement maybe finalised during detail engineering.
- 48 Post Insulator 24 KV for bringing down the HV-n. GI Flat up to 200mm above the ground level for earthing.
- 49 25 NB OLTC suction pipe should be brought down to the man height level.
- 50 OLTC Head earthing Arrangement.
- 51 100% percent output from the transformer shall be ensured even if one cooler pump and one fan of each bank (of 50% radiator stacks) are out of service.**
- 52 145 KV Antifog type, fully weather proof Bushings for HV terminal with expansion type terminal connector for Horizontal/vertical take off to be connected with outdoors bus. The size of conductor for the connector will be intimated later.
- 53 52 KV Antifog type fully weather proof Condenser bushing for L.V. terminals with suitable expansion type terminal connector for Horizontal & Vertical takeoff to be connected to outdoor bus.
- 54 36 KV Antifog type fully weather proof/ oil filled HV-n Bushings / T.V (test bushings) with suitable connector (i.e. 50mm X 6mm GI Flat) for solid grounding. The G.I. flat to be brought down to the 200mm above earth through tank wall by 24 KV porcelain Insulators.
- 55 Lightning Arrester Mounting Arrangement:**
On HV & LV side Lightning Arrestors will be mounted separately on Purchaser’s structure. **The recommended distance between transformer & LA may please be indicated.**
- 56 Remote Tap Changer Panel:**
- (i) Exterior - Light gray to shade No. 631 of IS- 5 of Semi Gloss.
- (ii) Interior - White Enamel Gloss.
- (iii) Degree of protection IP-52.**
- (iv) Material - 2 mm (min.) thick sheet steel (CRCA) as per IS - 513. However, the Frame, load bearing support/structure, relay/meter etc. mounted sheet shall be 2.5 / 3mm sheet steel (CRCA). Front door may be glass with steel frame -- as per approved drawing. On terminal block’s all power supplies fuses & links terminal are to be shrouded.
- (v) Panel wiring shall be done with PVC 2.5 mm² copper wire of 1.1 KV grade.
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57 Miscellaneous:

- (i) All alarm / relaying contacts to be provided by the bidder in addition to these mentioned above shall be suitable for 250 V ± 10% V, D.C. If the ratings do not meet this requirement; the bidder shall supply reliable auxiliary contactor / relays to meet the purchaser's requirement.
- (ii) All valves shall be provided with hand wheel for hand operation & shall be of M/s. Audco make / M/s. Petson / M/s. Precession / M/s. Maxons / M/s. Leader. Metal to be used in construction/manufacture of valve shall be gun metal/ stainless steel as recommended by CBIP manual.
- (iii) For all the bought out items, the manufacturer's name and the material used for such items shall be indicated in the offer. The make of all such bought out items shall be of reputed one.

6.010 MANDATORY SPARES:

Following list of mandatory spares shall be supplied along with the transformer as per ordered quantity mentioned in BOQ.

- (a) H.V. side bushing with metal part.....
- (b) L.V. side bushing with metal part.....
- (c) H.V. neutral bushing with metal part and gasket for HV and LV...
- (d) Buchholtz relay (with alarm/trip contacts).....
- (e) Oil surge relay (with alarm/trip contacts).....
- (f) Magnetic oil level gauge (with alarm / trip contact).....
- (g) Current Transformer of WT
- (h) Dial type oil temp. indicator with alarm/ trip contact
- (i) Local and remote Winding temperature indicator with alarm/trip contacts
- (j) Set of Gaskets (each type) for one transformer including bushings
- (k) Pressure relief device
- (l) Oil flow indicator with alarm contacts
- (m) Cooler pump with motor
- (n) Cooler fan with motor
- (o) Tap position indicator(local and remote)
- (p) Expansion joint (complete replacement for transformer)
- (q) Set of starter, contacts, relays and switches
- (r) Fuses(control) – for complete replacement of transformer
- (s) Lamps(indicative)- complete replacement for transformer.

6.020 SPECIAL TOOLS AND TACKLES:

Bidders shall furnish a list of recommended special tools and tackles, if required for installation and maintenance of each of the specified transformer type in 'Schedule I/C' and respective prices in 'Schedule-II/B' forming part of this specification. The list of tools and tackles shall include but not limited to (at the option of purchaser's Engineers) 8 (Eight) number hydraulic jacks each of 40 (forty) tonne capacity for the transformer. The bidder shall quote 'Firm' prices for the above items. Its cost however shall not be considered for evaluation of turn-key package.

7.000 PARALLEL OPERATION:

The transformers to be procured shall be compatible for successful parallel operation with other transformers of similar configuration.

8.000 DESIGN CRITERIA:

The basic design of the transformers shall be guided by the stipulations of 'Annexure -

D' forming part of this specification. The constructional aspect shall be as per CBIP manual as applicable.

9.000 DETAILED DESIGN REQUIREMENT:

Tanks

The tank shall be made of MS plate; so shaped as to reduce welding to a minimum. All seams shall be double welded for absolute oil - tightness. The Tank walls shall be reinforced by stiffeners of structural steel for general rigidity and also to damp transformer noise. All welding shall be done electrically and relieved of welding stresses.

The tanks of all transformers shall be complete with all accessories and shall be designed so as to allow the complete transformer in the tank & filled with oil, to be lifted by crane or jacks, transported by road, rail without over straining any joints and without causing subsequent leakage of oil.

The main tank body (during fabrication stage) excluding tap changing compartments, radiators and coolers shall be capable of withstanding full vacuum specified under respective clause of Testing.

The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plates or rails.

The base channels and tank stiffeners shall be designed to prevent retention of water.

Wherever possible the transformer tank and its accessories shall be designed without pockets wherein gas might be collected otherwise. Where pockets cannot be avoided pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes shall have a minimum inside diameter of 15mm except for short branch pipes, which may be 6mm minimum inside diameter. All joints shall be welded.

Each tank shall be provided with lifting lugs for lifting transformer with oil, minimum four jacking lugs and suitable haulage holes.

Each tank cover shall be of adequate strength, and shall not distort when lifted. Inspection opening of adequate size and in numbers as required shall be provided as necessary to give easy access to bushings or changing ratio or testing earth connection. Tank cover and inspection covers shall be provided with suitable lifting arrangement unless otherwise approved. Inspection covers shall not be more than 25 Kg each.

Protection shall be provided, where necessary, for each capillary tube required for oil and winding temperature indicators. The thermometer pocket shall be fitted with captive screwed caps to prevent the ingress of water. Pockets shall be located in the position of maximum oil temperature at C.M.R. & it shall be possible to remove the instrument bulbs without lowering the oil in the tank.

The tank shall be subjected to leakage test at fabrication stage (oil tightness test) as specified under respective clause of Testing. After the test all the welded joints will be checked for leakages. **No valve shall drip and no gasket joints shall sweat.**

The transformers are to be provided with bi-directional flanged wheels and axles shall be of such dimensions and so supported that under any service conditions they shall not deflect sufficiently to interfere with the movement of the transformer. Suitable locking arrangements shall be provided to prevent accidental movement of the transformer. All wheels shall be detachable and shall be made of steel as required. The wheels shall be suitable for 1676mm rail gauge on minor axis & 1676mm on major axis and also provision for fixing the wheels suitable for 2438mm rail gauge on major axis shall also be kept. The wheels shall be so arranged that they can be turned through an angle of 90° when the tank is jacked up clear of the rails. Means shall be provided for locking the swivel movement in positions. The wheels shall also be so placed that pinch bar can be used to move the transformer.

Deleted

All the valves opening directly to the atmosphere shall be fitted with blanking flanges.

Means shall be provided for padlocking all bottom valves in the open and closed positions. This is required for the valves where opening device like hand wheel, keys etc. are the integral part. Each valve shall be provided with indicator to show the actual position of the valve. The drilling of valve flanges shall comply with requirements of IS3639.

Facilities shall be provided for mounting the current transformers externally on the neutral bushings adjacent to the tank. The CTs shall be complete with proper weatherproof casing kiosk by the Transformer manufacturer. The requisite numbers and type of terminals for the above purpose both at the C.T. and the marshalling kiosk shall be intimated to the successful bidder during detail Engineering.

Two (2) earthing terminals capable of carrying for 5 seconds the maximum short circuit current of the system to which the transformer is connected shall be provided.

All gaskets used for making oil-tight joints shall be of proven materials such as granulated cork bonded with synthetic rubber or synthetic rubber gaskets.

10.118 Arrangement shall be made for installation of fiber optic temperature monitoring system conforming to given specification.

Cooling Plant:

The conservator shall be liberally dimensioned such that at the lowest ambient temperature and no load on the transformer the oil level shall not recede too low and at the highest ambient temperature & full load on the transformer the oil, shall not spill into

the breather pipe or to the exterior. The recommendations of “CBIP Manual” should be followed in totality.

- 9.202 There shall not be any pocket formation in radiators and coolers in which moisture may collect.
- 9.203 Clearance between all pipe work and live parts shall be more than the clearances specified for live parts to earth in relevant standards.
- 9.204 Radiators’ top and bottom headers shall be connected to the tank through isolating valves. Each in of a radiator banks shall have top and bottom gate valves. Each radiator shall be provided with drain plug at the bottom and air release plug at the top.
- 9.205 The oil circuit of all cooler shall also be provided with the following:-
Removable blanking plates to permit the blanking off the main oil connection of each cooler.
A thermometer pocket fitted with a captive screwed cap on the inlet and outlet oil branches of each separately mounted cooler bank.
- 9.206 All oil piping shall be with flanged gasket joints. The drilling of oil pipe flanges shall comply with relevant ISS. Separate expansion piece shall be provided in each oil pipe connection between the transformer and the separately mounted oil cooler to avoid transformer Vibration being transmitted to the cooler Banks.
- 9.207 Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.
- 9.300 **Air blowers (Fans) & Pumps:**
- 9.301 Air blower fans for air blast cooling shall be motor driven. They shall be suitable for continuous operation. Air blowers shall be complete with air ducting and coolers shall be designed so that they operate with a minimum of noise. In order to reduce transmission of noise and vibration the blowers shall either mounted independently or alternatively, on approved form on antivibration mounting shall be adopted. It shall be possible to remove the blower fan complete with motor without disturbing or dismantling the cooler structure. Blades of blowers/fans shall be suitably painted for outdoor use. If blowers / fans are mounted at a height less than 2.5 meter suitable painted wire-mesh guards shall be provided to prevent accidental contact with blades, for blowers / fans mounted at more than 2.5 M height shall be provided with outside guards against birds etc.
- The full - duty oil pumps & motors shall be provided. The necessary expansion joints, valves, bends, fittings & oil piping shall be supplied.
- 9.400 **Core:**
- 9.401 Core materials shall be directly procured either from manufacturers or through authorised importing organization of repute.
- 9.402 The core will be made of cold rolled grain oriented silicon steel laminations of low loss grade. The thickness of sheet steel should be 0.27mm.
- 9.403 The core laminations are to be subjected to a special debarring process where all burrs will be removed by continuous grinding. The above process will be followed by a stress
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relief annealing in a continuous annealing roller hearth furnace subjecting the laminations to a precisely controlled heating and cooling cycles in order to eliminate all mechanical stress induced during mechanical operations.

The core limbs will be bound by resin bonded glass tapes.

The core lamination joints will be 45° mitred and interleaved, which avoids local heats and reduces core loss.

After building in the horizontal position the core is to be erected using a core setting device in order to avoid bending of core and resultant mechanical stresses.

The core clamping frame shall be provided with lifting eyes. The whole core shall be electrically connected by an iron/copper strip at the tank for being earthed.

Conventional core construction/clamping drives a hole through core laminations. This weakens the core. As such a method of construction/clamping should be adopted so that hole through core laminating is avoided. Suitable tie plates and clamps to be incorporated so that core holes and core bolts are eliminated as far as practicable.

The size of the core shall be such that it will be able to withstand continuously 15% over voltage/over fluxing. The core-clamping frame shall be provided with lifting eyes for the purpose of tanking and detanking the active parts of the transformer. The whole core shall be electrically connected by an iron/copper strip to the tank for being earthed to drain off any electro static potentials that may buildup.

10.000 **Coils:**

Disc coils should be used. Each coil should be of paper insulated continuous and smooth electrolytic copper conductor.

The high voltage winding should be provided with a surge shield winding in order to distribute impulse voltage uniformly along with winding. The surge shield will be such that it will increase the series capacitance thereby giving a uniform surge voltage distribution.

The coils should be pre-shrunk before assembly.

Adjustable push bolts at the top end should clamp the coils. The coils and insulation will be perfectly dried and then oil impregnated at a high degree of vacuum followed by a keeping period at the high vacuum in order to drive out all traces of air. The detail drying & impregnation process is indicated under separate clause.

Value of the insulation resistance of the winding measured immediately after impregnation shall be intimated to the Purchaser.

The whole assembly shall be finally held by suitable means under axial compression of at least twice the aerial thrust likely to be set up under a terminal short circuit.

The Bidder shall describe the method devised to develop the impulse withstand strength of transformer, in his tender and illustrate it by oscillographic test records of a type test made on a similarly wound transformer of an equivalent or higher voltage class.

The switching surge withstand strength of the windings shall be developed according to the best modern practice and the expected values shall be indicated. Inter phase insulation barriers shall be provided. Full details of the arrangement of inter winding insulation and inter phase insulation barriers shall be submitted.

The winding assembly with all connections, spacers, clamps and leads shall be electrically and mechanically strong to withstand the stresses arising out of 2 sec. dead short circuit at the terminals. No loosening or insulation weakness should result.

INSULATING OIL:

- 11.000 The oil should be free from inhibitors. The oil required for first filling of the transformer plus ten percent extra oil should be supplied along with the transformer. The oil shall conform to IS-335 (latest amendment) and shall be sent in drums, which will become the property of the purchaser. The oil drums (Non returnable) shall be made of steel sheet suitable to withstand the rigorous of transit hazards without leakage.

The source of the oil shall be indicated in the tender. The recommended value of Electric strength of oil (min. break down voltage as per ISS) to be used in transformer may be stated. It is preferable not to mix oils from different suppliers. The characteristic of oil shall be as per requirement specified in Annexure - 'E' forming part of this specification.

- 12.000 **TERMINAL ARRANGEMENTS:**

Terminal arrangement of the transformer for both HV, L.V. shall be as per ISS-2099-1973 (latest revision) if any. The bushing terminals and terminal fittings shall carry the full rated transformer current continuously without the temperature rise of any part exceeding 20°C over a maximum ambient air temperature of 50°C. They shall operate satisfactorily in heavy rain or in industrial atmosphere laden with abrasive coal dust, ash, fog, gas, salt and mild acids. They shall be free from corona, and shall not cause radio interference. They shall be made from wet process porcelain. The detail requirement of Bushings has been already mentioned under Annexure 'D'.

- 13.000 **TAPS AND TAP CHANGE GEAR:**

On-load tap changing gear (OLTC) shall be furnished as specified. The details of the method of diversion of the load current during tap changing, mechanical construction of the gear and the control features of the OLTC gear shall be enclosed with the tender. Information regarding the service experience on the gear and a **list of important users shall also be furnished**. The current diverting contacts shall be housed in separate oil chambers, not communicating with the main tank of the transformer. The contacts shall be accessible

for inspection and their tips shall be replaceable. The transformer shall give full load outputs on all taps.

a) Manual mechanical control:

The cranking device for operation of the OLTC gear shall be removable and suitable for operation at about 1350mm above ground level. The mechanism shall be complete with following:-

- i) A mechanical tap position indicator.
- ii) A mechanical operation counter.
- iii) Mechanical stops to prevent over cranking of the mechanism beyond extreme tap positions.
- iv) The diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of ancillary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safe guard the transformer and its ancillary equipment.
- v) The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position.

This switch shall be provided in addition to any other switch/switches, which may be required for remote tap position indicator.

b) Electrical control:

- i) This shall include local and remote electrical control. The control circuit shall have the following features:
 - ii) An interlock to cut off electrical control automatically upon recourse being taken to the manual mechanical control.
 - iii) Reinforcement of the initiating impulse for a tap changes, ensuring completion of the initiated tap change to the next (higher or lower) tap.
“Step-by-step” operation, ensuring only one tap change from each tap changing impulse and a lockout of the mechanism if the control switch (or push button) remains in the operated position.
 - iv) An interlock to cutout electrical control when it tends to operate the gear beyond either of the extreme tap positions.
 - v) An electrical interlocks to cut-off a counter for a reverse tap change being initiated during a progressive tap change and until the mechanism comes to rest and resets circuits for a fresh operation.
 - vi) The following auxiliary devices for electrical control of the OLTC shall be housed in weatherproof cabinet complete with 2.5mm² copper conductors of 1.1 KV grade PVC wirings near the transformer and also on the tap changer drive.
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- a) Motor protective switch with magnetic and thermal overload devices for controlling the incoming A.C. supply.
 - b) Control Selector Switch Local / Remote.
 - c) Tap changer-driving motor.
 - d) Limit switch to open in position 1 and highest position.
 - e) Hand interlock switch.
 - f) Local control / push button Raise / Lower mechanically operated contact closed during "Raise TC operation.
 - g) Mechanically operated contact closed during "Lower" TC operation.
 - h) Mechanically operated contact open during tap change.
 - i) Mechanically operated contact closed during tap change.
 - j) Motor contact radial switch for Tap position Indicator.
 - k) Odd / Even paralleling switch.
 - l) Tap change motor contactor Raise tap position No.
 - m) Tap change motor contactor lower tap position No.
 - n) Brake contactor for Motor.
 - o) Step by step contactor.
 - p) Position Indicator resistance/thermostat.
 - q) Heaters in T.C. driving gear.
 - r) Signal lamp for "Motor protective Switch Off".
 - s) Emergency push button - "Off for Motor protective Switch".
 - t) Contact for passage position.
 - vii) The following devices shall be mounted on Remote Tap Changer Control panel complete with 2.5 mm² copper conductor of 1.1 KV grade PVC wirings to be offered by Bidder:
 - a) Out of step relay.
 - b) Time delay for out of step relay.
 - c) Sequence selector switch Independent / off / Follower / Master.
 - d) Remote control switches Raise / Lower / Neutral.
 - e) Auxiliary Raise Contactor.
 - f) Auxiliary Lower Contactor.
 - g) Auxiliary step-by-step contactor.
 - h) Electric bell for out of step alarm.
 - i) Buzzer for tap change in progress.
 - j) Signal lamp for tap change in progress.
 - k) Signal lamp for out of step.
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- l) Signal lamp for tap change control supply “ON”.
 - m) Tap position Indicator.
 - n) Push button switch.
- Necessary interlock, blocking independent control when the units are in parallel i.e group control (parallel operation) through Master/Follower/independent, shall be provided with proven scheme. Under abnormal condition if one tap changer sticks, out-of-step condition shall have to be limited to one tap difference between the units by switching off supply to motor. Details of out-of-step protection provided for the taps shall be furnished in the tender.

Cables for control interconnection between the OLTC control cabinet and RTCC control panels is under purchaser scope. Cable glands shall however be fitted in the control cabinet as per Purchaser’s requirement.

14.000 COOLING EQUIPMENT FOR TRANSFORMER:

Forced oil, air blast cooled (OFAF) type of transformer shall be quoted. The full duty oil pumps and motors shall be provided. The necessary expansion joints, valves, bends, fittings and oil piping shall be supplied. **Continuous rated output shall be available even when one pump and one fan of each bank are out of service.**

Weather-proof Cooler control cabinets complete with 2.5mm² Copper Conductor of 1.1KV grade PVC wirings, cable glands, heaters and cubicle light AC power outlet socket shall be supplied with the following:-

- i) Local control selector switches Auto / OFF / Manual.
 - ii) MCB with motor protection for supply source 1 and 2.
 - iii) No volt contactors for supply failure.
 - iv) Winding temperature Indicator.
 - v) Control contacts (two sets) on WTI - one for Automatic fan starting and other for automatic pump starting.
 - vi) Alarm and Trip Contacts on WTI.
 - vii) Oil Temperature Indicator.
 - viii) Alarm and Trip contacts on OTI.
 - ix) Thermal overload relays with Contractors of Fan and Pump Motor Starters.
 - x) Contactors for Auto-supply change over from supply source 1 to 2 or vice versa as in (ii) above.
 - xi) Necessary Interlocking Contactors.
 - xii) Heaters and Heater Switch.
 - xiii) Illumination lamp & lamp switch.
 - xiv) Auxiliary contactors for starting and stopping the pumps and fans from Remote Control Panel.
 - xv) Alarm and trip contacts on Buchholtz.
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- xvi) Alarm contacts on low oil level alarm.
- xvii) Alarm and trip contacts on Tap Changer Buchholtz.
- xviii) Alarm contact on oil flow indicator.
- xix) Fan and pump motors.
- xx) Signal lamps for Fans & pumps 'ON' Local indication.
The items between xv to xix above may be on Transform itself. The followings are to be supplied along with Remote Control panel complete in all respects.
- xxi) Signal lamp for control supply "ON".
- xxii) Remote Control selector switches Auto / OFF, Hand / OFF.
- xxiii) Signal lamp for Fans and Pumps; "ON" Indication.
- xxiv) Start and stop push buttons for each cooler Bank.
- xxv) Winding Temperature Indicator.
- xxvi) Alarm circuits for (a) pump and fan failure (b) 415V/240V/110V AC supply failure.
- xxvii) Test circuit for fan and pump motors even when the transformer is in de-energised condition.

The automatic cutting in and cutting out of radiator cooling fans and pumps shall be with the variation of transformer load or temperature.

15.000 Control Connections and Instrument Wiring, Terminal Board and Fuses:

- i) All wiring connections, terminal Boards, fuses and links shall be suitable for tropical atmosphere. All terminals of the local instruments, devices, CT, fans, etc. shall be also of weatherproof construction. Any wiring liable to be in contact with oil shall have oil resisting insulation and bare ends of standard wire shall be sweated, together to prevent seepage of oil along with wire.
 - ii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the limited compression type. All wiring to a panel shall be taken from suitable terminal boards.
 - iii) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduits runs shall be adequately drained and ventilated conduits shall not run at or below the ground level.
 - iv) When 415V connections are taken through junction boxes or marshalling boxes they shall be adequately screened and 415 'VOLTS DANGER' notice must be affixed outside of the junction boxes or marshalling boxes.
 - v) All wiring shall be in accordance with relevant IS. All wiring shall be stranded copper of 1.1 KV grade and size not less than 4 Sq. mm. for CT leads and not less than 2.5 Sq. mm. for other connection.
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- vi) All wires shall have ferrules, which bear the same number at both ends. Same ferrule numbers shall not be used on wires in different circuits on the same panels.
Ferrules shall be white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in block and shall not be affected by damper oil.
- vii) Stranded wires shall be terminated with tinned Ross terminals, Claw washer or crimped tubular lugs. Separate washers shall be used for each wire. The size of the washers shall be suited to the size of the wire terminated. Wires shall not be joined or tied between terminal points.
- viii) No live metal shall be exposed at the back of the terminal boards.
- ix) All fuses shall be of cartridge type (HRC).
- x) Fuses and links shall be labeled.

INTERNAL EARTHING ARRANGEMENT:

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 fixed potential.

The top main core clamping structure shall be connected to the tank body by a copper strip. One or more of the following shall earth the bottom clamping structure:-

- a) By connection through vertical tie-rods to the top structure.
- b) By direct metal-to-metal contact with the tank base maintained by the weight of the core and windings.
- c) By a connection to the top structure on the same side of the core as the main earth connection to the tank.

The magnetic circuit shall be earthed to the clamping structure at one point only through a link placed in an accessible position beneath the 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.

Magnetic circuits having an insulated sectional construction shall be provided with separate earth links for each individual section.

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.

All earthing connections with the exception of those from the individual coil clamping rings shall have adequate bigger cross sectional area. Connections inserted between laminations of different section of cores shall have a cross sectional area of not less than

0.2 Sq.cm.

17.000 **INSULATION CO-ORDINATION:**

The Contractor shall furnish (1) Impulse flashover, (2) Dry flashover and (3) Wet flashover - Characteristics for the bushings spark gaps arcing horns set at different distances of separation and also (4) Impulse volt - time characteristics of the transformer winding and bushing to enable the purchaser to obtain effective insulation co-ordination among the Transformer, lightning arrestors and the rest of the station Equipment.

18.000 **PAINTING:**

All steel surfaces exposed to weather shall be given a priming coat of zinc chromate and two coats of light grey paint.

All steel surfaces in contact with insulating oil, as far as practicable, shall be painted with heat-resistant, oil-insoluble insulating varnish.

The surface to be painted shall be hot sandblasted to remove all rust and mill scale of foreign adhering matter or grease.

All paints shall be carefully selected to withstand tropical heat and extremes of weather as indicated in the specification. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

19.000 **DRYING OUT BEFORE DISPATCH:**

Each Transformer shall be sealed under a positive pressure of dry N₂ gas for delivery (with cylinder, pressure gauge etc.). As it may be necessary to dry out the unit at site, the contractor shall furnish detailed instructions regarding the drying out at site.

If the Transformer is transported with tank partly filled with oil (covering the winding) the necessary oil gauge shall be provided in the tank for supervision of the oil level, oil gauge shall have proper-chained cover cap.

20.00 **Deleted**

INSPECTION & TESTING:

As such, the bidders are required to visit BSPTCL's website and follow the MQP and FQP indicated therein fully.

The purchaser and / his authorized representative reserves the right to witness any / or all tests conducted in the manufacturer's works during manufacturing stages and after completion. The manufacturer shall intimate the dates of the testing **at least 3 (three) weeks in advance** for the purchaser to depute his representative.

Stage inspection will be carried out for core materials. Call notice for such stage inspection shall accompany the following documents, as applicable, as proof towards use of prime core materials:-

- i) Invoice of supplier.
- ii) Mill test certificate.
- iii) Packing list.
- iv) Bill of lading.
- v) Bill of entry certificate by the customer.

STAGE INSPECTION:-

Stage inspection on core, windings, tank, OLTC and all other accessories etc. will be carried out by the Supplier in the presence of BSPTCL's representative on free of cost to BSPTCL. Before tanking of the core and windings, all the measurements will be taken on the above components, so as to ensure their compliance to the above Specification and the Guaranteed Technical Particulars. The possible routine tests like measurement of D.C. resistance, no load current and no load loss, determination of Knee Point Voltage, specific core loss, tank tests etc. will be conducted during stage inspection. For determination of number of turns in the windings, the manufacturer shall provide dummy core, so as to accommodate the LV winding and determining the ratio between the unknown No. of turns (winding) and known No. of turns, wrapped around the LV winding. The purchaser's representative at his discretion may choose small strips of core for testing at CPRI. Also, a small piece of conductor for each type of winding and core material shall be made available to the purchaser's representative. Apart from the above, the purchaser at his discretion reserves the right to carry out the stage inspection at other stages also, for which advance intimation shall be given and all necessary co-operation shall be rendered by the manufacturer. The Supplier shall give at least three week notice in advance for deputing Inspecting Officer(s) to their works. Type Tests and routine tests on the transformer shall be conducted only if the stage inspection report and the pre-tanking tests are found to be in order as per this Specification.

FINAL INSPECTION & TESTING:-

Before offering for final inspection, type tests and routine tests, the Supplier shall furnish the factory test results (except dielectric tests) of the offered transformer(s) along with list of equipment/meters/instruments to be used during testing (both routine and type tests) along with calibration certificates of measuring instruments. The Purchaser may direct the Supplier for use of better equipment /meters during inspection/testing. The calibration of all the meters/instruments to be used during testing should have been done in Government approved laboratory.

21.100 TESTS DURING MANUFACTURE:

The following test shall be performed on the Transformer during stages of manufacture in addition to the other customary tests of the manufacturer for the equipment & the test certificates shall be furnished to BSPTCL along with the final test certificates to be submitted to BSPTCL before dispatch, as a complete test report of this transformer.

Vacuum Test (Test on transformer tank)

- a) This test is conducted at fabrication stage. Top tank is subjected to full vacuum and tested at an internal pressure of 3.33KN/m^2 (25 torr) for 1 hour. The permanent deflections of
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flat plates after the vacuum has been released will not exceed the values as specified below:

Horizontal length of Flat plates (mm)		Permanent deflection (mm)
1.	up to and including 750	5.0
2.	751 - 1250	6.5
3.	1251 - 1750	8.0
4.	1751 - 2000	9.5
5.	2001 - 2250	11.9
6.	2251 - 2500	12.5
7.	2501 - 3000	16.0
8.	Above 3000	19.0

b) Leakage/Pressure Test at Fabrication stage -

This test shall be done at Fabrication stage. Transformer tank and all oil filled compartments shall be tested for oil tightness by filling with air / oil / water and applying a pressure equal to normal head plus $35 \text{ KN} / \text{M}^2$ or twice the normal head, whichever is lower, measured at the base / cover of the tank. This pressure shall be maintained for a period of not less than 12 hours for water or 1 hour for air during which no leakage shall occur. The permanent deflection of flat plates after the excess pressure is released shall not exceed the values specified Sl. No. (a) above.

- c) Other tests:**
- i) Material test for core sheet
 - ii) Core Insulation test of core & clamp (at 3.5KV for 1 min.)
 - iii) Bushing power factor test
 - iv) Measurement of Insulation resistance after drying and impregnation of winding.
 - v) Partial discharge test for winding (if applicable)
 - vi) Bushing tan delta test

21.200 ROUTINE TESTS:

The manufacturer shall conduct the following tests on the transformer as routine tests after an initial Dissolved Gas Analysis of the transformer oil.

- a) Measurement of voltage and check of polarity and voltage vector relationship.
 - b) Measurement of insulation resistance.
 - c) Measurement of winding resistance i.e. H.V. winding at all taps and full winding of LV for all 3 phases.
 - d) Measurement of Turns ratio at all taps.
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- e) Measurement of no-load loss and magnetizing current measurement at 90%, 100% & 115% excitation.
- f) Separate source power frequency voltage withstand test at 50 Hz for 1 min.
- g) **Induced over voltage withstand test.:**
An externally generated voltage of 50Hz to 100 Hz shall be used to excite a winding for a period of 1 (one) minute, frequency excitation voltage may be used for short duration of '6000/test frequency' seconds, but this duration shall not be less than 15 (fifteen) seconds. The magnitude of test voltage shall be as per relevant item of 'Annexure-D' of this specification. The value of the exciting current, voltage and the frequency of excitation shall be noted on the test report.
- h) Impedance and load loss measurement to be conducted between HV/LV at normal tap & extreme taps at normal load current and calculating loss.
- i) Tests on on-load tap changer i.e. operation test on OLTC.
- j) Insulation resistance of Auxiliary Circuit (2.5 KV for 1-minute)
- k) Calculation of efficiency at full load, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ load at unity and 0.80 lagging power factors. Calculation of regulation at unity power factor & .80 lagging power factor.
- l) Magnetic balance test for 3 Ø transformer.
- m) Measurement of no-load current with 415 V, 50 Hz A.C. supply on L.V. side for all three phases.
- n) Continuity test for OLTC.
The above test is to be done by shorting the L.V terminals of the transformer and applying 3 Ø phase A.C. voltage in the H.V. terminals. The voltage shall be regulated so that the rated current shall flow into the H.V. winding at a particular tap. The tap position of the transformer shall be changed locally through OLTC gear in either direction. There will be no current zero throughout the tap changing operation.
- o) Dye penetration test on lifting lug & jacking haul as per relevant standard.
- p) Sweep frequency response analysis (SFRA) as per relevant standard. This should be done before leaving the transformer from manufacturing site and after arrival of transformer on work site.

21.300 TYPE TESTS:

The following Type Test shall be conducted on one transformer of rating 80MVA, 132/33 KV.

- a) **Lightning impulse test:**
As per relevant ISS stipulation in IS-2026 (latest version). The lightning impulse level i.e. tests voltage values shall be stipulated in 'Annexure-D'. The above test shall be conducted on a particular phase keeping the tap at position No. 1, 5 or 17 to be decided during testing.
 - b) **Temperature rise test (on every unit):**
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Temperature rise test has to be conducted at minimum tap. The test shall be conducted on transformer for different ratings i.e. ONAN, ONAF, OFAF for different windings guided by the following. The reading of fiber optic temperature monitoring system shall be recorded simultaneously in addition to OTI and WTI readings and result would be inferred accordingly for assessing temperature rise and hot spot temperature.

- i) Temperature rise curves of oil Vs time in hours for different windings.
- ii) Winding cooling curves Vs time in hours for different windings.
- iii) The temperature rise shall be limited to stipulation indicated in 'Annexure-D'.
- c) Tank Vacuum test as per Cl.21.100(a).
- d) Tank Pressure test as per Cl.21.100(b).

LIMITS OF TEMPERATURE RISE:-

The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50 degree C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly. For actual maximum temperature at the location of installation, refer perfect synopsis.

<u>Sl. No.</u>	<u>Nature of the part or of the liquid.</u>	<u>Temperature.</u>	<u>Maximum value of:</u> Temperature rise at a Maximum ambient air Temp. not exceeding 50 degree C.
1	Contacts in air, silver-faced copper, Copper alloy or aluminium alloy (see Notes (i) & (ii)).	95	40/45
2	Bare copper of tinned aluminium alloy.	75	25
	Contacts in oil:	90	40
	Silver-faced copper, copper alloy or Aluminium alloy [see note- (i)].	80	30
3	Terminals to be connected to external Conductors by screws or bolts silver faced (see note (iii)).	105	55
4	Metal parts acting as springs.	(See note iv).	(See note iv).
5	Metal parts in contact with insulation of the following classes:		
	Class Y:(for non-impregnated Materials).	90	40
	Class A:(for materials immersed in oil Or impregnated).	100	50
	Class E:in air	120	70
	In oil	100	50
	Class B:in air	120	70
	in oil	100	50
	Class F:in air	155	105
	In oil	100	50
	Enamel:oil base	100	50
	Synthetic, in air	120	70

Synthetic, in oil	100	50
6 Any part of metal or of insulating Material in contact with coil, except Contacts.	100	50
7 Oil	90	40

- Notes: (i) When applying the temperature rise of 45° C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.
- (ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as 'bare'.
- (iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.
- (iv) The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75°C.

21.400 SPECIAL TESTS:

The following special tests shall be conducted by the manufacturer on one transformer of rating 80MVA covered by this specification without any extra cost.

a) Over fluxing test:

The transformer shall be excited from the L.V. side with H.V. side open circuited and the voltage shall be gradually raised to 115% of rated voltage at which the initial readings of voltage, current, no-load losses and vibration shall be taken and transformers should be kept energized for a further period of about 30(thirty) minutes. The transformer current, losses, noise & vibration shall again be measured during that period. Same data shall also be taken by reducing the excitation to 100% & 90% level before finally de-energising the transformer.

b) Pressure testing:

The transformer tank together with its radiators, pipework, bushing will be subjected to a pressure corresponding to twice, the normal head of oil or the normal pressure plus 35 KN/ M² whichever is lower. The applied pressure will be measured at tank cover & maintained for one hour during which no leakage shall occur.

- c) Measurement of Zero-sequence impedance of three-phase transformer.
 - d) Measurement of acoustic sound level.
 - e) Measurement of the harmonics of the no-load current.
 - f) Measurement of the power taken by the fans & the oil pumps.
 - g) Measurement of winding capacitance & loss tangent.
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- h) In addition, dynamic short circuit withstand test as per the requirement of IEC 60076 shall be carried out on *1st manufactured unit at CPRI (If not available)*. The remaining units to be manufactured based on successful SC tested design. As such all transformers shall be similar in all respect & shall be able to withstand short circuit test successfully. **Decision regarding dynamic short circuit shall be taken by BSPTCL and actual cost shall be reimbursed.**

21.500 **REPEAT TESTS:**

The following tests shall be repeated on one transformer of rating 80MVA, 132/33KV covered by this specification **without additional charge.**

- a) Measurement of no-load loss & magnetizing current at 90%, 100% & 115% excitation. Over fluxing test as indicated above.
- b) Magnetic balance test.
- c) Measurement of no-load current with 415 V; 50 Hz A.C. supply on L.V. side for all three phases.
- d) Dissolved Gas Analysis of Transformer oil. (As per IS/IEC-599).

21.600 **TEST CIRCUIT DIAGRAM & QAP:** The contractor shall furnish the test circuit diagram along with detailed QAP to be followed along with all the relevant information therein against all the tests indicated under Clause 21.100 to 21.500 to the Purchaser before inspection & testing of the transformer for Purchaser's approval. The Purchaser's representative would not be deputed for witnessing the tests if the test circuit diagrams and QAP are not approved. The QAP shall be based on the information provided on BSPTCL's website as general guidelines for the tenderers.

21.700 **TESTS ON ASSOCIATED EQUIPMENT:**

Porcelain bushings, current Transformer, winding temperature and oil temperature indicating devices, Buchholtz and oil surge relays, PRV, Air cell, magnetic oil level gauges, level switches, on load-tap changing gear, auxiliary motors, fans / blowers, starters, cooler control cabinet, insulating oil and other major associated equipment / materials covered by the contract shall be tested by the contractor in accordance with the relevant ISS/other applicable standards. Bought out items, if any shall be tested in the respective manufacturers' works and all such test reports shall be submitted along with the routine test result of the main equipment.

21.800 **TEST CERTIFICATES:**

Contractors shall furnish 10(ten) copies of each certificate of tests mentioned above. No dispatches shall be effected without obtaining dispatch clearance from the Purchaser.

21.900 **TESTS ON COMPLETION:**

Wherever possible all tests shall be carried out before shipment. Should, however, it becomes necessary for the final tests as to performance and guarantees to be held over

until the plant is erected at site they shall be carried out in the presence of the Contractor's representative within three months of the commissioning of the plant, unless operating or other site conditions necessitate postponement or within such time as may be considered reasonable by the Purchaser after the completion of erection. The tests however shall not be postponed beyond two more months, should it be necessary to postpone the tests any further due to 'force majeure', then such tolerance shall be applied to the guaranteed performance as may be specified in technical specifications inconsideration of the period that the equipment has been in operation. Should the result of these tests are not come within the margin specified, the tests shall, if required, be repeated within one month from the date the plant is ready for repeat testing, and the Contractor shall pay to the Purchaser all reasonable expenses which he may be put to by such repetition.

The tests and re-tests shall be carried out in accordance with the stipulations of technical specifications. The purchaser shall, on giving seven days' notice in writing to the Contractor setting out any grounds of objection, which he may have, in respect of the work, be at liberty to reject any drawings and all or any plant or workmanship, the subject of the said ground of objection, which in his opinion is not in accordance with the contract.

22.000 DELIVERY AND COMMISSIONING SCHEDULE:

The equipment covered by this specification shall be delivered as per the completion schedule mentioned in Annexure G.

23.000 TRANSPORTATION:

The supplier shall obtain clearance of the competent authority regarding the limiting dimension permissible for transport by rail / road. The entire responsibility regarding transport clearance etc shall rest on the supplier. In the event of an award of contract twelve (12) copies of the drawing showing the maximum loading dimensions of large single piece / items of the equipment inset with the clearance sections shall be submitted. As such, transportation, handling and shifting of transformers etc. are covered in the scope of work of this tender as indicated above.

24.000 DRAWINGS / DOCUMENTATION:

A) Languages:

All drawings, technical data or correspondence, submitted to the Purchaser for approval or for information, shall be in English. All dimensions shall be in Metric Units.

B) Tender Drawings:

The tender drawings shall be in triplicate comprising the following:

- a) General outline and shipping dimensions, net and shipping weights, height of crane hook for lifting core, bushing etc.
 - b) Sectional views of bushings, cooler heat exchanger, showing in details special arrangement of cooling, if any adopted, etc.
 - c) Schematic electrical diagrams for cooler control OLTC.
 - d) Single line diagram of the oil flow system.
 - C) Details of Auxiliary:**

Within forty five (45) days from the date of receipt of the Purchaser's Letter of Intent the Contractor shall provide the Purchaser with details of all the auxiliaries to be supplied, and also of others, not forming part of the Contractor's supply but essential for the safe and satisfactory working of the plant and equipment in terms of the contract.
 - D) Procedure for Drawing Approval:**

Four (4) prints with dark lines on white background shall be furnished of each drawing submitted for approval. One copy shall be returned to the contractor marked "Approved" and if they are not in conformity with provision of the contract then this copy shall be marked "Approved with corrections indicated" or "Examined and returned for Correction", the Engineer will give reasons for such correction and the Contractor shall make the necessary corrections and re-submit three (3) copies for final approval. Immediately on receipt of a finally approved drawing the Contractor shall furnish the Purchaser with twelve (12) copies of prints of such drawing along with soft copy on CD medium. Six (6) of the copies of prints shall be on airmail papers and six (6) on cloth back prints for field use. Standard time for approval/commenting of drawings against each submission may be considered as 30(thirty) days.
 - E) Revision:**

If any minor revision are made after a drawing has been approved, the Contactor shall furnish twelve (12) prints along with softcopy in the same manner as described above subsequent to each revision.
 - F) Binding Data and Arrangement Plans:**

Within thirty (30) days of the receipt of letter of intent the Contractor shall submit for approval the following documents for BSPTCL's approval:

 - i) Dimensioned general layout and arrangement drawings of the equipment and its auxiliaries.
 - ii) Outline drawings indicating weight, dimensions, forces and loads, to enable the design of the foundation structures and associated equipment to be completed by the Purchaser.
 - iii) Structural drawings and schedule of all sleeves, foundation bolts and parts to be set in the foundation.
 - iv) Schematic drawings of all piping, lubrication and cooling arrangement, wiring, connection and interlocking diagrams showing the points where connections have to be made by the Purchaser.
 - G) Detailed Drawings:**
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1. The bidders shall furnish along with their tenders part- I, the following particulars/ dimensional drawings of the transformers and other accessories for the purpose of preliminary study:-
 - a) General out line drawings.
 - b) Sectional views showing the general construction features and disposition of various fittings.
 - c) G.A drawings of cooler control cabinet and RTCC panel.
 - d) Schematic drawings of OLTC, RTCC and cooler control etc.
 - e) Foundation drawings.
 - f) Bushing drawings showing the full details of construction of condenser bushing and other relevant date.
 - g) Dimension of the largest parts to be shipped and the position in which these are to be transported.
 - h) Technical literatures on Tap change control, cooling system, Relays Meters, and General constructional features for winding, temperature Indicator, Buchholz Relay, Oil Temp, Indicator etc.
 - i) Type Test Reports, with corresponding drawings.
 - j) Short circuit test report with corresponding drawing.
2. All drawings should be in ink and suitable for microfilming. The drawings shall include the following information.
 - i) Dimensions and Tolerance on dimensions.
 - ii) Material designation used for different components with reference to standards.
 - iii) Fabrication details such as welds, finishes and coatings.
 - iv) Catalogue or part number for each component and the total assembly with bill of materials.
 - v) Identification Marking.
 - vi) Weight of individual components and total assembled weight.
 - vii) All dimensions and date shall be in S.I Units.
3. The successful bidders within 30(thirty) days after placement of the order, shall furnish six sets of the following drawings for the approval of the purchaser.
The drawing in auto-cad should also be submitted. Besides, details and calculations required for Design review as envisaged in CBIP manual and to demonstrate ability to withstand dynamic short circuit required as per IEC/ISS and CIGRE SC12 working group 12.22 etc. shall be submitted along with drawings.

1.	Outlined G.A drawing showing front, side elevations and plan of transformer and all accessories with detailed dimensions, position of centre of Gravity etc.
2.	Table of fittings for OGA.
3.	Detailed foundation Drawings with weightscalculation.
4.	Combined rating and diagram plate.
5.	Drawings of each type of bushings, lifting dimensions, clearance between .T.& L.T terminals and ground, quantity of insulating oil, name plant, details etc.
6.	Large scale drawing of HV and LV windings of the transformer showingwinding

	arrangement, conductor cross-section and weights, the nature and arrangement of insulator and terminals connectors etc..
7.	Schematic control and wiring diagram for all auxiliary equipment including OLTC cooler control and drawings showing temperature indicators, alarm circuits etc.
8.	Drawing showing construction and mounting details of Marshaling Box/Kiosk.
9.	Schematic diagrams showing the flow of oil in the cooling system as well as each limb and windings, longitudinal and cross sectional view showing the duct size, Cooling pipes etc. for the transformer / heat exchanger. All drawings to scale shall be furnished.
10.	Detailed drawing showing wheel loading and ordinates of centre of gravity.
11.	Crane requirements for assembling and dismantling of transformers.
12.	Dimensional drawing for terminal connectors.
13.	Twin bi-directional roller.
14.	Valve schedule plate.
15.	Oil filling instruction plate.
16.	Thermo syphon filter
17.	General arrangement of RTCC panel.
18.	Drawing and scheme showing Fiber optic temperature monitoring and control system.
19.	Drawing and details of maintenance free breather system.
20.	Inter connection cabling diagram between transformer and all panels.
21.	Constructional details and sectional views of on-load tap changer.
22.	Complete bill of material.
23.	CT diagram plate.
24.	Assembly of core with details of stacks dimensions and weights etc.
25.	Detailed dimensions, assembly and description of auxiliaries.
26.	Constructional details of tank including material, dimension, thickness, reinforcing member used if any.
27.	Any other drawing and detail required by the purchaser.

4. The purchaser shall communicate his approval/ comment on the drawings to the supplier within reasonable period. The supplier will depute his engineer for having discussion and design review. In case any modification is required according to the purchaser's comments, the supplier shall modify the drawings and resubmit six copies of the modified drawings for purchaser's approval within two weeks from the date of communication of comments on the drawings.
5. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviations shall be permitted without written approval of the purchaser. All manufacturing & fabrication prior to the approval of the drawing shall be at the supplier's risk.

H) Assembly and Erection Instruction:

Within a reasonable time after purchase order but at least three months before delivery the Contractor shall furnish twelve sets of the following for the use of Purchaser's field Engineers:

- i) Descriptive literature and drawings to illustrate the working principles, method of assembly and dismantling.

- ii) Instruction Book for proper erection and assembly of all equipment with programme of work and necessary instructions for checking and recording proper assembly of the plant.
- iii) Complete spare part handbooks with details of part nos., descriptions and diagrams. Separate recommendations shall be made for the parts required for the first five (5) years of operation. Parts requiring frequent replacement shall be enlisted separately from parts required for ensuring reliability in unforeseen emergencies.

I) **Final Drawings and Operation Manuals:**

The Contractor shall furnish twelve (12) complete set of prints and one permanent negative of all detailed drawings of the equipment actually supplied. Twelve (12) sets of comprehensive manuals for use in the operation and maintenance of the plant shall also be supplied. These documents shall reach the Purchaser along with the main equipment or earlier.

FITTINGS:

The following fittings shall be provided with each transformer, covered in this specification.

- (a) Conservator for main tank with oil filling hole and cap, air-cell, vacuum application valve, vacuum equalizing valve, isolating valves, drain valve, shut off valve, magnetic oil level gauge with low level alarm contacts, dehydrating breather, with oil seal.
 - (b) Conservator for OLTC with drain valve, surge relay (oil flow operated), vacuum application valve, vacuum equalizing valve, magnetic type oil level gauge with low level alarm contacts, oil-level indicator and silica gel breathers.
 - (c) Oil preservation equipment.
 - (d) Pressure relief devices with alarm/trip contacts.
 - (e) (i) Buchholz relay, double float/read type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts (Rating 1 Amp. 250 V DC/ 220V DC) test cock, gas collection box and gas check valve at ground level.
(ii) Separate Buchholz relay with above features to be provided for OLTC chamber.
 - (f) Air release plug.
 - (g) Inspection openings and covers.
 - (h) Bushing with metal parts and gaskets to suit the termination arrangement.
 - (i) Winding temperature indicators for local and remote mounting. One RWTI with a four-point selector switch shall be provided.
 - (j) Top Oil temperature indicator with maximum pointer along with two sets of contactors.
 - (k) Cover lifting eyes, transformer-lifting lugs, jacking pads, towing holes and core and winding lifting lugs.
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- (l) Protected type mercury or alcohol in glass thermometer.
 - (m) Bottom and top filter valves with threaded male adaptors, bottom sampling valve and drain valve.
 - (n) Rating and diagram plates on transformers and auxiliary apparatus.
 - (o) Earthing terminals.
 - (p) Flanged bi-directional wheels.
 - (q) Cooler Control Cabinet with pad locks.
 - (r) On load tap changing equipment and OLTC control cabinet with pad locks.
 - (s) Drain valve plugs shall be provided in order that each section of pipe work can be drained independently.
 - (t) Insulating Oil.
 - (u) Terminal marking plate.
 - (v) Jacking pads//lugs
 - (w) Lifting bollards.
 - (x) Haulage lugs.
 - (y) Cover lifting lugs.
 - (z) Valve schedule plate.
 - (aa) Bushing CT
 - (bb) Cooling fans
 - (cc) Motor pumps
 - (dd) Marshalling Box
 - (ee) RTCC Panel
 - (ff) Bushing Terminal Clamps & Connectors
 - (gg) Oil flow indicator
 - (hh) Valves, as indicated at Cl.No.5.4.2 of this Specification
 - (ii) Wiring upto marshalling box with PVC SWA PVC copper cables, 1100Volts grade.
 - (jj) One Set of hand tools of 'Taparia' or 'GEDORE' Make, packed in a carry bag/box, broadly comprising of double ended spanners (Open jaws, cranked ring, tubular with Tommy bar, of different sizes as used in the Transformer –one set), adjustable wrenches (of different sizes as used in the Transformer –one set), gasket punches (of different sizes as used in the Transformer –one set), pliers (flat nose, round nose and side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle(one),adjustable hacksaw(one) and cold chisel(one) shall be supplied.
 - (kk) Thermosyphon Filter
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- (II) 8(Eight) Probes & 8(eight) Channel Optic Fiber Temperature Sensor System as per this specification

Note:- The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of the above rated Power transformers are deemed to be included.

SPANNERS AND SPECIAL TOOLS (INCLUDED IN THE SCOPE OF THE CONTRACT):-

One Set of hand tools of 'Taparia' or 'GEDORE' Make, packed in a carry bag/box, broadly comprising of double ended spanners (Open jaws, cranked ring, tubular with Tommy bar, of different sizes as used in the Transformer –one set), adjustable wrenches (of different sizes as used in the Transformer –one set), gasket punches (of different sizes as used in the Transformer –one set), pliers (flat nose, round nose and side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle(one),adjustable hacksaw(one) and cold chisel(one) shall be supplied for each Transformer.

25.000 MISTAKES IN DRAWINGS:

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omission in the drawings or other particulars supplied by him whether such drawings or particulars have been approved by the BSPTCL or not, provided that such discrepancies, errors and omissions be not due to inaccurate information or particulars furnished to the Contractor by the purchaser's engineer.

26.000 CO-ORDINATION WITH OTHER MANUFACTURERS:

The Contractor shall co-ordinate with the Purchaser's other contractors/ manufacturers and truly exchanges all technical information to ensure satisfactory and economical design. No remuneration shall be payable by the Purchaser for such Technical co-ordinations.

The Contractor shall forward to the Purchaser copies of all correspondences and drawings, so exchanged.

The Bidder shall co-ordinate in all respects with the manufacturer of Fire prevention and Extinguishing System by Nitrogen (N₂) Injection method for Transformer etc. and shall freely exchange all relevant information to ensure satisfactory and economic design. **The transformer manufacturer should ensure that the offered transformer will have all provisions required for successful installation and operation of the Fire prevention and Extinguishing System by Nitrogen (N₂) Injection method and thus suitable measures shall be taken in the transformer body itself wherever required to suit the above Fire prevention and Extinguishing System by Nitrogen**

(N₂) Injection method. Charges for the same shall be included in the price of the transformer.

27.000 ANNEXURES:

The following 'Annexures' are enclosed herewith this specification and shall form part of this specification

Annexure -A : General site information

Annexure - B : Auxiliary Supply system Data.

Annexure - C : Inspection & Quality Control.

Annexure - D : Design Criteria of Transformers.

Annexure - E : Characteristics of EHV grade Transformer oil.

Annexure - F : Reference Standards for Transformers and connected equipments and devices.

Annexure - G : Delivery/ Commissioning schedule.

28.000 SCHEDULES:

Bidder must completely fill in all the relevant schedules as mentioned below furnished along with this tender specification. Failure to comply with this requirement shall result in declaring the offer incomplete and accordingly rejection of the bids:

Schedules: Part -I (Techno-Commercial Bid)

- i) Schedule:I/A - General Particulars.
- ii) Schedule:I/B - Guaranteed Technical Particulars.
- iii) Schedule:I/C - List of Special tools & Tackles
- iv) Schedule:I/D - Time schedule for completion of supply
- v) Schedule:I/E - Past experience/Proven Performance record.
- vi) Schedule:I/F - List of drawings/Certificate/documents.
- vii) Schedule:I/G - Schedule of Deviation from Techno-Commercial Requirements.
- viii) Schedule:I/H -Declaration sheet
and other techno-commercial schedules provided with NIT.

Schedules:Part - II (Price Bid)

- i) Schedule:II/A - Schedule of Items & quantities (prices to be quoted in the price format provided with NIT).
 - ii) Schedule:II/B - Price List for Special Tools & Tackles.
 - iii) Schedule:II/C - Cost of withdrawal of techno - commercial deviations as declared by Schedule-I/G.
 - iv) Schedule:II/D - GTP (For Transformer Losses, resistance etc.)
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29.000 WARRANTY/ GUARANTEE:

Whether or not the equipment has been installed under his supervision, the Contractor shall be agreeable to the 'Warranty/ Guarantee' Clause as stipulated in BSPTCL's "General conditions of Contract" mentioned in this bidding document, which is 60(sixty) months from date of commissioning or 66(sixty six) months from date of delivery at site whichever comes earlier. However, it may be noted that the contractor shall be agreeable to make this guarantee applicable for the main equipment (i.e. transformer), its fittings and accessories, transformer oil, spares as well as the Fire-prevention and extinguishing system, its fittings and accessories and fiber optic system etc. "The Manufacturer shall also provide warranty/guarantee against any DGA violation in the transformer up to five (5) years from the date of delivery of the Transformer. In the event of any DGA violation, the Manufacturer shall undertake the diagnosis, repair, replacement work of the Transformers without any cost burden to the Purchaser". Similarly, the checking of "no load loss", "load loss" etc. may be arranged by BSPTCL just prior to end of guarantee period to verify the performance of machine w.r.t. initial factory test conditions. Violation in test figures beyond reasonable limits may lead to non-compliance of quality requirement. The obligation under Guarantee clause may be invoked in such conditions.

30.000 SPECIFICATION FOR NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM FOR LARGE CAPACITY OIL-FILLED TRANSFORMERS.

- 1.0: The fire prevention and extinguishing system shall work on the "Oil drain, Nitrogen Injection and Stir" method. The system shall operate correctly during internal fault in the transformer or external fire on transformer, which includes fire due to bursting of transformer bushings.
- Fire detectors provided on the transformer body shall take minimum time for detection of fire and initiate the fire protection system on receipt of other required signals.
- 2.0 System shall operate on station DC auxiliary supply (250 V DC). Alternately system shall have its own power supply unit (if operating on AC supply) for operation during supply failure.
- The system shall operate in 'Auto'/ 'Remote Electrical'/ 'Local Manual' modes. Provision shall be available to keep the system "Out", which is necessary for preventing any mal-operation during maintenance of the transformer.
- 3.0 Fire protection system shall operate in Auto mode on receipt of minimum three positive feedback signals, namely differential relay or fire detector, pressure relief valve or rapid pressure rise relay or Buchholtz relay and electrical isolation of transformer through master trip relay or HV & LV circuit breaker in series, to avoid any mal-operation of system. Fire protection system shall operate in Remote electrical mode on receipt of signal for electrical isolation of transformer and by operating switch provided in a box which shall
-

be accessible only after breaking the glass cover on control panel.

The Local manual operating system shall be used only in case if the system fails in Auto mode / Remote electrical mode / power failure.

The system shall start operation in auto or remote electrical or local manual, initially draining a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and simultaneously closing Isolation valve in the conservator line and then inject nitrogen gas with appropriate flow rate at high pressure from lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

Isolation valve in the conservator line shall operate mechanically on transformer oil flow rate with electrical signal for monitoring on control panel. However in case of bursting of transformer bushing conservator oil should be isolated from main transformer tank without any additional signal to operate isolation valve.

The system shall preferably have built in facility for monitoring or display of the following.

- i) Open / Close status of valves.
- ii) Healthiness of all sensors.
- iii) Operation of PRV / Rapid Pressure rise relay (RPRR).

Provision shall be available for annunciation (along with audible alarm) of the following.

- i) Detection of fire due to external causes ii) Low nitrogen pressure.
- iii) System initiated
- iv) Tank pressure beyond the set limit
- v) Operating signal cable faulty.
- vi) Operation of conservator isolation valve (PNRV)
- vii) Supply failure.

5.0 However bidder shall confirm whether it is advisable to initiate the system even when transformer is not electrically isolated due to stuck breaker problem etc.

6.0 The system shall have **built-in-on-line testing facility**, which will be operable without affecting the functioning of the transformer.

7.0 The protection system shall be compatible to be hooked on to the SCADA or fire alarm system. Suitably spare contacts shall be made available for operation of fire

system. System using microprocessor, micro controller shall be given preference.

- 8.0 All valves used in system shall preferably be stainless steel ball/butterfly type. Limit switches shall be provided wherever required.
The connecting cables shall be fire retardant low smoke (FRLS) armoured cable. Cables passing along the top of the transformer shall be the fire survival (FS) type.
- 9.0 Fire extinguishing cubicle shall be of 2 mm (min.) thick sheet steel (CRCA) as per IS- 513. However, the Frame, load bearing support / structure, relay / meter etc. mounted sheet shall be 2.5 / 3mm sheet steel (CRCA) -- as per approved drawing.
- 10.0 The remote control panel, to be mounted inside the control room shall accommodate the necessary control units, operating switches push buttons etc. and also alarm annunciation unit.
- 11.0 The bidder shall, furnish the complete details including bill of materials of the fire prevention and extinguishing system offered. The list of all accessories including FRLS, fire survival cable, pipes, valves, sensors, control cubicle, nitrogen gas cylinder etc. shall be listed out and furnished in the offer.
- 12.0 The bidder / manufacturer shall ensure that fire prevention and extinguishing system offered is foolproof and reliable. Installation, testing and commissioning of the fire protection system shall also be in the successful bidder's scope.
- 13.0 Fire protection scheme to the power transformer should have authentic certification regarding performance similar to one issued by LAPEM (MEXICO)/TAC/RDSO.
- 14.0 **The bidder /manufacturer shall have a minimum experience of five years in the design, manufacturing, testing and commissioning of Nitrogen Injection Fire Protection System. The bidder/ manufacturer shall also furnish details of similar Nitrogen Injection Fire Protection Systems supplied so far including customer, address and order reference indicating period of system in operation after successful commissioning. Similar units offered by bidder / manufacturer shall be in successful operation for a minimum period of two years Government sector in India.**
The bidder / manufacturer shall also furnish 2 years performance certificate from end user Government sector in India for similar systems in proof of the satisfactory operation. The purchaser

however reserves the right to waive the minimum experience condition stipulated, in the case of firms having collaboration with well-experienced firms of repute. The experience of collaborating firm in the manufacturer of similar equipments shall be not less than validity as per CEA guidelines. The waiving of the minimum experience condition will be considered by the purchaser only on furnishing the performance guarantee (as per GCC) for Fire protection system by collaborating firm.

: **STANDARD:**

Fire prevention & Extinguishing System by Nitrogen (N₂) Injection method covered by this specification shall fully satisfy the requirements of the following:-

- i) Rule No. 64.2.f (ii) of Indian Electricity Rule, 1956.
- ii) Relevant concerned rules & regulations as laid by Tariff Advisory Committee.
- iii) Relevant clauses of OIL INDUSTRY SAFETY DIRECTORATE No. OSID-STD-173, 1998.

16.00: **TESTS**

16.10: **TYPE TESTS**

Test reports including that for Detectors along with declared response time as per TAC's letter shall be submitted along with the tender.

The system shall be tested by ULEM, LPC or a National Testing Body (BIS recognized laboratory) for confirming the efficacy of the system and its full compliance with TAC's rules. TAC's approval, if any shall be submitted with the tender.

16.20: **FACTORY TEST**

Test will be carried out on individual equipment of the system and the total system in the supplier's workshop in presence of purchaser's representative.

16.30: **PERFORMANCE TEST**

The bidder shall give complete details of the system and also arrange to demonstrate the operation of the fire fighting system, if desired by the purchaser.

17.00: **SUPERVISION**

The above Fire prevention & extinguishing System will be erected, tested and commissioned under the supervision of manufacture of NIFPS without any cost implication to BSPTCL.

18.00: **DRAWING AND MANUALS**

Detail layout drawing along with the equipment drawing to be given in the tender along with complete Bill of Materials. After awarding of contract, detailed dimensional drawing of the system and complete Bill of Materials

including location and size of plinth for cubicle and recommended capacity of oil soak-pit shall be submitted for purchaser's approval.

10 (ten) sets of all the above drawings and 10 (ten) sets of Operation and Maintenance Instruction Manual (bound) shall be submitted for purchaser's use.

31.00 Deleted

32.000 Technical specification of fiber optic system (should conform to IEC and protocol 61850)

The transformer shall be fitted with optical fiber temperature system for direct/real time temperature monitoring and control. The technical specification for such system is mentioned below:

'OPTIC FIBER TEMPERATURE SYSTEM' of proven quality and performance in Indian Utilities shall be provided in each transformer for measurement of temperature of windings, oil and core. Bidders are required to state in their offers regarding performance of such Optic Fiber Temperature System along with the names of the end-users in India. The end-user's certificates for such system will be furnished by the Bidders along with their Tender offers.

Following is the criteria for temperature measurement of oil, windings and core by using Fiber Optic sensors:-

1. System shall be with fiber optic sensors with proven and rugged technology. The probes shall be directly installed in each winding of both HV & LV of power transformer to measure the winding hot spot, top oil and core temperature. There will be **minimum eight probes** inside the transformer, out of which one probe should be installed in top of the transformer for the detection of top oil temperature.
2. The remaining Fiber Optic probes; one each shall be installed in each phase winding (both HV & LV)(6Nos.) at the hottest spot of each of the phase windings and the remaining one in hottest spot of the core. The locations of the probes shall be proposed by the Manufacturer and locations, to be finalized by agreement with the purchaser.
3. Probes shall be able to be completely immersed in hot transformer oil; they shall withstand exposure to hot kerosene vapour during the transformer insulation drying process. The probes shall meet the requirement to eliminate the possibility of partial discharge in high electrical stress areas in the transformer.
4. Temperature range of the system should be -30deg.C to $+200\text{deg.C}$ and accuracy of $\pm 2\text{deg.C}$ with no recalibration required.
5. Probes shall be all silica, double PFA Teflon jacketed; Kevlar cabled fiber with perforated outer jacket to allow complete oil filling; and white Teflon protective Helix wrap having improved visibility and mechanical strength.
6. A microprocessor based monitoring and recording unit shall be a part of the system, having 8(eight) channels. System should include analog outputs for each measurement channel. Temperature resolution of the analog outputs shall be $\pm 0.1\text{ deg. C}$ and the system shall offer user programmable temperature alarm outputs with 6 relays, alarm lights and controller system status indicators. All inputs and outputs of the system shall meet the requirements of surge test of IEEE C37.90.1-1989 in which a 3000V surge is applied to all the inputs and outputs without permanent damage to the instrument.
7. The system shall be capable of retaining temperature data of a minimum of 90 days at one (1) Reading /minute and should retain max temperature of each channel until reset.

8. The transformer manufacturer should submit data showing that the probes are located in the hottest point of the winding and oil, while submitting drawings for approval.
9. The Fiber Optic cables are to be brought out of the main tank through tank wall penetrator feed through plate. The Feed through plate shall be welded on to the Tank. The external fiber optic extension cable shall then be run to main control cabinet, routed inside the conduits with large bend radius. Protective cover shall be provided for the Tank Wall Feed through Plate.
10. The controller shall be housed in cooler control cubicle or in a separate enclosure having degree of protection IP56 class, mounted on the transformer tank. The position shall be clearly indicated in the GA drawings.
11. Temperature Rise Test Measurement shall be made with the FO Thermometers. The Optic Fiber Temperature System shall be operational during temperature tests and be demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified and temperature data for all probes (hourly readings) recorded and reported in the test report. The hot spot temperature rise of the windings above ambient temperature shall not exceed 54 deg. C (both for ONAN & ONAF) and the top oil temperature rise above ambient temperature shall not exceed 40 deg. C (both for ONAN & ONAF) as per this specification.
12. For remote indications on RTCC panel, output of 4to 20mA shall be made available. Digital Temperature Indicators shall be provided in the RTCC Panel for indications of temperatures in each of the windings, top oil and core from the Optic Fiber Temperature Sensor Controller Unit. This shall also be demonstrated during temperature rise test.

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ANNEXURE - 'A'

GENERAL SITE INFORMATION

- 1.100 **Location:**
Shall be informed at the time of award/ NOA/ DI.
- 1.200 **Meteorological Data:**
- 1.210 **Temperature:**
The daily average ambient temperature throughout the year ranges between 5°C/50°C. The peak ambient temperature is 50°C.
- 1.220 **Relative Humidity:**
The relative humidity is expected to be between 10% during dry season and 100% max. during monsoon season. The dry seasons means generally the calendar months from November to May and the wet season from June to October of the English Calendar year.
- 1.230 **Rainfall:**
The daily rainfall ranges 25mm to 75mm per day during the monsoon making an average year rainfall of 1500mm.
- 1.240 **Wind:**
The max. wind velocity will be 170 Km/hour. The wind speed and wind loads shall be taken as per the latest IS-875: 'Code of practice for structural safety of buildings, Loading Standards'.
- 1.300 **Seismic Loads:**
The max. earth - quake may be assumed as 0.075g in the horizontal direction and 0.0375g in the vertical direction. The seismic loads to be considered for the design of the structures should be taken as per the latest IS-1893 'Criteria for earthquake resistant design of structure' and IS-4326: Code of practice for earthquake resistant construction of buildings.
- 1.400 **Atmospheric Conditions:**
For equipment design considerations the atmospheric condition shall be taken as laden with industrial, and town gases and with dust in suspension (during dry months, Fog, smoke and mild acids shall also be present.
-

ANNEXUTE - 'B'

AUXILIARY SUPPLY SYSTEM DATA

- 1.01 L.T. system (Star point solidly grounded) voltage: $415\text{ V} \pm 10\%$ (3 phase),
1 Phase AC Supply = $240\text{ V} \pm 10\%$
Frequency = $50\text{ Hz} \pm 3\%$
- 2.01 DC supply (ungrounded)
Voltage: $250/220\text{ V} \pm 10\%$ (to be decided during Drg. Approval stage)
Shortcircuit current level: 15 KA
-

ANNEXURE - 'C'

INSPECTION AND QUALITY CONTROL

- 1.00 The contractor shall prepare, submit, discuss with the purchaser and finalize based on the said discussions, within sixty (60) days from the Letter of Intent / Award / Acceptance, **detailed quality plan (QAP)** in the pro-forma approved by the Purchaser, for all components of the equipment manufactured by contractor setting out during the various stages of manufacture the quality practices and procedures to be followed by his quality control department, the relevant reference documents/standards, acceptance level, inspection documentation raised etc. In these quality plans the purchaser will identify 'Hold Points' beyond which work will not progress without his consent in writing. For the components/equipment purchased by the contractor for the purpose of this contract, his purchase specification and enquiries shall call for such quality plans. Along with their proposals the quality plan of the sub-vendor shall be discussed and finalized by the Contractor in the aforesaid manner and shall form part of the purchase order on his sub-vendor. The Purchaser (BSPTCL) also reserves the right to carryout quality audit and quality surveillance of the system and procedures of contractor's / sub- vendors' quality management and control activities. However, such audit or quality surveillance by Purchaser shall not relieve the Contractor of any of his responsibilities under the terms of the contract.
 - 2.00 Within ninety (90) days from the date of Letter of Intent / Acceptance, the contractor shall furnish the field quality manuals for the various field activities detailing the procedures and inspection check lists for transportation, storage/preservation, erection, pre-commissioning and commissioning activities which will be followed by Purchaser's Erection Contractor. If deemed fit, Purchaser reserves the right to call for contractor's supervision of the equipment erection.
 - 3.00 The field quality manuals shall indicate the various assembly/erection/operation tolerance and the limits of deviations for each individual equipment and system.
 - 4.00 Purchaser reserves the right to depute Engineers for stage inspection/testing and inspection/testing after completion of manufacture.
 - 5.00 The information and requirement uploaded on BSPTCL website regarding "Quality Assurance Plan" and "Field Assurance Plan" etc. must be gone through and submission of documents should be done according.
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ANNEXURE - 'D'

DESIGN CRITERIA

1. Rated capacity (at full load) : 80 MVA(Bi-directional power flow)
& 50°C maximum ambient.
 2. Reference standard: : IS:2026 (latest)
 3. Voltage rating : HV winding-132 KV
LV rating- 33KV
 4. Voltage ratio at no Load : 132KV / 33 KV
 5. Impedance voltage at rated MVA base at 75°C
 - i) Tap No.5 (Normal) ----- 12.5% **with no negative tolerance**
 - ii) Tap No. 1 (Maximum) -----
 - iii) Tap No. 17(Minimum) -----
The above transformers shall be designed on the basis of percentage impedance as indicated above. But percentage impedance at any tap position should match with the percentage impedance of transformer-s as indicated under Clause No. 8.000 of this specification.
 6. High Voltage connection. : Star with neutral brought out through
36 KV bushing for solid ground connection.
 7. Low voltage connection. : star
 8. Polarity & Vector Symbol. **Subtractive & YNyno**
 9. System of earthing- HV : Neutral effectively earthed.
LV
 10. No. of phases & windings. : 3-ph., 2-windings.
 11. Frequency and operation : 50 Hz \pm 3%
 12. Type of cooling of full rated : OFAF
capacity. 80 MVA OFAF
 13. Rated 3 phase full load capacity at an ambient temperature of 50 degree : 64 MVA OFAN
48 MVA ONAN
 14. Highest Voltage System
a) HV 145 KV
b) LV 36 KV
 15. Temperature rise limit at full : 40°C for top oil by thermometer.
Load rated capacity over 45°C for winding by resistance.
ambient of 50°C 54 °C Maximum for winding hot spot
temperature rise over ambient temperature of
50 °C (measured by fibre optic temperature
measurement and otherwise)
 16. Core Material CRGO Silicon Steel lamination (HIB or better)
-

17. Working flux density in any part of the core at rated MVA, voltage and frequency. 1.6 Tesla. This has to be established by calculation and otherwise.
18. The over voltage which the transformer must withstand without injurious heating, combined voltage and frequency fluctuations
- | | |
|------|---------------------|
| i) | 115 % continuously |
| ii) | 125% for 1 minute |
| iii) | 140 % for 5 seconds |
19. Type of construction of core Core type Oil immersed, Outdoor type, 2 winding with external heat exchanger.
20. Tap changer: High speed transition resistor, constant flux variation as per clause 3.2 of IS:2026 (Part-IV), suitable for bidirectional power flow. ON load tap for a voltage variation of - 15% to + 5 % (in steps of 1.25%) to be provided on H.V. side(Neutral end) of the winding. Total no. of position shall be 17(Seventeen). Design provision should be kept in such a way that the transformer will be capable of delivering full specified load with a b o v e variation of HV side for continuous operation required for system demand.—Should strictly conform to IEC:60214. Only design which have been type tested in accordance with these standards (IEC:214:1976) will be accepted. All the type test certificates as per the above standard shall be submitted alongwith the tender.
Control- a) Local/Manual b) Remote & Electrical
21. Short circuit rating. : Dead short circuit at the terminal of any of the winding for **5 (five)** seconds.
22. Separated source power: Neutral insulation graded 70 KV. frequency voltage for H.V.
Neutral end
23. BIL of the windings. :
- | | | |
|------|--------|--------|
| i) | H.V. - | 650 KV |
| ii) | L.V. - | 170 KV |
| iii) | HV-n - | 170 KV |
24. Power frequency voltage of winding. :
- | | | |
|------|-------|--------|
| i) | H.V.- | 275 KV |
| ii) | L.V.- | 70 KV |
| iii) | HV-n- | 70 KV |
25. BUSHINGS:
- a) Rating of Bushings:-
- | | | |
|-----------------------------|---|--------------------|
| i) H.V. side (Antifog type) | : | 145 KV, 1250 Amps. |
| ii) L.V. side -do- | : | 52 KV, 2000 Amps. |
| iii) H.V.- Neutral | : | 36 KV, 2000 Amps. |
- b) Power frequency 1 min. dry & wet withstand voltage:-
- | | | | |
|-----|-----------|---|---------|
| i) | H.V. side | : | 275KV. |
| ii) | L.V. side | : | 105 KV. |
-

- iii) H.V. - Neutral : 70 KV.
- c) Impulse withstand voltage full wave:-
 - i) H.V. side : 650 KVP.
 - ii) L.V. side : 250KVP.
 - iii) H.V. - Neutral : 170 KVP.
 - d) Creepage Distance : 25mm/KV (minimum)
 - e) Partial Discharge Level : 500 pico- columb
 - f) Noise level : As per NEMA TR-1
 - g) Should conform to IEC 60137, phase winding above 33 Kv shall have fully rated porcelain condenser anti fog type bushing as per IEC 137. Bushing of 33 kv shall be oil filled communicating type.

26. Terminal Arrangement:-

- a) H.V. side: Outdoor bushings with expansion type terminal connector (Extruded type) for ACSR double Moose suitable to take both horizontal and vertical take off. Details to be finalized during engineering.
- b) L.V. side: Outdoor bushing with expansion type (Extruded type) terminal connector suitable for both horizontal and vertical take off for ACSR double moose. Details to be finalized during engineering
- c) H.V. Neutral: Bare outdoor bushing terminal suitable for termination of 50mm x 6mm G.I. Strip/flat through post Insulator of adequate rating.

27. Railgauge:
 - i) 1676 mm on minor (shorter) axis.
 - ii) 1676 mm & 2438 mm on major axis i.e. provision for fixing the wheels at two different points as indicated above shall be kept.

28. Parallel operation: Ref. Cl. 8.000 of this Specification.

29. Utility : Step down transformer for supplying 33KV loads.

30. Transformer oil: **EHV grade oil as per Annexure – ‘E’ of this specification.**

31. H.V.-n C.T. details: Core I II
Ratio: 800-400-200/5 1200-600-300-150/5
Class: PS 5P20
Burden: - 10 VA.
KPV:1000-500-250V-----
Iexc. 125-250-500mA at Vk -----
Resistance of sec.wdg. 2.0-1.0-0.5 Ohm(max) ----- at 75 deg. C.

The above rating is tentative. This shall be decided during approval of drawing for individual site/ GSS.

32. Bushing CT to be provided on each phase (HV, LV & neutral) for REF (Core-I) and metering (Core-II) its rating etc would be decided during design and engineering stage. Parameter for WTI CT for each winding shall be provided by the bidder. Accuracy class PS as per IS 2705 (for relevant protection and duty) as per IEC 185.

32. RTCC Panel : The transformer shall be supplied with RTCC Panel as per specification.

33. Life of Transformer 25 Years (min.)

34. EQUIPMENT COLOUR CODE :

The following code of practice shall be adopted for colour finish of the respective electrical equipment:-

	Equipment	Colour	Finish
a)	<u>Transformers</u>		
	i) Installed outdoor (i.e. oil immersed transformers)	IS5 – 632 of IS-5 (Dark admiralty grey)	Mat
b)	<u>Misc. Panel & JB's etc.</u>		
	Exterior	IS5 – 631 of IS-5 (Light grey)	Semi gloss
	Interior	White / Off-white	Semi gloss

35. Core to clamp/ bolt insulation, test voltage: 3.5KV D.C. for 1(one) min.

36. Mounting of Cooling Equipment : The transformer shall be compact as far as possible(due to space constraint of the existing S/S) and provision shall also be made to mount the cooling equipment (i.e. radiators, cooling fans and pumps sets) in either side of the transformer so that the same can be erected on either side of the transformer depending on the availability of space of existing Sub-Station of BPTCL.

37. The noise level of transformer, when energized at normal voltage and frequency with fans & pumps

running shall not exceed, when measured under standard conditions, the value specified in NEMA standard publication TR-1.

38. The transformer shall be designed with particular attention to the suppression of maximum Harmonic voltage, specially the third harmonic and fifth harmonic so as to minimize Interference with communication circuit.
 39. Value of current density should not exceed 2.8Amp./mm^2 while working at any tap position.
 40. Time in minutes for which the transformer can be run at full load without exceeding maximum permissible temperature as reference ambient temperature when supply to
 - (i) Fan is cut off -20 Minutes
 - (ii) Pump and Fan cutoff-10 Minutes
 41. Min. Knee point voltage of core shall be 110% of rated .This to be verified drawing on load test. Increase of voltage by 10% for 110% rated voltage should not increase excitation current by more than 50%.
 42. The core reactance of the winding shall not be less than 20%
 43. HV insulation shall be graded and LV should fully insulated.
 44. The current rating of terminal and connection arrangement shall be more than 1.5 times of current rating of transformer
 45. Transformer terminal shall be silver plated copper.
 46. Neutral terminal to be brought to ground level by brass tinned copper grounding has of approved size for routing to neutral CT.
 47. Control cabinet: The standing floor mounted type made of 3mm thick steel sheet Hinged door stopping main board to cover sides. 15mm neoprene gasket, IP-55 as per IS:2147, 20% spare terminal blocks.
 48. Each radiator bank to have 2 No. 100% oil immersed in line axial flow motor pump – one in service and one in standby. Centrifugal pump shall not be accepted.
 49. One standby fan of at least 20% capacity shall be provided with each bank. The blades of cooling fan shall be of galvanised steel cast aluminium alloy. Thickness of galvanisation to be 55 microns or more.
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ANNEXURE - 'E'

CHARACTERISTICS OF EHV GRADE TRANSFORMER OIL

Sl. No.	Schedule of Characteristics	Requirement of EHV Grade Transformer Oil
1.	Appearance	As per ISS 336
2.	Density at 27°C (Maximum)	As per ISS 335
3.	Kinematic Viscosity (Max)	As per ISS 335
4.	Inter facial tension at 27°C (Min.)	As per ISS 335
5.	Flash Point (Min.)	As per ISS 335
6.	Pour Point (Max)	As per ISS 335
7.	Neutralisation value (total acidity) (Max)	As per ISS 335
8.	Corrosive Sulphur	As per ISS 335
9.	Electrical Strength breakdown voltage (Min)	
	a) New untreated oil as received condition (Min.)	30 KV (rms).
	b) After treatment (Min.)	60 KV (rms.)
10.	Dielectric dissipation factor (tan-delta) at 90°C (Max)	0.002

11. ~~Specific resistance (resistivity)~~

a) ~~At 90°C (Min)~~ ~~35 X 10¹² Ohm-cm~~

b) ~~At 27°C (Min)~~ ~~1500 X 10¹² Ohm-cm~~

12. ~~Oxidation Stability~~

a) ~~Neutralisation value, after oxidation (Max)~~ ~~0.40 mg/KOH/g~~

b) ~~Total sludge after oxidation (Max)~~ ~~0.1% by weight~~

13. ~~Presence of oxidation inhibitor~~ ~~As per ISS-335~~

14. ~~Sulphuric Acid absorption co-efficient (SK Value) (Max)~~ ~~As per ISS-335~~

15. ~~Water content (Max)~~ ~~30 ppm (as received)~~

16. ~~Ageing characteristics after accelerated ageing test~~

a) ~~Resistivity at 27°C~~ ~~2.5 X 10¹² Ohm-cm~~

b) ~~Resistivity at 90°C~~ ~~0.2 X 10¹² Ohm-cm~~

e) ~~Dielectric loss factor (tan delta) at 90°C~~ ~~0.20~~

d) ~~Total acidity mg/KOH/g (Max)~~ ~~Neutralisation value
0.05 mg/KOH/g~~

e) ~~Sludge content after ageing (%) Max.~~ ~~0.05% by weight.~~

N.B.: Apart from above requirement, the transformer oil shall conform to all the requirement of ISS-335 (Latest revisions)

ANNEXURE - 'F'

REFERENCE STANDARDS FOR TRANSFORMERS AND CONNECTED EQUIPMENT AND DEVICES.

STANDARDS:-

All transformers and associated equipment and accessories shall, except where modified by this Specification, be designed, manufactured and tested in accordance with the latest editions of the relevant International (IEC), Indian (IS) and British (BS) standards. In case of conflict, the order of precedence shall be (1) IEC, (2) IS, (3) Other.

Reference to particular standard or recommendation in this Specification does not relieve the Supplier of the necessity of providing goods and services, complying with other relevant standards or recommendations.

The list of standards, provided in this Specification is not to be considered exhaustive and the supplier shall ensure that equipments supplied under this contract meet the requirements of the relevant standard whether or not it is mentioned here.

IEC	IS	BS/other	Title
60076	2026	171	Auto Transformers
P-1-2000			
P-2-1993			
P-3,5-2000			
P-6-1997			
-	-	6056	Methods of measurement of transformer and Reactor sound levels
-	-	4360	Weldable structural steel-
-	-	61	Threads for light gauge copper tube and fittings
-	-	3600	Steel pipes and tubes for pressure purpose
-	-	4504	Flanges for pipes, valves and fittings
529	13947	EN60529	Enclosures for electrical apparatus (App.C-13947)
214	-	4571	On load tap changers
60137(1995)	2099	223	Bushings for alternating voltages above 1000V
-	3347	-	Dimensions for porcelain transformer bushing for use in lightly polluted atmospheres
223	-	4963	Tests on hollow insulators

60354(1991)	6600	BSCP-0160	Loading guide for transformers
606	-	-	Application guide for power transformers
60296(Amd1-1986)	335	BS-14	Specification for unused mineral insulating oil for Transformers and reactors
34	325	-	Three phase Induction Motors
185	2705	-	Current Transformers
518	-	-	Dimensional standardization of terminals for HV Equipment
616	5578	-	Terminal and tapping markings for Power Transformers
(11353)	-	-	Code of practice for installation and maintenance of Transformers
-	1886	-	Fittings and accessories for power transformers
-	3639	-	Gas operated relays
-	3637	-	Industrial cooling fans
-	6272	-	Degrees of protection provided by enclosures for rotating electrical machines
-	4691-	-	Specification for voltage transformers
186	3156	-	Graphical Symbols for drawings
617	-	-	Galvanising
-	2629	729	Methods of testing uniformity for zinc coated articles
-	2633	-	Colours for ready mixed paints and enamels
-	5	-	Degrees of protection provided by enclosures for Low voltage switchgears and control gears
-	2147	-	Silicagel
-	3401/1992	-	Guide for sampling and analysis of dissolved gas in oil filled equipment.
-	9434	-	Oil impregnated paper insulated Bushing Dimension and requirements.
-	12676	-	Insulation Co-ordination
60071, P-1-1993	-	-	Markings & Arrangements for switchgear Bus bars, Main connections and Auxiliary wiring
P-2-1996	-	375	Application Guide for Gas operated Relays.
-	3638/1996	-	On-load Tap-changer.
60214(1989)	8468	-	Methods for switching Impulse Test on High Voltage Insulators.
-	8269	-	Installation of Transformers.
-	10028/1981	-	

(Part-2)

- 10028/1981 - Maintenance of Transformers.
 - (Part-3)
 - 10561/1983 - Application Guide of Power Transformers.
- 60542,
-

Amd 1-1988	8468/1997	-	-	Application Guide for On-load Tap-changer.
-	8263	-	-	Method for Radio Interference Tests on High Voltage Insulators.
-	3202	-	-	Code of practice for climate proofing of Electrical Equipment.
-	6702/1972	-	-	Method for determination of Electric strength of Insulating Oils.
-	6103/1971	-	-	Method of Test for specific Resistance of Elect. Insulating Liquids.
-	6262/1971	-	-	Method of Test for power factor and Dielectric Constant of Electrical Insulating Liquids.
-	6104/1971	-	-	Method of Test for Interfacial Tension of oil against water by the Ring Method.
60034, P1-22(1972-2000)	-	-	-	Rotating Electrical Machines.
60044, P-6-1992	-	-	-	Instrument Transformers. Amd P1-2000,
60060, Amd P-2-1996	-	-	-	High Voltage Test Techniques. P-1-1989,
60085 (1994)	-	-	-	Thermal Evaluation and classification of Elect. Insulation.
60270 (1981)	-	-	-	Partial Discharge Measurements.
60404-8-7 (1998)	-	-	-	Specification for Individual Materials-Cold Rolled Grain oriented Electrical Steel sheet and strip delivered in fully processed state
60529 (Amd 1-1999)	-	-	-	Degree of protection, provided by enclosures (IP- Code)
60551(Amd 1-1995)	-	-	-	Determination of Transformer and Reactor Sound Levels.
60567(1992) -	-	-	-	Guide for sampling Gases and oil from oil-filled Electrical equipment for the analysis of free and Dissolved Gases
60599(1999)	-	-	-	Mineral Oil-Impregnated Electrical Equipment in service-Guide to the Interpretation of Dissolved and Free Gases Analysis.
60722 (1982)	-	-	-	Guide to the Lightning and Switching Impulse Testing of Power Transformers and Reactors.
60815 (1986)	-	-	-	Guide for selection of Insulators in respect of polluted conditions.
-	-	-	-	Low voltage switchgear & control gear.
(1984-2000)	-	-	-	
-	IEEE C 57.93 1995	IEEE	IEEE	Guides for Installation of Liquid Immersed Power Transformers.
-	-	IEEE Std 80	IEEE	Guide for safety and AC Sub-station Grounding.
-	-	IEEE Std 979	IEEE	Guide for Sub-station Fire protection.
-	-	IEEE Std 980	IEEE	Guide for containment and control of oil spills in Sub-stations.
-	-	CBIP Pub.295/ NFPA	CBIP NFPA	Manual on Transformers. 2006 National Fire Protection Association.
-	-	NEMA-	NEMA-	Standard No.1.
-	-	Indian Electricity	Indian Electricity	- Rules-1956.

The standards, mentioned above are available
from:Standard: Name and Address:

IS	Bureau of Indian Standards, Manak Bhawan, 9-Bahadur Sahah Zafar Marg, New Delhi - 110001, India.
IEC	International Electro Technical Commission, Bureau Central dela Commission, Electro Technique International, 1-Ruede Verembe, Geneva, SWITZERLAND.

Fire prevention & Extinguishing System by Nitrogen (N2) Injection method covered
by this specification shall fully satisfy the requirements of the following:-

- i. Rule No. 64.2.f (ii)of Indian Electricity Rule, 1956.
- ii. Relevant concerned regulations as laid by Tariff Advisory Committee.
- iii. Relevant clauses of OIL INDUSTRY SAFETY DIRECTORATE No. OSID-STD-173,
1998.

Transformer meeting with requirements of other authoritative International Standards that ensure equal or better performance than the standards, mentioned above shall also be considered. When the transformer, offered by the supplier conforms to other standards, salient points of difference

Between standards adopted and the standards, specified in this specification shall be clearly brought out in the offer. Two copies of such standards with authentic translation in English shall be furnished along-with the offer.

ANNEXURE G

REQUIREMENT AND DESIRED DELIVERY FOR 80 MVA 132/33 KV TRANSFORMERS.

A. REQUIREMENT:

SL. No, Description of equipment Quantity as per BOQ

1. Three phase, 50 Hz, ONAF/ONAN/OFAF,
80 MVA, 132/33 KV Power
transformer Having 12.5% impedance
at normal tap
as mentioned in Schedule M of Section IV
, with OLTC, fittings, accessories, fire fighting
& control equipment with first filling of
oil plus 10% extra oil

 2. Spare Parts
 - (a) H.V. side bushing with metal part.....
 - (b) L.V. side bushing with metal part.....
 - (c) H.V. neutral bushing with metal part and gasket for HV and LV...
 - (d) Buchholtz relay (with alarm/trip contacts).....
 - (e) Oil surge relay (with alarm/trip contacts).....
 - (f) Magnetic oil level gauge (with alarm / trip contact).....
 - (g) Current Transformer of WT
 - (h) Dial type oil temp. indicator with alarm/ trip contact
 - (i) Local and remote Winding temperature indicator with alarm/trip contacts
 - (j) Set of Gaskets (each type) for one transformer including bushings
 - (k) Pressure relief device
 - (l) Oil flow indicator with alarm contacts
-

- (m) Cooler pump with motor
- (n) Cooler fan with motor 1 nos.
- (o) Tap position indicator(local and remote)
- (p) Expansion joint (complete replacement for transformer)
- (q) Set of starter, contacts, relays and switches
- (r) Fuses(control) – for complete replacement of transformer
- (s) Lamps(indicative)- complete replacement for transformer.

B. DESIRED DELIVERY

The commissioning time of each transformer shall be 3(three) months from arrival of main body at site. This period includes the foundation casting time, if required.

The overall delivery/commissioning time indicated above shall extend suitably due to time taken in taking up short circuit test on first manufactured unit at CPRI. In any case, the manufacturer has to arrange short circuit test within 5 months and compliance of observation during short circuit test, if any, within 3 months, i.e. the total period not exceeding eight (8) months.

SCHEDULE-I/A
GENERAL PARTICULARS

1. Name & designation of the representative of Bidder to whom all references shall be made for expeditious commercial and Technical clarifications :
2. a) Whether the equipment offered is strictly in accordance with the Purchaser's Tender specification and General conditions of Contract. : Yes / No.
- b) If 'NO' whether the following 'Schedules' reflecting the deviations has been filled up.
- i) 'Schedule:Part - I/G Deviation Sheet (Technical & commercial Particulars) : Yes / No.

NOTE:If the Schedules:Part I/G is not filled up, the bidder shall be deemed to have accepted BSPTCL's 'Specification Technical Particulars', 'General Conditions of Contract' and SCCin Toto)

3. a) State whether all the specified test facilities including SFRA, are available in the work premises of the manufacturer of the offered equipment/materials: : Yes / No
- b) If 'No' state the names of the Laboratory/Testing authority where the particular Tests (which can not be done in the manufacturer's works) are intended to be carried out. :
4. Whether the bidder is agreeable to : Yes / No
-

accept BSPTCL's specification clause of
***'Inspection & Quality Control 'Vide'
Annexure - C'*** of this specification.

5. It is confirmed that plant performance : Yes / No
guarantee/warranty is valid whether the
same has been installed and commissioned
under the suppliers' supervision or not.
6. Whether all the items of Price-bid have been : Yes / No
quoted.

N.B.:strike out whichever not
applicable in the above 'Yes/No'.

7. State whether the manufacturer possesses in house : Yes / No
testing laboratory duly accredited by NABL for
carrying out type and routine test.
Also, facility for "VPD" and "air-conditioning : Yes / No
winding section".
8. Sate whether the manufacturer has been blocklisted : Yes / No
By any government body in India during last Ten(10)
Years

**Signature of the Bidder with seal
Designation & Date.**

SCHEDULE - I/B

GUARANTEED TECHNICAL PARTICULARS

GUARENTEED TEHNICAL PARTICULAR FOR 80 MVA, 132/33 KVPOWER TRANSFORMER

Sl. No	Description	Units	To be quoted by bidder
1	Name of the Manufacturer		
2	Installation [indoor/outdoor]		
3	Reference standards		
4	Continuous Ratings		
a	Type of cooling		ONAN/ONAF/OFAF
b	Rating [MVA]		
i	With ONAN cooling	MVA	
ii	With ONAF cooling	MVA	
iii	With OFAF cooling	MVA	
c	Rated voltage		
i	HV [KV rms.]	KV	
ii	LV [KV-rms.]	KV	

d	Highest system voltage		
i	HV [KV rms.]		
ii	LV [KV-rms.]		
e	Rated frequency with $\pm\%$ variation		
f	Number of phases		
g	Current at rated full load and on principal tap		
i	HV [Amps]	Amp.	
ii	IV [Amps]	Amp.	
5	Connections		
	HV/LV		
6	Connection symbol and vector group.		
7	Temperature rise		
a	Temperature rise of oil above reference peak ambient temperature i.e.50 °C [by thermometer] [°C]		
i	At full ONAN rating [°C]	°C	
ii	At full ONAF rating [°C]	°C	
iii	At full OFAF rating[°C]	°C	

b	Temperature rise of winding above reference peak ambient temperature [by resistance method][°C]		
i	At full ONAN rating [°C]	°C	
ii	At full ONAF rating [°C]	°C	
iii	At full OFAF rating[°C]	°C	
c. .	Temperature gradients between windings & oil	°C	
d.	Limit of Hot spot temperature for which the Transformer is designed [°C]	°C	
e	Period of operation of transformer at full load without calculated winding hot spot temperature exceeding 108°C and top oil temperaure rise above ambient shall not exceed 40°C both for ONAN, ONAF and OFAF condition.	°C	
i	50% Coolers	Minutes	
ii	100% Coolers	Minutes	
8	Type of ON load tap changing switch		
9	Tapping on windings for		
i	Constant flux/variable flux/combined regulation.		
ii	Tapping provided at		
iii	Number of steps	%	
iv	Range of tapping for variation [+ percent to- percent]		

10 i	No load loss at rated voltage and frequency at principal tap [KW]	KW(max.)	
ii	No load loss at the voltage corresponding to highest tap [KW]	KW	
11	Load loss at rated output, rated frequency, ONAN ONAF and OFAF corrected for 75 °C winding temperature at:- [Copper loss + cooler loss]		ONAN ONAF OFAF
i	Principal tap [In KW]	KW	
ii	Highest tap [In KW]	KW	
iii	Lowest tap [In KW]	KW	
12	Auxiliary losses at rated output, normal ratio, rated voltage, rated frequency and ambient temperature [KW]	KW	
13	Total losses at normal ratio inclusive of auxiliary equipment losses [KW]	KW	
14	Positive sequence impedance on rated MVA HV to LV base at rated current and frequency at 75° Centigrade winding temperature at	%	HV to IV
i	Principal tap [%]	%	
ii	Highest tap [%]	%	
iii	Lowest tap [%]	%	
15	Zero sequence impedance at reference temperature of 75°C at principal tap [%]	%	
16	% reactance at rated MVA base at rated current and rated frequency at		HV to IV
i	Principal tap [%]	%	

ii	Highest tap [%]	%	
iii	Lowest tap [%]	%	
17	% resistance at rated MVA base at rated current and rated frequency at		HV to IV
i	Principal tap [%]	%	
ii	Highest tap [%]	%	
iii	Lowest tap [%]	%	
18	% Impedance at rated MVA base at rated current and rated frequency at		HV to IV
i	Principal tap [%]	%	
ii	Highest tap [%]	%	
iii	Lowest tap [%]	%	
19	a. Polarisation index i.e. ratio of Megger values at 600 secs to 60 secs, (H.V. to E,I.V. to E, L.V. to E, H.V. to I.V., H.V. to L.V.& I.V.to L.V.		
b.	Regulation at full load and 75°C winding temperature expressed as a percentage of normal voltage		
i	At unity power factor [%]	%	
ii	At 0.8 power factor [lagging][%]	%	
20	Efficiency at 75°C winding temperature as derived from guaranteed loss figures at		

a	At full load [%]	%	
b	At $\frac{3}{4}$ load [%]	%	
c	At $\frac{1}{2}$ load [%]	%	
21.i.	i Maximum efficiency [%]	%	
ii	Load at which maximum efficiency occurs[% of full load]	%	
22	Time in minutes for which the transformer can be run at full load without exceeding the maximum permissible temperature at reference ambient temperature when supply to:-		
i	Fans is cut off	Minutes	
23	Short time thermal rating of		
i	LV winding in KA and duration in seconds	KA/Sec	
ii	HV winding in KA and duration in seconds	KA/Sec	
24	Permissible over loading:-		
a	HV winding		
b	LV winding		
25	Terminal arrangement		
a	High voltage [HV]		

b	Low voltage (LV)		
c	Neutral		
26	Insulating and cooling medium		
27	[A] Test voltage HV LV		HV LV
i.	Lightning impulse withstand test voltage [KVP]	KV Peak	
ii	Power frequency withstand test voltage [dry and wet] [for 1 minute] [KV-rms.]	KV Peak	
iii	Switching impulse test voltage [KVP]	KV Peak	
	[B] Design value of surges transferred on tertiary terminals:		
	I For 1300[900] KVP, 1.2/50 micro second surge striking HV terminal and with		
a	Both the tertiary terminals open[KVP]	KV Peak	
b	One terminal earthed [KVP]	KV Peak	
ii	For 900[550] KVP, 1.2/50 micro second surge striking IV terminal and with		
a	Both the tertiary terminals open [KVP]	KV Peak	
b	One terminal earthed [KVP]	KV Peak	
28	Partial discharge level as per relevant IEC/ISS		

29	Noise level when energized at normal voltage, frequency without load and with all cooling fans, oil pumps in running condition.	dB(A)	
30	External short circuit withstand capacity [MVA] and duration [seconds]	MVA/Sec	
31	Over-fluxing withstand capability of the Transformer		
32	DETAILS OF CORE		
a	Type of core construction		
b	Type of corner joints of the core		
c	Maximum flux density at		
i	Rated voltage [220 /132/33 KV] & rated frequency 50 Hz][in Tesla]	Tesla	
ii	Highest system voltage [245 /145/36 KV] and lowest system frequency [48.5Hz.][inTesla]	Tesla	
d	No load current, no load loss and no load power factor at normal ratio and frequency [Amp/KW/p.f.]	A/KW/p.f.	
i	10 percent of rated voltage		
ii	25percent of rated voltage		
iii	50 percent of rated voltage		
iv	85 percent of rated voltage		
v	100 percent of rated voltage		

vi	105percent of rated voltage		
vii	110 percent of rated voltage		
viii	112.5 percent of rated voltage		
ix	115 percent of rated voltage		
x	120 percent of rated voltage		
xi	121 percent of rated voltage		
xii	125 percent of rated voltage		
e	Core laminations:-		
i	Material of core lamination [HIB/Laser grade]		
ii	Grade of core laminations		
iii	Thickness of core lamination [mm]	mm	
iv	Specific loss [watt/Kg.] at rated voltage and rated frequency	watt/kg	
v	Specific loss [watt/Kg.] at highest system voltage and lowest system frequency	watt/kg	
vi	Whether specific core loss graph [flux density vs. watt/Kg.submitted		
vii	VA/Kg at rated voltage and rated frequency	VA/kg	

viii	VA/Kg. at highest system voltage and lowest system frequency	VA/kg	
ix	Whether VA/Kg. Vs. flux density graph submitted.		
x	Insulation of core laminations		
f	CORE ASSEMBLY:-		
i	Core diameter [mm]	mm	
ii	Core window height [mm]	mm	
iii	Core leg centre [mm]	mm	
iv	Gross core cross-sectional area [m ²]	m ²	
v	Whether details of core widths, stacks and calculation furnished as per enclosed annexure		
vi	Distance between centres [mm]	mm	
vii	Total height of core [mm]	mm	
viii	Core bolt size [mm]	mm	
ix	Core bolt Insulation [mm]		
	In case of bolt less core design		
1)	Details of core belting.		

2)	Material, grade & type.		
3)	Width.	mm	
4)	Thickness.	mm	
5)	Fixing method.		
x	Details of top end frame.		
xi	Details of Bottom end frame.		
xii	Details of clamp plate [Material, thickness, Insulation]		
xiii	Details of clamp plate [material, thickness, Insulation]		
xiv	Total core weight [kg]	kg	
xv	Core loss basing on core loss graph at operating flux density [rated voltage and rated frequency] [kw]	KW	
xvi	Core stacking factor		
xvii	Net core area Sq. m.	m ²	
xviii	Margin towards corner joints, cross fluxing etc [kw]	KW	
xix	Total core loss at rated voltage and rated frequency [xv+xviii] [kw]	KW	
xx	Dielectric loss at rated voltage and rated frequency [KW]	KW	

g	Whether steel rings are used for the windings? If so, whether these are split?		
h	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings?		
i	Winding Insulation		
i.	H.V. & Regulating ungraded		
ii	LV		
j	Insulating material used for		
i	H.V. & Regulating winding.		
ii	L.V Winding		
iii	For core bolts washers and end plates.		
iv	Tapping connection.		
k	Insulating material used between		
i	H.V. and I.V. winding		
ii	Regulating winding and H.V. winding.		
iii	Core and L.V winding.		
iv	L.V. Winding and core.		

v	Regulating winding and core		
vi	H.V. winding and core		
vii	H.V. to H.V. winding [between phases]		
l	Type of axial coil supports.		
i	H.V. winding		
ii	Regulating winding		
iii	LV winding		
m	Type of radial coil supports		
i	HV winding		
ii	Regulating winding		
iii	LV winding		
n	Maximum allowable torque on coil clamping bolts (HV Regulating LV)		HV Regul. LV
o	Bare conductor size (mm).	mm	
p	Insulated conductor size (mm).	mm	
q	No. of conductors in parallel (Nos.).	Nos.	

r	No. of turns/phase		
s	No. of discs/phase		
t	No. of turns/disc		
u	Gap between discs. (mm).	mm	
v	Inside diameter (mm).	mm	
w	Outside diameter (mm).	mm	
x	Axial height after shrinkage (mm).	mm	
y	D.C.RESISTANCE		
i	L.V winding at 75 ° C (Ohms).	Ohms	
ii	H.V. winding at 75 ° C (Ohms).(series winding)	Ohms	
iii	LV winding and Regulating winding at normal tap at 75° C (Ohms).(common + reg. winding)	Ohms	
iv	LV winding and Regulating winding at highest tap at 75° C (Ohms).	Ohms	
v	LV winding and regulating winding at lowest tap. (Ohms).	Ohms	
vi	Total I ² R losses at 75 ° C. for normal tap. (KW)	KW	
Vii	Total I ² R losses at 75 ° C. for highest tap. (KW)	KW	

viii	Total I ² R losses at 75 ° C for lowest tap.(KW).	KW	
ix	Stray losses including eddy current losses in winding at 75°C (KW).		
a	Normal tap position	KW	
b	Highest tap position	KW	
c	Lowest tap position.	KW	
d	Any special measures taken to reduce eddy current losses and stray losses, mention in details.		
x	Load losses at 75°C [I ² R + stray].		
a	Normal tap position [KW].	KW	
b	Highest tap position [KW].	KW	
c	Lowest tap position [KW].	KW	
z	Details of special arrangement provided to improve surge voltage distribution in the windings		
aa.	Tandelta(Power factor) of Winding(Max.)		
bb	Max. tan delta (power factor) of windings at 20 C		
34	BUSHINGS. HV LV Neutral		HV LV Neutral
a	Make and type		

i	Rated voltage class [KV-rms.]	KW rms	
ii	Rated current [Amps.]	Amps.	
b.	Lightning Impulse withstand test voltage [1.2/50 micro second][KVP]	KV Peak	
c	Switching surge withstand test voltage [KVP]	KV Peak	
d	Power frequency withstand test voltage		
i	Wet for 1 min.(KV rms)	(KV rms)	
ii	Dry for 1 min. (KV rms)	(KV rms)	
e	Power frequency visible corona discharge voltage (KV rms)	(KV rms)	
f	Partial Discharge level(PC)		
g	Minimum creepage distance in mm	mm	
h	Minimum creepage distance in mm(protected)	mm	
i	Whether test tap is provided		
j	Quantity and grade of oil in bushing and specification	kg.	
k	Weight of assembled bushing(kg.)	kg.	
l	Minimu clearance height for removal of bushing (mm)	mm	

m	Under oil flashover or puncture impulse voltage(KVP)	KV Peak	
n	Under oil flashover or puncture power frequency voltage(KV rms)	KV rms	
o	Phase to earth clearance in air of live parts at the top of bushings	mm	
p	Maximum tan delta value at 20 deg. C		
Note:The details of windings are approximate may change during final design stage.			
35	Minimum clearance [mm]		Between Windings ground Phase to
(A)	Out of Oil		
i	HV	mm	
ii	LV	mm	
(B)	In Oil	mm	
i	LV to HV (radially)	mm	
ii	HV to Regulating(radially)	mm	
iii	LV to top yoke	mm	
iv	LV to bottom yoke	mm	
v	HV to top yoke	mm	

vi	HV to bottom yoke	mm	
vii	Regulating to Top yoke	mm	
viii	Regulating to bottom yoke	mm	
ix	Outer winding to Outer winding	mm	
x	Outer winding to Tank		
(a)	Length wise	mm	
(b)	Breadth wise	mm	
©	Width wise	mm	
36	Weight [Tolerance + 5%]		
	[Approximate value is not allowed]		
a	Core [Kg.]	Kg.	
b	Core with clamping [Kg.]	Kg.	
c	H.V. [series] winding insulated conductor [Kg.]	Kg.	
d	Regulating winding insulated conductor [Kg.]	Kg.	
e	L.V. winding insulated conductor [Kg.]	Kg.	

f	Coils with insulation [Kg.]	Kg.	
g	Core and winding [Kg]	Kg.	
h	Oil required for first filling [Liter/Kg.]	Litre/Kg.	
i	Tank and fittings with accessories [Kg.]	Kg.	
j	Untanking weight [Kg.]	Kg.	
k	l Total weight with oil and fittings [kg.]	Kg.	
37	DETAILS OF TANK		
a	Material for Transformer tank		
b	Type of tank		
c	Thickness of sheet		
	[No approximate value to be mentioned]		
i	Sides [mm]	mm	
ii	Bottom [mm]	mm	
iii	Cover [mm]	mm	
iv	Radiators [mm]	mm	

d	Inside dimensions of main tank		
	[No approximation in dimensions to be used]		
i	Length [mm]	mm	
ii	Breadth [mm]	mm	
iii	Height [mm]	mm	
e	Outside dimensions of main tank		
	[No approximation in dimensions to be used]		
i	Length [mm]	mm	
ii	Breadth [mm]	mm	
iii	Height [mm]	mm	
f.	Thickness of spray galvanization of tank bottom.		
g.	Vacuum recommended for hot oil circulation [torr]	torr	
h.	Vacuum to be maintained during oil filling in Transformer tank [torr]	torr	
i.	Vacuum to which the tank can be subjected without distortion [torr]	torr	
j.	No. of bi-directional wheels provided	Nos.	

k.	Track gauge required for the wheels		
i	Transverse axis	mm	
ii	Longitudinal axis	mm	
l.	Type and make of pressure relief device and minimum pressure at which it operates [Kpa]	Kg./sq. cm	
38	CONSERVATOR		
a	Total volume [Liters]	Liters	
b	Volume between the highest and lowest visible oil levels [Liters]	Liters	
c	Power required by heaters [if provided][KW]	KW	
d	Conservator sheet thickness	mm	
39	OIL QUALITY		
a	Governing standard		
b	Density in gms/cu-cm	gms/cu-cm	
c	Kinematics viscosity in CST	CST	
d	Inter facial tension at 27°C in N/m	N/m	
e	Flash point in °C	°C	

f	Pour point in °C	°C	
g	Acidity [neutralization value] in mg of KOH/gm	KOH/gm	
h	Corrosive sulfur in %	%	
i	Electric strength [breakdown voltage]		
i	As received [KV-rms.]	KV rms	
ii	After treatment [KV-rms.]	KV rms	
j	Dielectric dissipation factor [tan delta] at 90°C		
k	Saponification value in mg of KOH/gm	KOH/gm	
l	Water content in ppm	ppm	
m	Specific resistance		
i	At 90°C [ohm-cm]	ohm-cm	
ii	At 27 °C [ohm-cm]	ohm-cm	
n	N- dm analysis CA%		
	CM%		
	CP%		

o	Oxidation stability		
i	Neutralization value after oxidation		
ii	Total sludge after oxidation		
p	Characteristic of oil after ageing test as per		
	ASTMD-1934		
i	Specific resistance at		
	27°C [ohm-cms]	ohm-cm	
	90°C [ohm-cms]	ohm-cm	
ii	Tan delta		
iii	Sludge content		
iv	Neutralization number		
v.	% of Napthanic Content		
vi.	% of Paraffinic Content		
vii.	Details of oil preserving equipment offered		
40	RADIATORS		

a	Overall dimensions lxbxh [mm]	mm	
b	Total weight with oil [Kg.]	Kg.	
c	Total weight without oil [Kg.]	Kg.	
d	Thickness of radiator tube [mm]	mm	
e	Types of mounting		
f	Vacuum withstand capability		
g	Total radiating surface in sq.m	sq.m	
h	Type and make of material used for the radiators		
i	Total number of radiators/Banks for Transformer and dimensions of tubes.		
j	Thickness of hot dip galvanization of radiators.		
41	COOLING EQUIPMENT		Fan Motor
a	Make and type		
b	No. of connected units	Nos.	
c	No. of stand -by units	Nos.	

d	Rated power input	KW	
e	Capacity [cu-m/min. or] [liters/min]	cu-m/min.	
f	Rated voltage [volts]	Volts	
g	Locked rotor current [Amps.]	Amps	
h	Efficiency of motor at full load [%]	%	
i	Temperature rise of motor at full load [°C]	°C	
j	BHP of driven equipment	HP	
k	Temperature range over which control is adjustable [°C]		
l	Whether the fans and pumps are suitable for continuous operation at 85 % of their rated voltage.		
m	Estimated time constant in v		
i	Natural cooling	Hrs	
ii	Forced air cooling	Hrs	
iii	Forced oil cooling	Hrs.	
42	GAS AND OIL OPERATED RELAY		
a	Make		

b	Type		
c	Size	mm	
d	Whether supervisory alarm and trip contacts provided and their sizes and Nos.		
43	[I] TEMPERATURE INDICATORS		O.T.I. W.T.I.
a	Make and type		
b	Permissible setting ranges for alarm and trip		
c	Number of contacts		
d	Current rating of each contact		
e	Whether supervisory alarm contacts provided?		
f	Size [lxbxd]		
g	Nos.		
h	Ratio and type of CT used for winding Temperature indicators.		HV LV
	[II] OPTIC FIBER TEMPERATURE SYSTEM		
a	MAKE & TYPE		
b	Whether the offered Optic Fiber Temperature System fulfills the stipulations for the same as per this Specification		

c	Whether the end-user's certificate for offered Optic Fiber Temperature System, from Indian Utilities furnished		
d	Whether, the Bidder has got past experience of supply of Transformers with Optic Fiber Temperature System [YES/NO]	Yes/No	
e	If 'YES', please state the No. of such Transformers, supplied along with the name(s) of Organisation(s), to whom supplied with Make of the Optic Fiber Temperature System, supplied and performance of the same.		
44	APPROXIMATE OVERALL DIMENSIONS OF TRANSFORMER INCLUDING COOLING SYSTEM, TAP CHANGING GEAR ETC.		
a	Length [mm]	mm	
b	Breadth [mm]	mm	
c	Height [mm]	mm	
45	a Minimum clearance height for lifting core and winding from tank [mm]	mm	
b	Minimum clearance height for lifting tank cover [mm]	mm	
46	SHIPPING DETAILS		
a	Approximate weight of heaviest package [Kg.]	Kg.	
b	Approximate dimensions of largest Package [Kg.]	mm	
47	Transformers will be transported with oil/gas.		
48	Size of rail recommended for the track.		

49	Details of current transformers including CT for separate mounting in neutral connection to earth	mm	
a	Quantity		
b	Type and voltage class		
c	No. of cores		
d	Ratio		
e	VA burden		
f	Accuracy class		
g	Minimum knee point voltage [volts]	Volts	
h	Maximum magnetization current at minimum knee point voltage [mA]	mA	
i	Maximum secondary winding resistance at 75°C[ohms]	Ohms	
50	LIFTING JACKS:-		
a	Governing standard		
b	No. of jacks in one set		
c	Type and make		
d	Capacity [tonnes]	T	

e	Pitch [mm]	mm	
f	Lift [mm]	mm	
g	Height in closed position [mm]	mm	
h	Mean diameter of thread [mm]	mm	
51	MARSHALLING KIOSK		
a	Make and type		
b	Details of apparatus proposed to be housed in the kiosk		
52	Details of anti-earthquake device provided, if any		
53	Separate conservator and Buchholz relay provided		
54	TAP CHANGING EQUIPMENT		
	[These details refer to the basic rating of O.L. T.C. as guaranteed by OLTC manufacturers]		
a	Make		
b	Type		
c	Power flow [Uni.-directional/bi-directional/restricted bi-directional]		
d	Rated voltage to earth [KV]	KV	

e	Rated current [Amps.]	A	
f	Step voltage [volts]	Volts	
g	Number of steps		
h	Control - manual/local-electrical/remoteelectrical		
i	Voltage control [Automatic/Non -automatic]		
j	Line drop compensation provided/not provided		
k	Parallel operation		
l	protective devices		
m	Auxiliary supply details		
n	Time for complete tap change [one step][Sec.]	Sec	
o	Diverter selector switch transient time [cycles]	m Sec	
p	Value of maximum short circuit current [Amps]	KA	
q	Maximum impulse withstand test voltage with 1.2/50 micro seconds full wave between switch assembly and ground [KVP]	KVp	
r	Maximum power frequency test voltage between switch assembly and earth [KV-rms]	KV rms	
s	Maximum impulse withstand test voltage with 1.2/50 micro-seconds across the tapping range [KVP]	KV p	

t	Approximate overall dimensions of tap changer [WxBxD] in mm.	mm	
u	Approximate overall weight [Kg.]	Kg.	
v	Approximate mass of oil [Kg.]	Kg.	
w	Particulars of the OLTC control panel for installation in control room		
55	DRIVINGMECHANISM BOX		
a	Make and type		
b	Details of apparatus proposed to be housed in the box		
56	Types of terminal connectors and drawing No		
a	HV		
b	LV		
57	Details of painting, galvanization conforms to this Specification [Yes/No]	Yes/No	
58	Type of oil level indicator and whether Supervisory alarm contact for low oil level provided [Yes/No]	Yes/No	
59	Type and size of thermostat to be used		
60	No. of breathers provided [Nos.]	Nos.	
61	Type of dehydrating agent used for breathers		

62	Valve sizes and numbers		
a	Drain valves- mm-Nos.		
b	Filter valves- mm-Nos.		
c	Sampling valves- mm-Nos.		
d	Radiator valves- mm-Nos.		
e	Other valves- mm-Nos.		
63	Maintainance free breather for main tank	Yes/No	
64	a) Type and make of PRV.		
b	No. of each type of devices per transformer		
c	Min. pressure at which device operates.	Kg./sq. cm	
65	Please enclose the list of accessories and fittings, being provided on transformer. Please confirm, these are as stipulated in the tender.		
66	Whether the transformer, covered is fully type tested and if so, whether copies of type test certificates, enclosed with the tender.		
67	Whether bidder can supply transformer, wound on vertical coil winding machine. Preference shall be given to the bidder who will ensure supply of transformer wound on vertical winding machines.		

68	In case SL.No.67 is not confirmed, what are the additional pre-cautions which shall be taken by the bidder to justify that the coil, wound on horizontal machine shall be equivalent in all respects to that which are wound on vertical winding machine.		
69	What are the arrangements, available for jointing the winding. Preference shall be given to the bidder using high-frequency brazing machines. In case other jointing techniques are used, adequacy of the same is to be recorded. Please note that bolted joints in the winding are not acceptable. This should be confirmed here.		
70	Please confirm that you will guarantee maximum Impedance variation between phases within the limit of 2% only.		
71	Please confirm that the transformer shall be dried by vapour-phase drying method. Please specify level of dryness.		
72	Please confirm whether the In-House facilities for all routine tests as per this Tender Specification are available with the bidder and the bidder shall agree to conduct these tests on the transformer in the event of order.		
73	Whether the Bidder has got In-House core-cutting facility for cutting core materials for the transformer ratings as offered. (YES/NO)	Yes/No	
74	If 'YES', following informations/confirmations are required: -		

a	<p>Name of the manufacturer of HIB Grade core material and if so, whether copies of type test certificates, enclosed with the tender.</p> <p>66. Whether bidder can supply transformer, wound on vertical coil winding machine. Preference shall be given to the bidder who will ensure supply of transformer wound on vertical winding machines.</p> <p>67. In case Sl.No.66 is not confirmed, what are the additional pre-cautions which shall be taken by the bidder to justify that the coil, wound on horizontal machine shall be equivalent in all respects to that which are wound on vertical winding machine.</p> <p>68. What are the arrangements, available for jointing the winding. Preference shall be given to the bidder using high-frequency brazing machines. In case other jointing techniques are used, adequacy of the same is to be recorded. Please note that bolted joints in the winding are not acceptable. This should be confirmed here.</p> <p>69. Please confirm that you will guarantee maximum Impedance variation between phases within the limit of 2% only. from whom core materials will be directly imported or through their accredited marketing organization of repute. If to be imported through the accredited Marketing Organisation, Please state the name of such Marketing Organisation and please enclose the relevant documents with the Tender Offer regarding accreditation of the said Marketing Organisation by the manufacturer of the HIB core material.</p>		
b	Grade, Trade Name and Thickness of the core material, to be imported		
c	Whether agreed for witnessing of core materials by BSPTCL's representative(s)		
d.	Whether, the Bidder has past experience towards direct import of core materials. If 'YES', the copies of recent past Import documents to be furnished with the Tender Offer (Please state, whether the said import documents are enclosed with the Tender Offer)		
e.	Whether, the Bidder has got In-House CNC Machine facility for cutting of core materials		
f.	Whether the Bidder is agreed to follow the procedures, as stipulated at Cl.No.5.4.8 (o), (p) &(q) of this Technical Specification, as applicable for those, who have got In-House core-cutting facility		
75	If the Bidder has no In-House core-cutting facility, the following informations/confirmations are required:-		

a.	Name of the core manufacturer of core materials from whom core materials will be directly imported or through their accredited marketing organization of repute. If to be imported through the accredited Marketing Organisation, Please state the name of such Marketing Organisation and please enclose the relevant documents with the Tender Offer regarding accreditation of the said Marketing Organisation by the manufacturer of the HIB core material.		
b.	Grade, Trade Name and Thickness of the core material, to be imported		
c.	Name of the core-cutting vendor and whether the said vendor has got In-House CNC Machine facility for cutting of core materials and whether the said vendor has been accredited by ISO		
d.	Whether, the Bidder has past experience towards direct import of core materials. If 'YES', the copies of recent past Import documents to be furnished with the Tender Offer (Please state, whether the said import documents are enclosed with the Tender Offer)		
76	75. Please confirm that the facility for partial discharge test		

SCHEDULE - I/B contd.

II. GUARANTEED TECHNICAL PARTICULARS OF FIRE PREVENTION AND EXTINGUISHING SYSTEM BY NITROGEN INJECTION METHOD

1. Name and address of the manufacturer :
 2. Address of the works :
 3. Testing facility available :
 4. Make and rating of the equipment :
 5. Time required for fire Extinguishing :
 6. Capacity of nitrogen cylinder :
 7. Capacity required for oil soak-pit :
 8. Weight and dimensions of fire
extinguishing cubicle :
 9. Weight and dimensions of control box :
 10. Power supply required
(250 V D.C./230 V A.C.) :
 11. Drawing, Literature, Bill of materials
and detailed scheme enclosed with the offer. :
 12. Whether approved by TAC :
(if yes, enclosed the copy of approval)
 13. Any other information the Bidder :
wishes to furnish.
-

14. Whether the Successful bidder is agreeable to ensure that Supervision of Installation & Commissioning of above Fire prevention & Extinguishing system will be done by their sub-vendor as per requirement for which the erection contractor will pay the supervision charges separately. : (YES / NO)
15. If yes, a Certificate from the sub-vendor must be submitted along with the tender.

**Signature of the Bidder with seal
Designation & Date**

SCHEDULE-I/C

LIST OF SPECIAL TOOLS AND TACKLES

Not to be considered for tender evaluation

Bidders shall tabulate below the schedule of special Tools and Tackles (if required) for erection, and maintenance of the equipment covered by this specification. The itemized prices of the same shall be indicated separately by the bidders in schedule II/B:Price List for special Tools and Tackles ‘under Price Bid’ of this specification.

Sl. No.	Description of items	ISS Ref. No.	Recommended Quantum
------------	----------------------	-----------------	------------------------

Date:.....

(Signature).....

Place:.....

(Name).....

(Designation)

(Common Seal)



SCHEDULE-I/D

(TIME SCHEDULE FOR COMPLETION OF SUPPLY, ERECTION AND COMMISSIONING)

The Bidders must submit the 'Bar Chart' in respect of following activities along with the tender.

Activities

- a) Procurement of raw materials
- b) Drawings submission and approval
- c) Fabrication
- d) Assembly
- e) Wiring
- f) Procurement of bought out items
- g) Stage inspection & witnessing test
- h) Short circuit test at CPRI followed by other required tests.
- i) Inspection of complete equipment and witnessing routine/type/special tests as applicable.
- j) Transportation
- k) Erection & Commissioning (if applicable)

- NOTE:**
1. The bar chart shall be prepared 'in months' with date of issue of 'Letter of Intent / Award / Acceptance' as the base date.
 2. Bar chart shall be submitted for all the transformers covered by this specification and shall be matched with the 'Delivery Schedule' as mentioned in this specification.
-

SCHEDULE - I/E

SCHEDULE OF PAST EXPERIENCE

(ii) To be filled in as per the requirement of Eligibility criteria mentioned in the bidding document of present turn tender as applicable for transformer manufacturer

Bidders shall fill-in this schedule in the following format for the type of equipment covered by this specification as a record of past experience.

Sl. No.	Purchaser/User (indicating Project)	Equipment type Supplied	Order Ref. No.	Year of Manufacture	Date of Commissioning
---------	--	----------------------------	-------------------	------------------------	--------------------------

Date:.....

(Signature).....

Place:.....

(Name).....

(Designation)

(Common Seal)



SCHEDULE-I/F

LIST OF DRAWINGS / CERTIFICATES / DOCUMENTS SUBMITTED ALONGWITH THE TENDER

Bidders shall furnish the following list of drawings, certificates, and other documents they would be enclosing alongwith their offer for the subject equipment. These drawings / certificates and documents shall form part of the “Technical and Commercial” bid.

<i>Documents No.</i>	<i>Description</i>
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

Date:.....	(Signature).....
Place:.....	(Name).....
	(Designation)
	(Common Seal)

SCHEDULE -I/G

SCHEDULE OF DEVIATIONS FROM TECHNO-COMMERCIAL REQUIREMENTS OF THE SPECIFICATION

NOTE: Bidder shall agree to all the techno-commercial terms and conditions of the bid documents. However, deviations, if any, should be stated as per the following schedule and to be submitted along with the techno commercial bid failing which it will be presumed that all terms and conditions are acceptable to them. Deviations taken elsewhere and not brought out in the following deviation schedule **will not be accepted**. The owner reserves the right to **reject the offer** on account of such deviations if the bidder, on advice of owner, does not withdraw the deviations. If there are no deviations, this deviation schedule shall be submitted along with the other schedules duly signed and stamped after stating NIL DEVIATIONS.

Name of the Project:...

Your NIT no:

Bidder's name and address:...

To:...

(Purchaser's Name and Address)

Dear Sir,

Following are the deviations proposed by us relating to techno-commercial terms and conditions. We confirm that we shall withdraw the deviations proposed by us at the cost of withdrawal indicated in the price bid failing which our bid may be rejected and Bid Security forfeited.

A. TECHNO-COMMERCIAL TERMS

Sl. No.	Reference Clause No.	Deviations with reasons
1.
2.
3.
4.

Signature of

Bidder: Date:...

Designation with Seal:...

SCHEDULE - I/H

DECLARATION SHEET

I, _____ certify that all the above data and information pertaining to this specification are correct and are true representation of the equipment covered by our quotation No. _____ dated _____

I hereby certify that I am duly authorized representative of the supplier whose name appears above my signature.

Supplier's Name:

Authorised Representative's Signature _____

Authorised Representative's Name (Typed) _____

Manufacturer's Intent : The manufacturer agrees to fully comply with the requirements and intent of this specification for the price indicated.

Manufacturer's Authorised Representative's

Signature: _____

Manufacturer's Authorised Representative's

Name (typed) _____

SCHEDULE:- II/A
SCHEDULE OF ITEMS & QUANTITIES
(Price not to be quoted here)

1) Bidders offer reference No. & date:

2) Validity period of the offer:

Sl. No.	Description	Qty (Nos) (as per BOQ)
1.	<p>80 MVA, 132KV / 33KV (145Class), 50 Hz, YNyno, Star (Earthed neutral) / , ONAN / ONAF / OFAF, out-door type, switch yard transformer with separately mounted cooler bank and On Load Tap Changer(HV side) of – 15% to + 5% Variation, with terminal connectors, CC cabinet, RTCC Panel, fiber optic temperature monitoring system, maintenance free breather along with all fittings and accessories.</p> <p>The above transformers shall be complete with all necessary and as applicable fittings, Accessories, auxiliaries and devices including but not limited to those specified against clause No.7.000. The transformers shall be complete with oil for first filling and 10% extra.</p>	
2.	<p>Complete set of equipment for Fire Prevention & Extinguishing System by Nitrogen (N2) Injection method as per technical specification for above Transformers. The above transformers shall be complete with all fittings, which are necessary for efficient operation of the transformers & supply of all necessary equipment for Fire Prevention & Extinguishing System by Nitrogen (N2) Injection method complete. Such parts shall be deemed to be within the scope of the supply whether specifically mentioned or not.</p>	
3.	<u>Test Charges:</u>	
a)	Temperature rise test	
b)	Impulse Test	
c)	Short circuit test(Thermal & Dynamic followed by other tests)	
4.	<u>Mandatory Spares (for above transformer):</u>	

a)	H.V. side bushing with metal part.	
b)	L.V. side bushing with metal part.	
c)	H.V. neutral bushing with metal part and gasket for HV and LV.	
d)	Buchholtz relay (with alarm / trip contacts).	
e)	Oil surge relay (with alarm / trip contacts).	
f)	Magnetic oil level gauge (with alarm / trip contact).	
g)	Current Transformer of WTI.	
h)	Dial type oil temp. indicator with alarm / trip contact	
i)	Local and remote Winding temperature indicator with alarm/trip contacts.	
j)	Set of Gaskets (each type) for one transformer including bushings	
k)	Pressure relief device	
l)	Oil flow indicator with contact	
m)	Cooler pump with motor	
n)	Cooler fan with motor	
o)	Tap position indicator(local and remote)	
p)	Expansion joint (complete replacement for transformer)	
q)	Set of starter, contacts, relays and switches	
r)	Fuses(control) – for complete replacement of transformer	
s)	Lamps(indicative)- complete replacement for transformer.	

Signature of Bidder's Authorised representative

Name of Bidder's Authorised representative

Designation of Bidder's Authorised representative

::Official Seal::



SCHEDULE :II/B

PRICE LIST FOR SPECIAL TOOLS AND TACKLES

(if recommended)

Not to be considered for bid evaluation.

Bidders shall quote below item wise FOR site prices for the list of ‘Special Tools and Tackles’ as recommended in the ‘Schedule - I/C’ of this specification. Prices shall be quoted as FIRM prices only.

Sl. No.	Description of items (As per item No. of Schedule ::Part I/C)	of Recommended Quantum	Unit ex-works Price (Rs.)	Unit F&I Charges or Unit freight charges (Rs.)*	Unit FOR Destination Price (Rs.)	Total FOR Destination Price(Rs.)
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6=4+5</i>	<i>7=6 x 3</i>

1. Packing & Forwarding charges, if extra-----
2. Applicable Excise duty, if extra ----- %
3. Applicable Education Cess, if extra----- %
4. Applicable Sales tax/VAT, if extra ----- %

* If the Bidder opts for BSPTCL’s Open Insurance Policy.

Date :..... (Signature).....

Place:..... (Name).....

(Designation)

(Common Seal)

SCHEDULE - II/C
WITHDRAWAL PRICE AGAINST DEVIATIONS

Cost of withdrawal of deviations indicated in schedules I/G.

Name of the Project)

Your NIT No.

(Bidder's Name & Address):.....

To

.....

.....

(Purchaser's Name & Address)

Dear Sir,

Following are the deviations as proposed by us relating to techno-commercial terms and conditions. We are also furnishing below the cost of withdrawal for the deviations proposed by us. We confirm that we shall withdraw the deviations proposed by us at the cost of withdrawal indicated in this attachment failing which our bid may be rejected and Bid Security forfeited.

Sl. No. Withdrawal	Clause No.	Deviation	Cost of
-----------------------	------------	-----------	---------

Date:..... (Signature).....

Place:..... Name).....

(Designation)

(Common Seal)

NOTE: Bidders may note that bids containing deviations without the cost of withdrawal price shall be considered as **unresponsive offer and will be out rightly rejected**. This schedule indicating the cost of withdrawal price for such deviations should be submitted along with the price bid only and will be taken into consideration for the purpose of bid evaluations.

SCHEDULE - II/D

GUARANTEED TECHNICAL PARTICULARS FOR TRANSFORMER LOSSES (SHALL BE FURNISHED IN THE PRICE BID)

Bidders shall furnish the following GTP of the Transformers in this Schedule.

(All losses to be indicated with IS/IEC tolerance, wherever applicable).

1. Iron losses at 50 CPS and at

- a) 90 percent rated voltage : KW
- b) 100 percent rated voltage : KW
- c) 110 percent rated voltage : KW
- d) Whether losses are FIRM :

2. Copper loss (at 75°C) KW at load:-

I) Between HV & L.V.

- a) 25% load :
- b) 50% load :
- c) 75% load :
- d) 110% load (based Sl.No.5 of this schedule) :

e) 100% Load

- i) At Tap No. 1(maximum) :
- ii) At Tap No. 5(principle) :
- iii) At Tap No. 17(minimum) :
- f) Whether losses are FIRM :

II) Between HV-TV

- i) At Tap No. 1 :
- ii) At Tap No. 5 :
- iii) At Tap No. 17 :

III) Between LV-TV :

3. Total losses (Copper loss + Iron loss)

I) Between HV-LV

- a) 25% load :
- b) 50% load :
- c) 75% load :
- d) 110% load :
- e) 100% load :

i) At Tap No. 1	:		
ii) At Tap No. 5	:		
iii) At Tap No. 17	:		
f) Whether the losses are FIRM	:		
4. Power for auxiliaries	:	KW	
5. Resistance voltage (at 75°C) at full load			
a) H.V.	:	%	
b) L.V.	:	%	
c) T.V.	:	%	
(All values shall be referred to rated MVA)			
6. Resistance of H.V. winding per phase (at 75°C)	:	Ohm	
7. Resistance of LV winding per phase (at 75°C)	:	Ohm	
8. Resistance of TV winding per phase (at 75°C)	:	Ohm	
9. Efficiency(75°C) at unity and 0.85 pf.	:	Unity P.F.	0.85
P.F.			
a) 100 percent load	:	%	%
b) 75 percent load	:	%	%
c) 50 percent load	:	%	%
d) 25 percent load	:	%	%

Date:..... (Signature).....

Place:..... Name).....

(Designation)

(Common Seal)

NOTE:-

1. Submission of price schedule and complete information called for in the ‘Schedules’ of this specification is the primary condition for consideration of the tender.
2. For the purpose of comparison of prices the purchaser will take into account the evaluated cost of losses of the transformer as mentioned below:
 - i) Rs 2,77,275.00 /- per KW of Iron (No load) loss.
 - ii) Rs. 1,32,495.00/- per KW of Copper (load) loss and auxiliary loss.

**BIHAR STATE POWER TRANSMISSION CO. LIMITED,
PATNA**

SECTION – III

SPECIFIC TECHNICAL REQUIREMENT FOR SUPPLY OF POWER TRANSFORMERS

S1.No.	Description	Page No.
3.01	Scope	
3.02	Climate and isoceraunic condition	
3.03	Type and rating	
3.04	Parallel Operation	
3.05	Auxiliary power supply	
3.06	Evaluation of losses	
3.07	Neutral C.T.	
3.08	Price Variation formula---- Deleted	
3.09	Requirement and desired delivery	
3.10	Earthquake & wind design load	
3.11	Annexure-I (Type and rating)	
3.12	Annexure II (Price Variation Clause) --- Deleted	
3.13	Annexure-I (Type and rating)	

SECTION - III

SPECIFIC TECHNICAL REQUIREMENT FOR SUPPLY OF POWER TRANSFORMERS.

SCOPE

This section of the specification covers the specific technical particulars climate and Isoeraunic conditions, system particulars suiting which power transformers shall be offered as per the general technical requirements given in the section –II of this specification.

The specific technical requirements and the schedule of Requirements are specified hereunder.

CLIMATE AND ISOCRERAUNIC CONDITION:

The climate and Iscreraunic conditions at site are given below:

- | | | | |
|--------|--|---|-------------------------|
| (i) | Maximum ambient temperature in shade | - | 50 ⁰ C |
| (ii) | Minimum ambient temperature in shade | - | 4 ⁰ C |
| (iii) | Maximum daily average ambient temperature | - | 35 ⁰ C |
| (iv) | Maximum yearly average ambient temperature | - | 30 ⁰ C |
| (v) | Maximum relative humidity | - | 100% |
| (vi) | Average number of thunder storm days | - | 80 P/U |
| (vii) | Average rainfall per annum | - | 125 cm. |
| (viii) | Maximum wind pressure | - | 150 Kg. /M ² |
| (ix) | Height above sea level | - | Not exceeding 1000 m |
| (x) | Earthquake acceleration | - | 0.05x2g. |

TYPE AND RATING:

The equipment offered shall be suitable for continuous operation of full rated capacity under the condition specified in Clause No. 3.2 above. The type and rating of the transformers proposed for procurement against the tender are specified in Annexure- I.

PARALLEL OPERATION

The transformer proposed for procurement against tender are also required to operate in parallel with similar transformer.

The percentage impedance for all transformers are given in Schedule M of Section IV.

AUXILIARY POWER SUPPLY:

The purchaser will make separate arrangements of providing low tension A.C and D.C. supply for auxiliary equipment and control use. All the auxiliary electrical equipment / Accessoriesshall be suitable for operation on the following supply system:-

- (i) For auxiliaries-
- (a) 240 Volts, single phase, 50 HZ, Neutral grounded A.C. supply system.
 - (b) 415 volts, three phase, 50HZ, Neutral grounded A.C supply.
- Tolerance
- (a) Frequency- between 90% and 105% of normal Frequency of 50 HZ.
 - (b) Voltage - from 110% to 85% of the normal voltage.
- (ii) For control, alarm and protective devices. - 250 V available from the station battery.

The D.C. supply is subjects to a variation of purpose of $\pm 10\%$.

DELETED

DELETED

NEUTRAL C.T.

The tender shall quote separately for one multi- Ratio Bushing/ turret mounted current transformer of suitable ratio of class PS as per IS- 2705 for providing one common neutral lead for the purpose of restricted earth fault protection.

REQUIREMENT AND DESIRED DELIVERY:

The quality proposed for procurement and desired delivery are the detailed in the schedule of requirement and desired delivery enclosed as Annexure - III of this specification.

The quantity mentioned in the schedule is tentative and are subject to increase or decrease at the time of finalization of tender and placement of order at the discretion of the purchaser.

EARTH QUAKE & WIND DESIGN LOAD:

The equipment offered shall be designed to withstand repeated earthquake acceleration of $0.05 \times 2 \text{ g}$ and wind load 150 Kg /M^2 in the projected area simultaneously without damage to component part and without impairment of operation.

ANNEXURE –I

TYPE AND RATINGS OF 80 MVA, 132/33 KV POWER TRANSFORMERS

1. Rated capacity (at full load) : 80 MVA(Bi-directional power flow) & 50°C max. ambient and losses shall be as per latest CEA guidelines
2. Reference standard: : IS:2026 (latest)
3. Voltage rating : HV winding-132 KV
LV rating-33 KV
4. Voltage ratio at no Load : 132KV / 33 KV
5. Impedance voltage at rated MVA base at 75°C
 - i) Tap No.5 (Normal) : 12.5 % with no negative tolerance
 - ii) Tap No. 1 (Maximum) :
 - iii) Tap No. 17(Minimum) :

The above transformers shall be designed on the basis of percentage impedance as indicated above. But percentage impedance at any tap position should match with the percentage impedance of transformer-s as indicated under Clause No. 8.000 of this specification.
6. High Voltage connection. : Star with neutral brought out through 36 KV bushing for solid ground
7. Low voltage connection. : star
8. Polarity & Vector Symbol. **Subtractive & YNyno**
9. System of earthing- HV : Neutral effectively earthed.
LV
10. No. of phases & windings. : 3-ph., 2-windings.
11. Frequency and operation : 50 Hz ± 3%
12. Type of cooling of full rated capacity. : OFAF
13. Rated 3 phase full load capacity at an ambient temperature of 50 degree : 80 MVA OFAF
64 MVA OFAN
48 MVA ONAN
14. Highest Voltage System
 - a) HV : 145 KV
 - b) LV : 36 KV
15. Temperature rise limit at full : 40°C for top oil by thermometer.
Load rated capacity over : 45°C for winding by resistance.
ambient of 50°C : 54 °C Maximum for winding
hot spot temperature rise over
ambient temperature of 50 °C (:
measured by fiber optic
temperature measurement
and otherwise)

16. Core Material CRGO Silicon Steel lamination
17. Working flux density in any part of the core at rated MVA, voltage and frequency. 1.6 Tesla. This has to be established by calculation and otherwise.
18. The over voltage which the transformer must withstand without injurious heating, combined voltage and frequency fluctuations
- iv) 15 % continuously
- v) 25% for 1 minute
- vi) 40 % for 5 seconds.
19. Type of construction of core Core type Oil immersed, Outdoor type, 2 winding with external heat exchanger.
20. Tap changer: High speed transition resistor, constant flux variation as per clause 3.2 of IS:2026 (Part-IV), suitable for bidirectional power flow. ON load tap for a voltage variation of - 15% to + 5 % (in steps of 1.25%) to be provided on H.V. side (Neutral end) of the winding suitable for bidirectional power flow. Total no. of position shall be 17(Seventeen). Design provision should be kept in such a way that the transformer will be capable of delivering full specified load with above variation of HV side for continuous operation required for system demand.—Should strictly conform to IEC:60214. Only design which have been type tested in accordance with these standards (IEC:214:1976) will be accepted. All the type test certificates as per the above standard shall be submitted alongwith the tender. Control- a) Local/Manual b) Remote & Electrical
21. Short circuit rating : Dead short circuit at the terminal of any of the winding for **5 (five)** seconds.
22. Separated source power : Neutral insulation graded 70KV frequency voltage for H.V. Neutral end
23. BIL of the windings :
- i) H.V. - 650 KV
- ii) L.V. - 170 KV
- iii) HV-n - 170 KV
24. Power frequency voltage of winding. :
- i) H.V. - 275 KV
- ii) L.V. - 70 KV
- iii) HV-n - 70 KV
25. BUSHINGS:
- a) Rating of Bushings:-

- i) H.V. side (Antifog type) : 145 KV, 1250 Amps.
- ii) L.V. side -do- : 52 KV, 2000 Amps.
- iii) H.V.- Neutral : 36 KV, 2000 Amps.
- b) Power frequency 1 min. dry & wet withstand voltage:–
 - i) H.V. side : 275KV.
 - ii) L.V. side : 105 KV.
 - iii) H.V. – Neutral : 70 KV.
- c) Impulse withstand voltage full wave:–
 - i) H.V. side : 650 KVP.
 - ii) L.V. side : 250KVP.
 - iii) H.V. – Neutral : 170 KVP
- d) Creepage Distance : 25mm/KV (minimum)
- e) Partial Discharge Level : 500 pico-coulomb
- f) Noise level : As per NEMA TR-1

Should conform to IEC 60137, phase winding above 33 Kv shall have fully rated porcelain condenser anti fog type bushing as per IEC 137. Bushing of 33 kv shall be oil filled communicating type.

26. Terminal Arrangement:-

- a) H.V. side: Outdoor bushings with expansion type terminal connector (Extruded type) for ACSR double Moose suitable to take both horizontal and vertical takeoff. Details to be finalized during engineering.
- b) L.V. side: Outdoor bushing with expansion type (Extruded type) terminal connector suitable for both horizontal and vertical take off for ACSR double moose. Details to be finalized during engineering
- c) H.V. Neutral: Bare outdoor bushing terminal suitable for termination of 50mm x 6mm G.I. Strip/flat through post Insulator of adequate rating.

- 27. Railgauge : 1676 mm on minor (shorter) axis
1676 mm & 2438 mm on major
- 28. Parallel operation : Ref. Cl. 8.000 of this Specification.
- 29. Utility : Step down transformer for supplying 33KV loads.
- 30. Transformer oil : **EHV grade oil as per Annexure –‘E’ of this specification.**
- 31. HV-N C.T. details :

	CoreI	CoreII
Ratio:	800-400-200/5	1200-600-300-150/5
Class:	PS	5P20

Burden: —10 VA—
 KPV: —1000-500-250V—
 Iexc: —125-250-500mA at V_k—
 Resistance of sec.wdg.: 2.0-1.0-0.5Ohm(max) at 75 deg.C.

The above rating is tentative. This shall be decided during approval of drawing for individual site/ GSS.

Bushing CT to be provided on each phase (HV, LV & neutral) for REF (Core-I) and metering (Core-II) its rating etc would be decided during design and engineering stage. Parameter for WTI CT for each winding shall be provided by the bidder. Accuracy class PS as per IS 2705(for relevant protection and duty) as per IEC 185.

- 32 RTCC Panel : The transformer shall be supplied with RTCC Panel as per specification.
- 33. Life of Transformer : 25 Years (min.)
- 34. EQUIPMENT COLOUR CODE :

The following code of practice shall be adopted for colour finish of the respective electrical equipment:-

Equipment	Colour	Finish
<u>Transformers</u>		
a) i) Installed outdoor (i.e. oil immersed transformers)	IS5 – 632 of IS-5 (Dark admiralty grey)	Mat
<u>Misc. Panel & JBs etc.</u>		
b) Exterior	IS5 – 631 of IS-5 (Light grey)	Semi gloss
c) Interior	White / Off-white	Semi gloss
35. Core to clamp/ bolt insulation, test voltage:	3.5KV D.C. for 1(one) min.	
36 Mounting of Cooling Equipment	: The transformer shall be compact as far as possible(due to space constraint of the existing S/S) and provision shall also be made to mount the cooling equipment (i.e. radiators, cooling fans and pumps sets) in either side of the transformer so that the same can be erected on either side of the transformer depending on the availabilityof space of existing Sub-Station of BPTCL.	

37. The noise level of transformer, when energized at normal voltage and frequency with fans & pumps running shall not exceed, when measured under standard conditions, the value specified in NEMA standard publication TR-1.

38. The transformer shall be designed with particular attention to the suppression of maximum Harmonic voltage, specially the third harmonic and fifth harmonic so as to minimize Interference with communication circuit.

39. Value of current density should not exceed 2.8Amp./mm² while working at any tap position.
40. Time in minutes for which the transformer can be run at full load without exceeding maximum permissible temperature as reference ambient temperature when supply to
- a. Fan is cut off -20 Minutes
 - b. Pump and Fan cutoff-10 Minutes
41. Min. Knee point voltage of core shall be 110% of rated. This to be verified drawing on load test. Increase of voltage by 10% for 110% rated voltage should not increase excitation current by more than 50%.
42. The core reactance of the winding shall not be less than 20%
43. HV insulation shall be graded and LV should fully insulated.
44. The current rating of terminal and connection arrangement shall be more than 1.5 times of current rating of transformer
45. Transformer terminal shall be silver plated copper.
46. Neutral terminal to be brought to ground level by brass tinned copper grounding has of approved size for routing to neutral CT.
47. Control cabinet: The standing floor mounted type made of 3mm thick steel sheet Hinged door stopping main board to cover sides. 15mm neoprene gasket, IP-55 as per IS:2147, 20% spare terminal blocks.
48. Each radiator bank to have 2 No. 100% oil immersed in line axial flow motor pump – one in service and one in standby. Centrifugal pump shall not be accepted.
49. One standby fan of at least 20% capacity shall be provided with each bank. The blades of cooling fan shall be of galvanised steel cast aluminium alloy. Thickness of galvanisation to be 55 microns or more.
50. Losses shall be as per follows:

No load Loss(kW)	Load Loss (kW)	I ² R Loss (kW)	(Stray + Eddy Loss) (kW)	Aux. loss
35	200	170	30	5

25. Maximum Permissible Losses of Transformers

80 MVA 50 MVA

31.5

MVA

i) Max. No Load Loss at rated voltage and frequency

kW

35 25 18

ii) Max. Load Loss at rated current and frequency and at 75°C at principal tap between HV & LV

kW **200 125 110**

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iii) Max. I²R Loss at rated current and frequency and at 75°C at principal tap between HV & LV

kW **170 105 93.5**

iv) Max. Auxiliary Loss at rated voltage and frequency

kW **5 3 2**

ANNEXURE- II (Applicable only if specifically mentioned in general terms and conditions of contract)

PRICE VARIATION CLAUSE FOR POWER TRANSFORMERS COMPLETE WITH ALL ACCESSORIES AND COMPONENTS

The price quoted/confirmed is based on the input cost of raw material/components and labour cost as per IEEMA circulars considering schedule opening of techno commercial bid as base date. In case of any variation in these prices and index numbers, the price payable shall be subjects to adjustment up or down in accordance with the following formula:-

$$P = \frac{P_o}{100} + 29 \frac{C}{C_o} + 27 \frac{ES}{ES_o} + 7 \frac{IS}{IS_o} + 5 \frac{IM}{IM_o} + 7 \frac{TB}{TB_o} + 15 \frac{W}{W_o}$$

Wherein,

P = Price payable as adjusted in a accordance with the above IEEMA formula.

P_o = Price quoted/confirmed on base date indicated above.

C_o = Average LME settlement price of copper wire bars. This price is as applicable for the month, **two** months prior to the date of tendering.

ES_o = C&F price of CRGO Electrical Steel Sheets. This price is as applicable on the 1st working day of the month **one** month prior to the date of tendering.

IS_o = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100). This index number is as applicable for the week ending 1st Saturday of the month, **three** months prior to the date of tendering.

IM_o = Price of Insulating Material. This price is as applicable on the 1st working day of the month, **one** month prior to the date of tendering.

TB_o = Price of Transformer Oil. This price is as applicable on the 1st working day of the month, **one** month prior to the date of tendering

W_o = All Indian average consumer price index number for industrial workers as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 2001 = 100). This index number is as applicable on the first working day of the month, **three** months prior to the date of tendering.

AND

C = Average LME settlement price of copper wire bars. This price is as applicable for the month, **two** months prior to the date of delivery.

ES = C&F price of CRGO Electrical Steel Sheets. This price is as applicable on the 1st working day of the month, **one** month prior to the date of delivery.

IS = Wholesale price index number for Iron & Steel (Base:1993-94=100). This index number is as applicable for the week ending 1st Saturday of the month, **three** months prior to the date of delivery.

IM = Price of Insulating Material. This price is as applicable on the 1st working day of the month, **one** month prior to the date of delivery.

TB = Price of Transformer Oil. This price is as applicable on the 1st working day of the month, **one** month prior to the date of delivery.

W = All Indian average consumer price index number for industrial workers as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 2001 = 100). This index number is as applicable on the first working day of the month, **three** months prior to the date of delivery.

The date of delivery shall be the date on which the transformer is notified as being ready for inspection/dispatch (in the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto) whichever shall be earlier.

Note:

- a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central state of local taxes, octroi etc. transformers manufactures import major raw materials like copper, CRGO Steel Sheets. TOBS and Insulating pressboards etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.
- b) All prices are as on first working day of the month.
- c) The details of prices are as under:
 - 1) The LME price of Copper Wire Bars (in Rs. /MT) is the LME average settlement price of Copper grade A for one month prior to the month of the circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
 - 2) The price of CRGO Electrical Steel sheets (in Rs. /MT) suitable for Transformers of ratings above 10 MVA or voltage above 33 KV is the averages C&F price in US & per MT converted into Indian Rupees with applicable exchange rate prevailing as on 1st working day of month, as quoted by primary producers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
 - 3) The wholesale price index number of Iron & Steel is as published by the Office of Economic Adviser, Ministry, Govt. of India, New Delhi with base 1993-94=100. This wholesale price index number is being published weekly on

provisional basis. However, the same gets finalized after eight weeks and is normally available after two months. Therefore, we are considering in our calculations the final index for the first Saturday of the month two months prior to the date of which the prices of other raw materials such as AI, IM are published for corresponding month.

- 4) The price of Insulating materials (in Rs./Kg) of pre-compressed pressboards of size 10 mm thick 3200mm x 4100mm is the average C&F price in free currency per MT converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month as quoted by primary suppliers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
- 5) The price of TOBS is C&F price (in Rs./K Ltr.) for N-60 grade Oil as published in ICIS-LOR button for the 1st week of the previous month. This price is normally published in USS per US Gallon which is converted in Rs./K Ltr. with applicable exchange rate prevailing on working day of the subsequent month. This price is the landed cost inclusive of applicable customs duty only but exclusive of countervailing duty.

Note: *If above formula has undergone any modification, the one applicable as on date of tendering shall be followed. The bidders are required to provide latest information in this regard, if any, with reference formula with their techno-commercial bid.*

ANNEXURE- III

REQUIREMENT AND DESIRED DELIVERY FOR 80 MVA 132/33 KV TRANSFORMERS.

A. REQUIREMENT:

<u>SL. No.</u>	<u>Description of equipment</u>	<u>Qty. in number (as per BOO)</u>
1.	Three phase, 50 Hz, ONAF/ONAN/OFAP, 80 MVA, 132/33 KV Powertransformer Having 12.5% impedance at normal tap as mentioned in Schedule M of Section IV , with OLTC, fittings, accessories, fire fighting & control equipment with first filling of oil plus 10% extra oil	
2.	Spare Parts	
(a)	H.V. side bushing with metal part.....	
(b)	L.V. side bushing with metal part.....	
(c)	H.V. neutral bushing with metal part and gasket for HV and LV...	
(d)	Buchholtz relay (with alarm/trip contacts).....	
(e)	Oil surge relay (with alarm/trip contacts).....	
(f)	Magnetic oil level gauge (with alarm / trip contact).....	
(g)	Current Transformer of WT	
(h)	Dial type oil temp. indicator with alarm/ trip contact	
(i)	Local and remote Winding temperature indicator with alarm/trip contacts	
(j)	Set of Gaskets (each type) for one transformer including bushings	

- (k) Pressure relief device
- (l) Oil flow indicator with alarm contacts
- (m) Cooler pump with motor
- (n) Cooler fan with motor
- (o) Tap position indicator(local and remote)
- (p) Expansion joint (complete replacement for transformer)
- (q) Set of starter, contacts, relays and switches
- (r) Fuses(control) – for complete replacement of transformer
- (s) Lamps(indicative)- complete replacement for transformer.

ANNEXURE- III

TECHNICAL SPECIFICATION FOR ON-LINE DISSOLVED GAS ANALYZER (DGA)

SYSTEM SCOPE:

This specification covers design, manufacture, assembly, testing at manufacturer's works before dispatch and supply (FOR Destination), installation, testing and commissioning at site of On-line Dissolved Gas Analyzer (DGA) system specified herein along with all their associated accessories required for satisfactory operation at various EHV substations of Utility.

The scope covers supply, installation & commissioning of On-line Dissolved Gas Analyzer system (Multigas) along with all required accessories suitable for dissolved gas analysis and moisture measurement of insulating mineral oil of transformer for carrying out interpretations as per IEC 60599- 2007-05 The equipment covered in this specification i.e. On-line Dissolved Gas Analyzer system shall meet the technical requirements listed below:

DETAILS OF TECHNICAL REQUIREMENT:

The equipment shall be used for On-line monitoring of fault gas Analysis in transformer oil. It shall measure all seven transformer fault indication gases i.e. Acetylene (C₂H₂), Methane (CH₄), Ethane (C₂H₆), Hydrogen(H₂), Ethylene (C₂H₄), Carbon Dioxide (CO₂), Carbon monoxide (CO) and moisture(H₂O) and the two atmospheric gases i.e. Oxygen(O₂)& Nitrogen(N₂). The Test kit shall meet the technical requirements listed below:

- The equipment shall be suitable for mounting/connecting on EHV transformers/ICTs up to & including 400 kV class without any outage. All the accessories/components required for mounting shall be in the scope of bidder.
- The equipment should be Gas Chromatography based equipment. The equipment shall be capable of extracting the seven Fault gases and the two Atmospheric gases and measuring them individually and reporting the concentrations from transformer oil.
- Moisture Measurement must be through a direct oil immersed Relative Saturation (RS) sensor.
- The monitor shall be equipped with an inbuilt oil circulation system with oil flow monitoring and alarm for stoppage of flow. Inlet and return oil lines must be of Stainless Steel.
- The monitor must have facility for collecting an oil sample for external oil tests, such as an external quick connect port plus sampling accessories.
- As the equipment is to be connected to transformer by the circulating oil lines, its performance should not be affected by vibrations, noise, transformers hum etc.
- The Equipment shall connect to the transformer main body in two locations. One connection is for supply of oil from the transformer, Second connection is for the return of the oil to the transformer.
- The equipment outfitted with the ability to communicate via modem or FO Port or RS232/RS485. The result shall be communicated to the local computers and as well as transmitted to remote location computers. Communication Protocols required: Modbus, DNP 3 Level 1, IEC 61850
- The equipment shall be able to measure gas concentration and when downloaded should immediately compare it with user selected alarm and caution level for immediate display. The sampling rate shall be selectable as for example 4 or 6 or 12 hrs etc.
- The equipment shall have inbuilt memory to store the results, for a minimum of 3 years
- The equipment should have Front panel display and controls. LCD display to provide up to date information at site level.
- The levels of dissolved gases shall be displayed in PPM. Also it shall be possible to set different alarms levels for dangerous levels immediately.

Detection of Gases:

The gases extracted shall be detected using a portable Gas Chromatograph (GC) with Thermal Conductivity Detector (TCD) or Flame Ionization Detector (FID) method. All the fault gases i.e. H₂, CH₄, C₂H₄, C₂H₆, C₂H₂, CO, CO₂ & two atmospheric gases i.e. O₂ and N₂ concentrations shall be individually measured and displayed. The measurement range, accuracy and repeatability for measurement of each gas shall be as under:

<i>Gasses</i>	<i>Minimum Detection Limit in ppm</i>	<i>Working Range</i>	<i>Accuracy (whichever is greater)</i>	<i>Repeatability</i>
Hydrogen (H ₂)	3	Up to 3000ppm	±3ppm or ±5%	<2%
Methane CH ₄ ,	5	Up to 7000ppm	±5ppm or ±5%	<1%
Ethane C ₂ H ₆	5	Up to 5000ppm	±5ppm or ±5%	<1%
Acetylene C ₂ H ₂	1	Up to 3000ppm	±1ppm or ±5%	<2%
Ethylene C ₂ H ₄	3	Up to 5000ppm	±3ppm or ±5%	<1%
Carbon Monoxide (CO)	5	Up to 10000ppm	±5ppm or ±5%	<2%
Carbon Dioxide (CO ₂)	5	Up to 30000ppm	±5ppm or ±5%	<1%
Oxygen (O ₂)	30	Up to 25000ppm	+30/-0ppm or ±5%	<1%
Nitrogen (N ₂)	5000	Up to 100000ppm	±5000ppm or ±10%	<20%

- Oil temperature Range : -10°C to + 120°C
- External Temperature Range : -50°C to + 55°C
- Humidity Range : 5 to 95 %
- Pressure withstand : The monitor must withstand pressure from Full Vacuum to 45 psi. Degree of protection of the enclosure : IP 66
- Enclosure material : Aluminium or Stainless Steel
- Operating Voltage : 230V AC ± 15%; 50 ± 5% Hz
- Communications : RS- 232/RS-485, Ethernet Fiber, USB
- Alarm : Sophisticated Programmable alarm system

Calibration:

Instrument must be provided with on-board automated Calibration verification facility to ensure performance to specifications throughout the service life of the equipment. The Monitor MUST be calibrated with a Reference Calibration Gas Standard that has a NIST Traceability Certificate.

Software:

The software should provide diagnostic report for individual pieces of equipment or for a full system, using the equipment tree. The necessary computer hardware & software shall be supplied for data Archival, Analysis and reporting. Equipment should be supplied with the user friendly PC software which provides fault indication and fault diagnostics including the following:

Fault indication:

- IEEE, IEC or user configurable levels of dissolved gases
- Rate of change trending

Fault Diagnosis:

- Key gases
- Ratios (Rogers, IEC. Etc)
- Duval’s Triangle

Apart from these tools there shall also be analysis Tool to identify the nature and severity of Transformer faults with greater specificity than other diagnostic tools based on ANN and Expert Analysis Tool. The Tool shall also be able to Harmonic Regression to remove harmonic components in the data, clearly revealing the underlying trends & Piecewise Linear Approximation to accurately assess gassing rate of change

Free hardware and software upgrade shall be supplied by the bidder till expiry of guarantee period.

Accessories:

The equipment shall be supplied with all necessary accessories required for carrying out on-line DGA of transformer oil complete in all respect as per the technical specification. Bidder has to furnish the list of accessories being supplied with the equipments. Free consumables till guarantee period shall be supplied by the bidder till expiry of guarantee period. The following shall be also form a part of supply.

1. Operation Manual
2. DGA Software Manual
3. PC Software manual
4. Compact disc giving operation procedures of Maintenance Manual & Troubleshooting instructions.

DEMONSTRATION:

The acceptance of the kit shall be subjected to the successful demonstration by supplier to the satisfaction of utility atprescribed site. The following functions must be demonstrated.

1. The Oil sampling.
2. The Gas extraction
3. The analysis of the gas sample and reporting the concentrations of the various gases.
4. The Calibration with reference to a NIST traceable gas standard.

The instrument not meeting the requirement will be summarily rejected.

ANNEXURE-IV

ON-LINE INSULATING OIL DRYING SYSTEM (CARTRIDGE TYPE) (IF SPECIFIED IN PS(PRICE SCHEDULE))

In addition to provision of air cell in conservators for sealing of the oil system against the atmosphere, each reactor shall be provided with an on line insulating oil drying system of adequate rating with proven field performance. This system shall be separately ground mounted and shall be housed in metallic (stainless steel) enclosure. The bidder shall submit the mounting arrangement. This on line insulating oil drying system shall be

- Designed for very slow removal of moisture that may enter the oil system or generated during cellulose decomposition. Oil flow to the equipment shall be controlled through pump of suitable capacity (at least 5 LPM).

- The equipment shall display the moisture content in oil (PPM) of the inlet and outlet oil from the drying system.

- In case, drying system is transported without oil, the same shall be suitable for withstanding vacuum to ensure that no air / contamination is trapped during commissioning.

In case, drying system is transported with oil, the oil shall conform to EMPLOYER specification for unused oil. Before installation at site, oil sample shall be tested to avoid contamination of main tank oil.

- Minimum capacity of moisture extraction shall be 10 Litres before replacement of cartridge. Calculation to prove the adequacy of sizing of the on line insulating oil-drying system along with make and model shall be submitted for approval of purchaser during detail engineering.

- The installation and commissioning at site shall be done under the supervision of OEM representative or OEM certified representative.

- The equipment shall be capable of transferring data to substation automation system conforming to IEC 61850 through FO port. Necessary interface arrangement shall be provided by the contractor for integration with automation system.

The equipment shall be supplied with Operation Manual (2 set for every unit), Software (if any), and Compact disc giving operation procedures of Maintenance Manual & Trouble shooting instructions.

GENERAL TECHNICAL REQUIREMENTS FOR ALL TRANSFORMERS:-

Duty Requirements.

The transformer will be used for bi-directional flow of rated power.

The transformer and all its accessories like C.Ts. shall be designed to withstand without injury, the thermal and mechanical effects of a short circuit at the terminals of any winding with full voltage, maintained on all other windings for duration of five seconds. The bidder is to furnish the supporting calculation towards above along with the bid offer. The short circuit level of the H.V. system to which the subject Transformer will be connected is 40KA(rms,3-phase fault) for 220 KV, 31.5KA(rms, 3-phase fault) for 132KV and 25KA for 33KV system.

The transformer shall be capable of being loaded in accordance with IS:6600 upto loads of 150 %. There shall be no limitation imposed by bushings, tap changer etc.

The transformer shall be capable of being operated without danger on any tapping at the ratedKVA with voltage variation of $\pm 10\%$ corresponding to the voltage of that tapping.

Radio interference and Noise level:

- (i) The transformers shall be designed with particular attention to suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuits.
- (ii) The noise level, when energized at normal voltage and frequency with fans and pumps running shall not exceed, when measured under standard conditions, the values, specified in NEMA, TR-1.

The transformer noise levels shall be measured as a routine test and in accordance with IEC-60551:1981.

Transformer shall be capable of operating under the natural cooled condition upto the specified load. The forced cooling equipment shall come into operation by preset contacts of winding temperature indicator and initially as ONAF upto specified load and then as OFAF. Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 150 degree centigrade. Also stopping of one or two cooling fans should not have any effect on the cooling system. Transformers fitted with two coolers each capable of dissipating 50 percent of the loss at continuous maximum rating shall be capable of operating for 20 minutes in the event of failure of the oil circulating pump or blowers, associated with one cooler, without the calculated winding hot spot temperature exceeding 115 degree centigrade at continuous maximum rating. The contractor shall submit supporting calculations for the above and the same shall be reviewed during design review.

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

Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation, which produces the following over fluxing condition:

- i) 125% for 1 minute The base voltage and frequency refer
140% for 5 seconds. to those mentioned in Clause 4.0 (3& 4).
- ii) Over fluxing withstand characteristics upto 170% shall be submitted along with the bid.

The tenderers shall recommend if any Surge Arresters and surge capacitors are required to be connected to tertiary terminals to protect the tertiary winding against transfer surges during fault and its transient conditions when the tertiary winding is unloaded. If so, full specifications of above equipments and the manner in which the same are required to be connected shall be given in the tender. In case, no surge protection devices are required, tenderer should comment, is solid earthing of one terminal of unloaded tertiary winding would be in order. The arrangement of earthing of terminals of unloaded tertiary winding is to be shown.

Auto/Power transformers shall be capable of withstanding the stresses that would develop because of inductive or capacitive loading on tertiary winding.

The transformer shall be free from any electrostatic charging tendency (ECT) under all operating conditions when all oil circulation systems are in operation. In general, oil flow speed shall not exceed 1.0 m/sec within winding in the oil flow system of the transformers. The manufacturer shall ensure that there is no electrostatic charging tendency in the design.

The transformers shall be capable of being continuously operated at the rated MVA without danger, at any tapping with voltage variation of -15% to +5% corresponding to the voltage of that tapping.

The transformers shall be capable of being over loaded in accordance with IEC-60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

Tank hotspot shall not exceed 130 Deg. Celsius. Maximum ambient temperature shall be considered as 50 Deg. C.

The transformer and all its accessories including bushing/ built in CTs etc. shall be designed to withstand without damage, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 2 secs. The short circuit level of the HV & IV System to which the transformers will be connected is as follows:

400kV system:	63kA for 1 sec (sym, rms, 3 phase fault)
220kV system:	40 kA for 1 sec (sym, rms, 3 phase fault)
132kV system:	31.5 kA for 1 sec (sym, rms, 3 phase fault)
33kV system:	25 kA for 3 sec (sym, rms, 3 phase fault)

However, for transformer design purpose, the through fault current shall be considered limited by the transformer self-impedance only (i.e. $Z_s = 0$).

Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1-phase through fault for transformer rated voltage applied to HV and / or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals as applicable. The tertiary terminals shall be considered not connected to system source. For short circuit on the tertiary terminals, the in-feed from both HV & IV system shall be limited by the transformer self-impedance only and the rated voltage of HV and IV terminals shall be considered. The maximum short circuit output current at the tertiary terminals shall be limited to a safe value to make the transformer short circuit proof.

The transformer shall be designed to withstand for short circuit duration of 2 seconds for Thermal stress and the same shall be verified during design review.

TRANSFORMER LOSSES:-

LOSSES OF TRANSFORMERS SHALL BE AS PER CEA GUIDELINES

In case of failure of the transformer, the supplier shall take back the faulty transformer from its plinth for replace the transformer with a new transformer and deliver, at their own cost, unload at the destination sub-station transformer plinth within three months period from the date of intimation of defects to the satisfaction of the owner, at free of cost. If the delivery after replacement will not be completed within three months, then the supplier shall pay penalty @ 0.5% of the contract price of said transformer for each calendar week of delay from the end of three months period from the date of intimation of defects. Also, the Purchaser reserves the right for forfeiture of the total Composite Bank Guarantee and

all the Securities, available with BSPTCL, in case the Supplier fails to pay the penalty by one month before the expiry of the guarantee period. Also, this will be taken as adverse in all future tenders.

CLEARANCE:-

The overall dimensions of the transformer shall allow for sufficient clearances for installation in a as per CBIP norms.

CONSTRUCTIONAL DETAILS:

The features and constructional details power transformer shall be in accordance with the requirements, stated hereunder:-

TANK AND TANK ACCESSORIES:

TANK:-

- (a) The transformer shall be enclosed in a suitably stiffened welded steel tank such that the transformer can be lifted and transported without permanent deformation or oil leakage. The construction shall employ weldable, low carbon, tested quality structural steel of an approved grade to BS:4360/ IS 2062. The transformer tank shall have rectangular shape. The minimum thickness of base and tank cover shall be 16mm. and that of sides is 10mm.
- (b) The tank of the transformer shall be complete with all accessories and shall be designed so as to allow complete transformer in the tank and filled with oil, to be lifted by crane or jacks, transported by road or rail without over-straining any joint and without causing subsequent leakage of oil.
- (c) All seams and those joints, not required to be opened at site shall be factory-welded and wherever possible they shall be double welded. Welding shall conform to BS-5135 / IS 9595. After completion of tank construction and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. Also radiographic tests shall be carried out on 5% of total weld length. The requirement of post-weld heat treatment for tank/stress relieving parts shall be based on recommendations of BS:5500, Table 4.4.3.1/ IS 10801.
- (d) All necessary precautions shall be taken to prevent ingress of moisture between flange plates, around gaskets and O-rings, at insulator/flange interfaces etc. due to high humidity.
- (e) Tank stiffeners shall be provided, if required, for general rigidity and these shall be designed to prevent retention of water.
- (f) The transformer shall be preferably of bowl type tank construction with the joint at as per detailed engineering above the bottom of the tank-In case the joint is welded, it shall be provided with flanges, suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise of the joint.
- (g) The main tank body excluding tap-changing compartments, radiators and coolers shall be capable of withstanding vacuums i.e. 100.64 KN/m² of gauge pressure, 760 mm of Hg.
- (h) The tank shall be designed to withstand:-

- (i) Mechanical shocks during transportation.
- (ii) Vacuum filling of oil.
- (iii) Continuous internal pressure of 35 KN/m² over normal hydrostatic pressure of oil.
- (iv) Short circuit forces.
- (I) Wherever possible, the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes shall have minimum inside diameter of 15 mm except for short branch pipes, which may be 6 mm minimum inside diameter.
- (j) All joints other than those, which may have to be broken, shall be welded, when required, they shall be double-welded. All bolted joints to the tank shall be fitted with suitable oil-tight gaskets, which shall give a satisfactory service under the operating conditions and guaranteed temperature-rise conditions. Special attention shall be given to the methods of making hot oil tight joints between the tank and the cover as also between the cover and the bushing and all other outlets to ensure that the joints can be remade satisfactorily at site and with ease with the help of semi-skilled labour. If gasket is compressible, metallic stops shall be provided to prevent over compression.
- (k) Adequate space shall be provided at the bottom of the tank for collection of sediments.
 - (l) The base of each tank shall be so designed that it shall be possible to move the complete unit by skidding in any direction without injury when using plates or rails.
 - (m) Tank shields shall be such that no magnetic fields shall exist outside the tank. They shall be of magnetically permeable material. If required, impermeable shields shall be provided at the coil ends. Tank shield shall not resonate when excited at the natural frequency of the equipment. Bidder may confirm use of tank shields in the schedule of additional information.
 - (n) Suitable guides shall be provided in the tank for positioning the core and coil assembly.
 - (o) The tank shall be designed in such a way that it can be mounted either on the plinth directly or on rollers, as per manufacturer's standard practice.
 - (p) When the transformers are provided with separately mounted radiators, flexible joints shall be provided in the main oil pipes, connecting the transformer tank to the radiator banks to reduce vibration and facilitate erection and dismantling.
 - (q) The transformer tank, fittings, radiators and all accessories shall be designed to withstand seismic acceleration, as specified.
 - (r) All connections, bolted to the tank shall be fitted with suitable gas oil resistant gaskets, made of such a material that no serious deterioration occurs under service conditions. Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be of closed design (without open ends) and shall be of one piece only. Rubber gaskets, used for flange connections of the various oil compartments shall be laid in grooves or in groove-equivalent retainers on both sides of the gaskets throughout their total length. Care shall be taken to secure uniformly distributed mechanical pressure over the gaskets and retainers throughout the total length. Gaskets of neoprene and/or any kind of impregnated/ bonded cork or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.

- (s) The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without damage when using plates or rails.

LIFTING AND HAULAGE FACILITIES:-

The transformer tank shall be provided with:-

- (a) Lifting lugs, suitable for the weight of the transformer, including core and windings, fittings and with the tank, filled with oil.
- (b) At least four jacking lugs and where required, with lugs suitably positioned for transport on a beam transporter.
- (c) Haulage lugs to enable a steel rope to be used safely for haulage in any direction.
- (d) The transformer must be provided with clearly marked locations for the fixing of jacks. The free space between the bottom of the tank and the fixing of jacks must be 300 - 350 mm.
- i. Lifting lugs: Four symmetrically placed lifting lugs shall be provided so that it will be possible to lift the complete transformer when filled with oil without structural damage to any part of the transformer. The factor of safety at any one point shall not be less than 2.
- ii. A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks. Each jacking pad shall be designed to support with an adequate factor of safety at least half of the total mass of the transformer filled with oil allowing in addition to maximum possible misalignment of the jacking force to the centre of the working surface.
- iii. Suitable provisions of pockets for OTI, WTI & RTDs including two spare pockets.

FOUNDATIONS, CABLE DUCTING ETC.:-

The Supplier will have to liaise with the Purchaser or its authorized contractor immediately after Design approval to finalize the detailed design of the following:-

- Transformer main tank foundations.
- Cooler bank foundations.
- Marshalling kiosk/control cabinet location and foundation.
- Cable ducting requirements.
- Adequate bunding design for the complete containment of all oil spills.
- Any other civil/electrical requirements for the installation of the transformer.

TANK COVER:

The tank cover shall be of adequate strength, shall not distort when lifted and shall be provided with suitable flanges having sufficient and properly spaced bolts. At least two adequately sized inspection openings, one at each end of the tank shall be provided for easy access to the internal connections of bushings, winding connections and earthing links. The inspection covers shall not weigh more than 25 Kg. The inspection cover shall be provided with lifting handles. The internal surface of the top cover shall be shaped to ensure efficient collection and direction of free gas to the Buchholz relay.

- (b) The tank and cover shall be designed in such a manner so as to leave no external pockets in which water can lodge, no internal pockets in which oil can remain when draining the tank or in which air can be trapped when filling the tank, and to provide easy access to all external surfaces for painting. The design of the tank cover should not present a safety hazard to personnel working on top of the unit.
- (c) It must be possible to remove any bushing without removing the tank cover.

- (d) One pocket shall be provided for stem type thermometer in addition to those for the Bulbs of the oil temperature and winding temperature indicators. These pockets shall be located in the position of the maximum oil temperature and it must be possible to remove any bulb without lowering the oil level in the tank. Captive screwed caps shall be provided to prevent the ingress of water to the thermometer pockets when they are not in use.
- (e) Bushings, turrets, covers of inspection opening, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.
 - To allow for the effect of possible induced and capacitive surge current flow, the tank cover and bushing turret shall be fixed to the transformer in such a way that good electrical contact is maintained around the perimeter of the tank and turrets.
- (f) All bolted connections shall be fitted with weather proof, hot oil resistant gasket in between for complete oil tightness. If gasket is compressible, metallic stops shall be provided to prevent over-compression.
 - (g) The top part of the tank cover shall be sloped to prevent retention of rain water and shall not distort when lifted.
 - (h) The tank cover and all covers for mounting, cleaning, man-holes, hand holes and inspection openings on tank etc. shall be earthed by suitable grounding conductors of the flexible type, having a cross-section of minimum 95 mm². Appropriate earthing studs with bolts and washers, made of stainless steel shall be provided.

AXLES AND WHEELS:

- (a) The transformer shall be designed with flanged bi-directional wheels and axles of a suitable size to carry the full weight of the transformer, oil and accessories. These shall be so designed as not to deflect excessively to interfere with the movement of the transformer. Wheels, axles and bearings shall be fully corrosion - resistant and complete with fittings to facilitate lubrication.
- (b) Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of the transformer.
- (c) The wheels are required to swivel and they shall be arranged so that they can be turned through an angle of 90 degrees when the tank is jacked up to clear of rails. Means shall be provided for locking the swivel movements in positions parallel to and at right angles to the longitudinal axis of the tank.
- (d) The rail track gauge shall be 5'6" (1676 mm) along longer axis as well as along shorter axis.
- (e) Foundation layout details will be furnished by the supplier during detailed Engineering.

5.4.1.6.

ANTI-EARTHQUAKE CLAMPING DEVICE:-

To prevent transformer movement during earthquake, clamping device shall be provided for fixing the transformer to the foundation. The Bidder shall supply necessary bolts for embedding in the concrete foundation. The arrangements shall be such that the transformer can be fixed to or unfastened from these bolts, as desired. The fixing of the transformer to the foundation shall be designed to withstand seismic events to the extent that a static co-efficient of 0.3 g. applied in the direction of least resistance to that loading, will not cause the transformer or clamping devices as well as bolts to be over-stressed. Special steps must be taken to prevent mal-operation of Buchholz relay in such conditions.

The details of the device used and its adequacy, suitability and design calculations to withstand seismic load shall be brought out in the additional information schedule.

CONSERVATOR VESSELS, OIL GAUGES AND BREATHERS:-

- (a) A conservator, complete with sump and drain valve shall be provided in such a position, so as not to obstruct the electrical connections to the transformer having a capacity between highest and lowest visible levels of 7½% of the total cold oil volume in the Transformer and the cooling equipment from minimum ambient temperature to 100 Degree C. The minimum indicated oil level shall be with the feed pipe from the main tank covered with not less than 15 mm depth of oil and the indicated range of oil level shall be minimum to maximum.
- (b) If the sump is formed by extending the feeding pipe inside the conservator vessel, this extension shall be for at least 25 mm. The conservator shall be designed so that it can be completely drained by means of the drain valve provided, when mounted as in service.
- (c) The conservator tank shall be bolted on to its support of mounting to allow for its removal for cleaning/repair. It shall be bolted onto the main tank to allow for its removal for cleaning/repair.
- (d) The conservator for main tank shall be fitted with a magnetic oil level gauge with low oil level, electrically insulated alarm contacts. The indicator shall have the minimum and maximum levels, indicated along with the normal level at an oil temperature of 25° C. The temperature markings shall preferably be integral with the level-indicating device. The gauge should be readable from the transformer base level. Sight glasses of oil level indicators shall be of laminated security glass. Sight glasses of transparent plastics will not be accepted.
- (e) Taps or valves shall not be fitted to oil gauge.
- (f) The oil connection from the transformer tank to the conservator vessel shall be arranged at a rising angle of 3 to 9 degrees to the horizontal upto the Buchholz Relay and shall consist of 80 mm inside diameter pipes as per IS:3639.
- (g) A valve shall be provided at the conservator to cut off the oil supply to the transformer, after providing a straight run of pipe for at least a length of five times the internal diameter of the pipe on the tank side of the gas and oil-actuated relay and at least three times the internal diameter of the pipe on the conservator side of the gas and oil-actuated relay.
- (h) The conservator tank shall be equipped with a nitrile rubber diaphragm or bag filled with dry air, which isolates the transformer oil space from the ambient air. The bag shall work satisfactorily and without damage at all anticipated oil temperatures.
- (i) Provision shall be made for monitoring the integrity of rubber bag and giving an electrical alarm when the bag is damaged.
- (j) The space inside the bag is to be connected to ambient air through a removable silica-gel type breather with oil trap and dust filter and mounted about 1400 mm above ground. No valve is to be placed between this breather and the conservator. The moisture absorption, indicated by change in colour of the tinted crystals inside the breather can be easily observed from distance. Minimum quantity of silica gel will be 1 Kg. for every 3500 ltrs. of oil in the tank. The containers for the dehydrating agent shall be of transparent plastics. The quality of plastic material shall be got approved from the purchaser.

- (k) The conservator for the OLTC/diverter switch can be either an integral, but completely separated part of the main conservator or a separate oil tank. It shall have a prismatic or magnetic oil level gauge.

VALVES AND LOCATION:-

General:-

- (a) Blank flanges, plates or captive screw caps shall be fitted to all valves and pipe ends, not normally connected in service.
 - (b) The omission of any, or the provision of alternative arrangements to the listed requirements, which alter the functional nature of the valve system, will not be accepted.
 - (c) All valves upto and including 100 mm shall be of Gun Metal. Larger valves may be of Gun Metal or may have cast iron bodies with Gun Metal fittings. They shall be of the full way type with internal screw and shall be opened by turning counter clockwise when facing the hand wheel.
 - (d) Means shall be provided for padlocking the valves in the open and closed positions. Provision is not required for locking individual radiator valves.
 - (e) Every valve shall be provided with an indicator to show clearly the position of the valve.
 - (f) All valves shall be provided with flanges having machined faces.
 - (g) All valves shall be suitable for continuous operation with transformer oil at 100°C.
 - (h) Suitable valves shall be provided to take sample of oil from OLTC chamber during Operation of the transformer.
 - (i) Oil sampling valves shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.
 - (j) Each transformer shall be fitted with the valves, identified in the following Sub-sections as a minimum requirement.

MAIN TANK:-

- (a) One 50 mm (NW 50) bore filter valve located near to the top of the tank.
- (b) One 50 mm (NW 50) bore filter valve located near to the bottom of the tank and diagonally opposite to the filter valve required against (a). Where design permits, this valve may be combined with item (c).
- (c) One 50 mm (NW 50) drain valve with such arrangements as may be necessary inside the tank to ensure that the tank can be completely drained of oil as far as practicable. This valve shall also be provided with an approved oil sampling device.
- (d) Two 25 mm (NW 25) oil valves for taking oil samples from the top and bottom of the tank. The top-oil sampling point shall be brought down to be accessible from ground level.
- (e) A flanged 50 mm (NW 50) valve suitably positioned near the top of the main tank for the connection by the Purchaser of a 'Hydran' monitor.
- (f) A 100 mm (NW 100) for the vacuum control switch tank will be provided on the tank cover.

CONSERVATOR:-

- (a) One valve between the conservator and gas actuated relay for the main tank and, where appropriate, for the tap change diverter switch tank.
- (b) One drain valve for oil conservator tank so arranged that the tank can be completely drained of all oil. It shall also be fitted with an oil-filling hole with cap.

TAP CHANGER/DIVERTER SWITCH:-

50 mm filter and 50 mm (NW 50) drain valve where selector switches are contained in a separate tank.

RADIATORS AND COOLER BANKS:-

Valves of adequate size as per 'CBIP Manual on Transformers (Publication No. 275)' at each point of connection to the tank shall be provided.

Air release plug(s) of adequate size shall be provided.

JOINTS AND GASKETS:-

- (a) All joint faces shall be arranged to prevent the ingress of water or leakage of oil with a minimum of gasket surface exposed to the action of oil or air.
- (b) Nitrile base cork or equivalent shall be used for gaskets. Oil resistant synthetic rubber gaskets are not permissible except where the synthetic rubber is used as a bonding medium for cork or similar material or where metal inserts are provided to limit compression.
- (c) Gaskets shall be consistent with the provision of a good seal and full details of all gaskets sealing arrangement shall be shown on the drawings.

PRESSURE RELIEF DEVICE:-

- (a) An approved pressure relief device of sufficient size shall be provided for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. It shall positively operate, at a pressure of 7+/- 1PSi (48+/- 6.8KN/Sq.mm) and automatically reset when pressure falls below this value. There will be no leakage of oil after resetting of PRD. Means shall be provided to prevent the ingress of rain or dust. Pressure relief devices of the type mounted below normal oil level shall be of the resetting type once the dangerous pressure has been reduced to prevent unnecessary release of oil.
- (b) Contacts shall be provided for alarm and trip and initiation on operation of the device. Baffles shall be provided when necessary to safely control the direction in which oil or gas is ejected.
- (c) Unless otherwise approved, the relief device shall be mounted on the main tank and if on the cover, shall be fitted with a skirt projecting 25 mm. inside the tank to prevent gas accumulation.
- (d) One of the following methods shall be used for relieving or equalizing the pressures in the pressure relief device.
 - (i) An equalizer pipe connecting the pressure relief device to the conservator
 - (ii) The fitting of silicagel breather to the pressure relief device, the breather being mounted in suitable position for access at ground level.
- (e) Loss of oil on operation of the relief device shall be contained within the transformer oil retaining area.
- (f) The bidders shall furnish constructional, design details of pressure relief device(s) and calculations along with the bids to prove that the size and setting of pressure relief device(s) is adequate, considering the rating of the transformer, the quantity of oil in the Transformer and the insulating oil will not catch fire in case of any short/ground fault inside the transformer.

EARTHING TERMINALS:

Two or more (as required) substantial steel flag type terminals (each having two tapped holes with M16 bolts, plain and spring washers), capable of carrying for 5

seconds the full lower voltage short circuit current of the transformer and suitable for connection to 50 x 8 mm. Galvanised steel flat shall be located one on either side and near to the bottom of the transformer to facilitate connection to the local earthing system. The supplier shall provide earthing strips up to the ground level. Also each radiator, marshalling Kiosk, OLTC etc. shall be suitably earthed to the transformer tank or else have earthing terminals as appropriate.

Two earthing terminals suitable for connection to 75 x 12 mm galvanized steel flat shall also be provided on each cooler, individual/common marshalling box and any other equipment mounted separately. For the tank-mounted equipment like online drying/ Online DGA/ Optical Sensor Box etc. double earthing shall be provided through the tank for which provision shall be made through tank and connected through two flexible insulated copper links.

Equipotential flexible copper link of suitable size at least 4 Nos. for Tank mounted turret with tank and tank with cover and or Bell shall be provided. For other components like - pipes, conservator support etc. connected to tank shall also be provided with equipotential flexible copper link.

Each transformer unit should have provision for earthing and connected to grounding mat when not in service. For this purpose, neutral shall have provision for connection to ground by a brass/tinned copper grounding bar supported from the tank by using porcelain insulator. The end of the tinned/brass copper bar shall be brought to the bottom of the tank at a convenient point for making bolted connection to 75 X 12 mm GS flat connected to station grounding mat. The other end of the tinned/brass copper bar shall be connected to the neutral bushing through flexible conductor/jumper.

HV & IV/LV Terminals shall also be earthed through neutral by flexible copper connection. Contractor shall provide suitable arrangement for the above.

CORROSION PROTECTION:

General:

-
- (a) Bidders shall state clearly the corrosion protection, applied to aluminum and aluminum-alloy parts.
- (b) Bidders shall draw attention to all exposed points in their equipment at which aluminum or aluminum- alloy parts are in contact with or in close proximity to other metals and shall state clearly the protection employed at each point to exclude air and moisture.
- (c) A full description of the corrosion prevention system, proposed by the Bidder shall be given and this is subject to acceptance by the purchaser. This description shall include details of surface preparation, rust inhibition, and paint thickness, treatment of fasteners and painting of surfaces in contact with oil.

The minimum standards acceptable to the purchaser are:-

- (a) Hot Rolled Steel:
 - (i) Grit blasting to grade sa 2.5 of ISO 8501-1.
 - (ii) Epoxy-base zinc primer. Coating thickness 25 micrometer.
 - (iii) Zinc spraying of tank bottom. Thickness 100 micrometer.
 - (iv) Epoxy-based micaceous iron-oxide paint. Coating thickness 40 micrometer.

- (v) Alkyd or phenolic-based micaceous iron-oxide paint. Coating thickness-40 micrometer.
- (b) Radiators and Fasteners larger than 12 mm:-
 - (i) Hot dip galvanized to IS:2633.
 - (ii) Cleaning and surface preparation followed by paint treatment as specified above.
- (c) Smaller fasteners, cable clips:-

Use of non-ferrous material, stainless steel or appropriate plated components.

RATING, DIAGRAM AND VALVE PLATES:-

The following plates or an approved combined plate shall be fixed to each transformer Tank at an average height of 1500 mm above the ground level:-

- (a) A rating plate bearing the data, specified in IEC 76 Part - I. This plate shall also include:-
 - (i) The short circuit current rating.
 - (ii) Time factor for each winding measured.
 - (iii) Measured no load current and no load losses at rated voltage and rated frequency.
 - (iv) Measured load losses at 75° C (Normal tap only).
 - (v) D.C. resistance of each winding at 75° C.
- (b) A diagram plate showing in an approved manner, the internal connections and the voltage vector relationship of the several windings, in accordance with IEC 76 Part-I with the transformer voltage ratio for each tap and, in addition, a plan view of the transformer giving the correct physical relationship of the terminals.
- (c) A plate showing the location and function of all valves and air-release cocks or plugs. This plate shall also if necessary warn operators to refer to the Maintenance Instructions before applying vacuum.
- (d) Current transformers Rating Plate.
- (e) Diagram plate, indicating the oil levels in the conservators dependent on the oil temperature.
- (f) Loading plan plate, showing transport dimensions and masses. This plate shall also warn the erection staff not to remove any cover, before filling the tank with oil to such a level where the windings are not exposed to the atmosphere. This shall be fixed directly on to the transformer tank and shall not be removed for transport.
- (g) Identification plates, alpha-numerical number in an approved manner, for all fans, marshalling cabinets, breathers, valves, cocks, accessories etc. (minimum size: 110mm x 50mm) rigidly fastened by rivets on corrosion proof base plates. In addition, the function (description) of the related devices shall be clearly indicated on these plates. The alphanumerical numbers on the identification plates shall be of such a size as to be clearly legible from the floor level.
- (h) Plates, showing all control, measuring and monitoring circuits and terminal blocks. These plates shall be rigidly fixed at the inner side of the hinged door of the concerned marshalling kiosk.
- (i) Plates, showing the control circuit/ block diagram of the OLTC. These plates shall be rigidly fixed at the inner side of the hinged door of the motor drive cubicle.
- (j) Out door arranged plates are to be of polished stainless steel of top quality only (back ground clear, engraving black, depth of engraving 0.5mm) stainless steel,

capable of withstanding the rigours of continuous outdoor service at site. Plates, arranged inside control and marshalling cubicles may be of material in accordance with manufacturer's standard, e.g. glass -fibre reinforced synthetic resin (subject for approval). All plates other than those located on tank cover shall be easily and clearly legible from ground level.

CORE:-

- (a) The core shall be constructed from high grade non-ageing cold rolled super grain oriented silicon steel laminations, known as HIB or better steel as trade name having high permeability and low hysteresis loss. B-H and specific loss curve shall be furnished in support of these materials. Laminations of one particular thickness i.e. 0.23mm to 0.27mm. or better (quoted grade and type) shall be used. Laminations of different grade(s) and different thickness(s) are not allowed to be used in any manner or under any circumstance.
- (b) After being sheared, the lamination shall be treated to remove all burrs and shall be reannealed to remove all residual stress. The insulation of the lamination, which is to be stated in the tender, shall be inert to the action of the hot transformer oil and pressure.
- (c) The design of the magnetic circuit shall be such as to achieve minimum possible active and reactive core losses during the entire life of the transformer.
- (d) The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations, which may cause local heating. The joints of limbs and yokes shall be designed and constructed to keep the no-load losses and the hot spot temperature in the magnetic core as well as the noise level as low as possible.
- (e) The core and winding shall be capable of withstanding the shock during transport, installation, service and adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions and reduce vibrations to a minimum for all operating conditions. Care shall also be taken to secure uniformly distributed mechanical pressure over all the laminations to prevent setting of the core and to limit noise and vibration to a minimum under service conditions.
- (f) The Transformer shall be of **BOLTLESS** core design. The Bidders will furnish documentary evidence with proof of their experience and performance in such type of design.
- (g) All steel sections, used for supporting the core shall be thoroughly sandblasted after cutting, drilling and welding. Any non-magnetic or high resistance alloy shall be of established quality.
- (h) When bell type construction is offered, suitable projecting guides shall be provided on core assembly to facilitate removal of tank. The supporting framework of core shall be so designed so as to avoid presence of pockets, which would prevent complete emptying of the tank through drain valve or cause trapping of air during oil filling.
 - (i) The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.
 - (j) The core and coil shall be so fixed in the tank that shifting will not occur when the Transformer is moved or during a short circuit.
 - (k) Oil ducts shall be provided where necessary to ensure adequate cooling. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts. Where the magnetic circuit is divided into pockets by cooling ducts parallel to the planes of laminations or by insulating material above 0.25 mm thick, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between pockets.
 - (l) The temperature gradient between the core and surrounding oil shall be maintained less than 20°C. The manufacturer shall demonstrate this either through a test (procedure to be mutually agreed) OR by a calculation.

- (m) The transformer shall be designed in such a way that the maximum flux density in any part of the core and yoke at rated M.V.A, rated frequency and rated voltage shall not exceed 1.5 Tesla. The tenderer shall establish this by calculation as per given format.
- (n) **Minimum knee point voltage is 110% of rated voltage. Accordingly, the operating flux density for design should be carefully chosen within the stipulated value to achieve the above minimum knee point voltage. The tenderer shall quote the practical achievable no load current at different percentages of rated voltage as per Guaranteed Technical Particulars along with a linear graph confirming the above said knee point voltage which will be verified during no load test method that 10% increase in voltage from 110% rated voltage causes the excitation current to increase not by more than 50%.**
- (o) The tenderer will offer the core for inspection and approval by the Purchaser during manufacturing stage. Tenderer's notice for this purpose shall be accompanied with the following documents towards use of prime core.
 - (i) Invoice of the supplier.
 - (ii) Mill's test certificates.
 - (iii) Packing list.
 - (iv) Bill of lading.
 - (v) Bill of entry certificates by customs.
- (p) **Core material shall be directly procured either from the manufacturer or through their accredited marketing organizations of repute and not through any agent.**
- (q) **The bidder should preferably have in-house core-cutting facility for proper monitoring and control on quality and also to avoid any possibility of mixing of prime material with defective/ second grade material. However, the core-cutting operation may be witnessed by BSPTCL's representatives at the works of the manufacturer and specific loss, other tests will be conducted on samples of core materials, selected at random by BSPTCL's representative.**

The following procedure is to be adopted for those manufacturers who have no in-house Core-cutting facility:

- (1) In the offer, against tender for transformers, the bidder should mention names of at least three manufacturers of Transformer core material who have at least 5 (five) years experience in manufacturing of Transformer grade core. The Transformer manufacturer (TM) can purchase the core from such manufacturer(s) for which approval will be accorded by BSPTCL.
- (2) The bidder should specify the grade, thickness of core material in the offer along with submission of all graphs/ documents, relating to the grade of core material, offered by them.
- (3) The documents, as mentioned against Sl. '(o)' should be submitted to BSPTCL, once the core materials are landed in any of the Indian ports and same should be offered to BSPTCL for inspection. The representative, deputed by BSPTCL for such inspection will record the following informations:-
 - a) The documents, as mentioned against Sl. '(o)' should be submitted to BSPTCL, once the core materials are landed in any of the Indian ports and same should be offered to BSPTCL for inspection. The representative, deputed by BSPTCL for such inspection will record the following informations:-
 - b) Purchase order No. & Date.
 - c) No. of packed coils with package Nos.
 - d) Gross weight.
 - e) Net weight

- f) Port of loading.
 - g) Port of discharge.
 - h) Name of the ocean vessel.
 - i) Grade and thickness of core material.
 - j) Any other information, as mentioned on the body of packed coils.
- (4) The bidder in its offer will mention the names of at least three Sub-vendors, to whom they intend to assign their core cutting. Such sub-vendors should have been approved by other Electricity Boards/ Electrical utilities and are accredited by some International recognised certification body like ISO:9000 etc., to ensure that a minimum quality parameters and tolerances are maintained. The experience, the details of core-cutting facilities, finishing and testing facilities etc., as available with such sub-vendors should be clearly outlined in the bid.
- (5) On award of contract, the TM is to assign the core-cutting to such sub-vendor(s) for which approval is to be given by BSPTCL
- (6) After the packed core coils are received by the BSPTCL's approved sub-vendors, the TM is to offer the same to BSPTCL for deputing representative(s) to first note down the details as per Sl (3) above and witness the cutting of cores and relevant tests on core samples.
- (7) The TM will offer the core materials for inspection during assembly stage and witnessing the stage inspection and relevant tests.
- (r) Further, the Bidder is required to furnish the copies of import documents (as mentioned at Sl. 'o' above) along with the tender offer in support of their direct import of core materials in the recent past.
- Tenderer shall furnish along with the bid the calculation towards Air-core reactance of H.V. winding and maximum peak value of magnetizing in-rush current and shall justify that the transformer will not trip due to this during initial charging and subsequent chargings**
- (s) The temperature of any part of the core or its support structure in contact with oil shall not exceed 120 deg C under normal operating condition and 130 deg C under 10% over voltage and maximum ambient air temperature conditions of 50 deg C. Adequate temperature margin shall be provided to maintain the long life expectancy for this material.

5.4.8.1 **EARTHING OF CORE CLAMPING STRUCTURE:**

The top main core clamping structure shall be connected to the tank body by a copper strip. The bottom clamping structure shall be earthed by one or more of the following methods:-

- (a) By connection through vertical tie-rods to the top structure.
- (b) By direct-metal-to metal contact with the tank base maintained by the weight of the core and windings.
- (c) By a connection to the top structure on the same side of the core as the main earth connection to the tank.

5.4.8.2. **EARTHING OF MAGNETIC CIRCUITS:**

- (a) The magnetic circuit shall be earthed to clamping structure at one point only through a removable link, placed in an accessible position just beneath an inspection opening in the tank cover and which, by disconnection, will enable the insulation between the core and clamping plates etc. to be tested at voltages upto 2.0KV(rms). The removable link shall have adequate section to carry ground fault current.
- (b) When magnetic circuits are subdivided into separate isolated sections by ducts perpendiculars to the plane laminations, all such sections shall be earthed.

5.4.8.3 **SIZE OF EARTHING CONNECTIONS:-**

To be proposed by the manufacturer for the Purchaser's approval

WINDINGS:-

- (a) The supplier shall ensure that the windings of all EHV class transformers are made in dust proof, conditioned atmosphere. **He shall furnish the facilities, available in this regard at his works along with the bid.**
- (b) The windings for system rated voltages of 220 KV and 132 KV shall have graded insulation, as defined in IEC-76 and IS-2026. The winding for 33 KV shall be fully insulated.
- (c) All neutral points shall be insulated to withstand the applied test voltage as per above standards.
- (d) The neutral ends of star connected three phase windings shall be connected at points, which are accessible from manholes in the cover and brought out via one bushing.
- (e) The conductors for the windings and connecting leads shall be of electrolytic grade copper, free from scales and burrs and shall have properly rounded corners to reduce electrostatic flux concentration.
- (f) The **CURRENT DENSITY, ADOPTED FOR ALL THE WINDINGS SHALL NOT EXCEED 2.8 AMPERE/SQ.MM.** The total net cross-sectional area of the strip conductors for calculating the current density for each winding shall be obtained after deducting the copper area, lost due to rounding up of the sharp edges of the rectangular conductors.
- (g) The copper conductors, used in the coil structure shall be best suitable to the requirements and all permanent current carrying joints of the windings and the leads shall be welded or braced.
- (h) The coils shall be supported between adjacent sections by insulating spacers and the barriers, bracings and other insulation, which shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings. The stacks of windings shall receive adequate shrinkage treatment before final assembly. Adjustable devices shall be provided for taking up any possible shrinkage of coils in services.
- (i) The transformer shall be designed to withstand impulse and power frequency test voltages as specified in IEC 76 and IS:2026.
- (j) The windings shall be capable of withstanding axial and radial forces during fault conditions as per clause No.5.1.2. of this specification. **The detailed calculation towards the above should be furnished along with the GTP & drawings.**
- (k) The short circuit temperature rise should not exceed the limits, fixed as per IS:2026. **The calculation towards the above for 220 KV, 132 KV and 33 KV windings shall be furnished along with the GTP & drawings.**
- (l) The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse or be catalytic and chemically active in the hot transformer oil during service. The dielectric strength of winding insulation shall conform to the values, given in IS:2026, as amended up to date.
- (m) The coil clamping arrangement and the finished dimensions of any oil duct shall be such as will not impede the free circulation of oil through the ducts.
- (n) No strip conductor wound on edge shall have a width exceeding six times its thickness.
- (o) The conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along the windings.
- (p) The windings and leads of all transformers shall be able to withstand the shocks, which may occur through rough handling and vibration during transport, switching and other transient service conditions including external short circuit. Adequate barriers shall be provided between windings and core and between windings. All leads or bars from the windings to the terminal boxes and bushings shall be rigidly supported. Stresses on coils and connections must be avoided.
- (q) The windings shall be located in a manner, which will ensure that they remain electromagnetically balanced and their magnetic centres remain co-incident under all conditions of operations.
- (r) Tappings shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratios.

- (s) The coils should be made up, shaped and braced to provide for expansion and contraction due to temperature changes.
- (t) Coil clamping rings, if provided, shall be of steel or of suitable insulating material.
- (u) All threaded connections shall be provided with locking facilities. All leads from the winding to the terminal board and bushing shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used, where practicable.
- (v) The assembled core and windings shall be vacuum dried and suitably impregnated before removal from the treating tank.
- (w) 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 the transformer as the main earth connection. However, same shall be proposed by the manufacturer for the Purchaser's approval.
- (x) Washers in contact with non-ferrous parts, which carry current, shall be of phosphorous bronze.
- (y) ~~The tertiary winding shall be suitable for connection of reactors or capacitors, which would be subjected to frequent switching. All the three windings shall be capable of withstanding stresses that may be caused by such switching. The Bidder shall furnish the details to prove his claim.~~
- (z) ~~The rating of the tertiary shall be one third of the total rating of the transformer. The tertiary winding shall be suitable for delivering its full rated power at any cooling of the Auto Transformer. Sufficient number of radial ducts shall be provided on tertiary winding for effective cooling. The tertiary winding shall withstand short circuit faults of the transformer upto the prescribed fault levels on HV & IV sides. The short circuit MVA capacity of the tertiary winding shall be 25 % extra over the calculated and designed short circuit MVA. **Detailed short circuit calculations of the transformer shall be furnished along with the offer.**~~
- ~~(aa) The tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals.~~
- ~~(bb) The current density of the conductor used for tertiary winding shall not exceed the current density, specified for the main winding's conductor.~~
- (cc) The design of the transformer shall ensure that the amplitude of surges, transferred from the HV or IV windings to the LV windings is effectively controlled well below the maximum limit, admissible with the BIL of the LV winding, which should be supported with calculations. The said stipulated limit shall be verified through RSO method or any other equivalent technical method to authenticate the submitted calculations during final testing .
- (dd) The tenderer should have in house availability of vapour phase Drying (VPD) plant for proper drying of the insulation. In case VPD facility is not available, the bidder will prove that the method of drying adopted by them is equivalent or better than VPD in terms of level of dryness and other benefits of VPD.
- (ee) The air-core reactance of HV winding of Transformer shall not be less than 20%.
- (ff) The transformer shall be designed to withstand a DC current of 10A per phase without Injurious heating.
- (gg) Tan delta value for windings shall not be more than 0.007, corrected at 20 deg. C but most preferred value is 0.005 or less, corrected at 20 deg. C. Temperature correction factor table shall be given by the manufacturer and shall form part of Test results.
- (hh) The barrier insulation including spacers shall be made from high- density pre-compressed pressboard (1.1 gm/cc minimum for load bearing and 1 gm/cc minimum for non-load bearing) to minimize dimensional changes.
- (ii) The conductor insulation shall be made from high-density (at least 0.75 gm/cc) paper having high mechanical strength. The characteristics for the paper will be reviewed at the time of design review.

GAS AND OIL-ACTUATED RELAYS:-

- (a) Each transformer shall be fitted with gas and oil-actuated relay equipment having alarm contacts, which close on collection of gas or low oil level, and tripping contacts which close following oil surge conditions. Separate relays shall be provided for on loadtap changer.
- (b) Each gas and oil-actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay.
- (c) Each relay shall be fitted with a calibrated glass window for indication of gas volume.
- (d) To allow gas to be collected at ground level, a small bore pipe shall be connected to the gas release cock of the gas and oil-actuated relay and brought down to a point, approximately 1400 mm above ground level,. Where it shall be terminated by a cock, which shall have provision for locking to prevent unauthorized operation.
- (e) The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that mal-operation of the relay will not take place under normal service conditions, including starting or stopping of oil circulating pumps whether by manual or automatic control under all operating temperatures.
- (f) The pipe work shall be so arranged that all gas arising from the transformer will pass into the gas and oil-actuated relay. The oil circuit through the relay must not form a delivery path in parallel with any circulating oil pipe, nor is to be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided. For this reason, bushing turrets, if fitted shall have vent pipes, which will route any gas collection through the relay.
- (g) A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the expansion pipe and the cross level of the relay.
- (h) A straight run of pipe work shall be provided for a length of five times the internal diameter of the pipe on the conservator side of the gas and oil-actuated relay.
- (i) The surge float contacts shall close at a rate of steady oil flow between the following limits. As far as possible, the limits shall also be met when the relay is subjected to oil surge conditions, produced by rapid opening of a lever operated gate valve.
- (j) The relays shall be so located as to be easily accessible from the top of the tank. Oil Pipe Connection I.D. (mm) Operational Limits for Relay.

	[Rising angles of 1° to 9°.]
25	700-1300
50	750 - 1400
75	900 - 1600
- (k) The gas collection contacts shall operate within the angle limits, specified for test:
- (l) When a transformer is provided with two conservators, the gas and oil - actuated relays shall be arranged as follows:
 - (i) If the two conservators are connected to the transformer by a common oil pipe, one relay shall be installed in the common pipe.
 - (ii) If the two conservators are piped separately to the transformer, two relays shall be installed, one in each pipe connection.
- (m) The clearance between oil pipe work and live metal shall be not less than the minimum clearances as per standard practice.

TEMPERATURE INDICATING DEVICES AND ALARMS:-

The Transformer shall be provided with approved devices for indicating the oil temperature and hot spot winding temperature of each winding. The devices shall have a dial type indicator and in addition, a pointer to register the highest temperature reached and re-setting device. Each temperature device shall have three separate contacts fitted, one of which shall be used to control the cooling plant motors, one to give an alarm and one to trip the associated circuit breakers.

- (a) Oil Temperature Indicator (OTI)
The thermometer for top oil temperature indication should be of 150mm. dial type. A temperature-sensing element, suitably located in a pocket on top oil

shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be $\pm 1.5\%$ or better. The temperature indicator dials shall have linear graduations to clearly read at least every 2 deg. C.

(b) Winding Temperature Indicator (WTI).

A device for measuring the hot spot temperature of each of the HV/IV/LV windings shall be provided. It shall comprise of the following:-

- i) Temperature sensing element.
- ii) Image Coil.
- iii) Auxiliary CTS, if required to match the image coil, shall be provided and mounted in the cooler control cabinet. For auto/Powertransformers, an additional CT is required in the lead to the primary terminal to give a true image of the temperature in the common/secondary winding. The current transformers shall be of class 1, and the rated primary current shall correspond to the rated current of the related transformer winding. The effective resulting rated secondary current shall be 2A. Matching units between current transformers and thermal replicas shall not be provided.
- iv) 150 mm diameter local indicating instrument with maximum reading pointer, mounted in cooler control cabinet and with two adjustable electrically independent ungrounded contacts (besides that required for control of cooling equipment), one for high winding temperature alarm and one for trip. The temperature indicator dials shall have linear graduations to clearly read at least 2 deg. C
- v) Calibration device.
- vi) In addition to the above, the following indication equipment shall be provided for each winding for remote indication.
 - 1) Remote winding temperature indicator:- It shall be suitable for flush mounting on RTCC panel. The difference between local and remote WT indication at any given time shall not exceed 1 deg. C.
 - 2) Auxiliary supply, if required, in RTCC panel, for RWTI, shall be 220V DC only.
 - 3) The drawing showing details of RWTI shall be submitted to the purchaser.
 - 4) Accuracy class of WTI shall be $\pm 1.5\%$ or better.
 - 5) Any special cable(s), required for shielding purpose for connection between cooler control cabinet and remote winding temperature indicator control circuit shall be in Bidder's scope.

(c) The winding temperature indicators shall be housed in the cooler control cabinet/marshalling kiosk. The tripping contacts of the winding temperature indicators shall be adjustable to close between 80° C and 150°C and to re-open when the temperature has fallen by not more than 10°C.

(d) The alarm contacts and the contacts used to control the cooling plant motors on the above devices shall be adjustable to close between 50°C and 100°C and to re-open when the temperature has fallen by a desired amount between 10° C and 15° C.

(e) All contacts shall be adjustable to a scale and must be accessible on removal of the relay cover. Alarm and trip circuit contacts shall be suitable for making or breaking 150 VA between the limits of 30 and 250 Volts AC or DC and of making 500 VA between the limits of 110 and 250 V DC. Cooler motor control contacts

- shall be suitable for operating the cooler contactors direct, or if necessary, through an interposing relay.
- (f) The temperature indicators in the marshalling kiosk shall be so designed that it is possible to move the pointers by hand for the purpose of checking the operation of the contacts and associated equipment.
 - (g) The working parts of the instrument shall be made visible by the provision of cut-away dials and glass-fronted covers. All setting and error adjustment devices shall be easily accessible.
 - (h) Connections shall be brought from the device to terminal boards, placed inside the marshalling cubicle.
 - (i) Terminals, links and a 63 mm moving iron ammeter shall be provided in the marshalling kiosk for each WTI for:-
 - (i) Checking the output of the current transformer.
 - (ii) Testing the current transformer and thermal image characteristics.
 - (iii) Disconnecting the bulb heaters from the current transformer secondary circuit to enable the instrument to be used as an oil temperature indicator.
 - (j) Sight glasses of temperature indicators shall be of laminated security glass. Sight glasses of transparent plastics will not be accepted.
- k) In addition to the above, **'OPTIC FIBER TEMPERATURE SYSTEM'** of proven quality and performance in Indian Utilities shall be provided in each transformer for measurement of temperature of windings, oil and core. Bidders are required to state in their offers regarding performance of such Optic Fiber Temperature System along with the names of the end-users in India. The end-user's certificates for such system will be furnished by the Bidders along with their Tender offers.

COOLING EQUIPMENT AND ITS CONTROLS:

Cooling Equipment:

- (a) The Cooler shall be designed using 2 x 50 % radiator banks.
- (b) Each radiator bank shall have its own cooling fans, oil pumps, oil flow indicators, shut off valves, lifting lugs, top and bottom oil filling valves, air release plug, a drain valve and thermometer pocket, fitted with captive screw cap on the inlet and outlet oil pipes.
- (c) One stand by fan of at least 20% capacity shall also be provided and identified with each radiator bank.
- (d) Cooling fans shall not be directly mounted on radiator bank which may cause undue vibration.
- (e) The exhaust airflow from cooling fan shall not be directed towards the main tank in any case.
- (f) Cooling fans for each radiator bank shall be located so as to prevent ingress of rainwater.
- (g) It shall be possible to remove the blower complete with motor without disturbing or dismantling the cooler structure framework.
- (h) The blades of cooling fans shall be of galvanised steel or cast aluminum alloy unless otherwise approved. Thickness of galvanization shall be minimum 55 microns.
- (i) Blower casings shall be made of galvanised steel of thickness not less than 2 mm or aluminum alloy and shall be suitably stiffened by angles or tees.
- (j) Galvanised wire guards with mesh not exceeding 12.5 mm shall be provided to prevent accidental contact with the blades. Guards shall also be provided over all moving parts. Guards shall be designed such that blades and other moving parts can not be touched by test fingers to IEC - 529:1976 (BSEN60529). Direction of rotation shall be indicated.
- (k) Two (2), 100% oil immersed in line axial flow motor pumps (out of which one pump shall be stand by) shall be provided with each radiator bank. The pumps shall be assembled on common shaft and housed in a common casing. The motor windings shall be immersed in a part of the circulating oil to obviate the need of packing glands and lubrications of the pump and motor bearings by external means. The stand by pump shall be connected in parallel at the same level. **CENTRIFUGAL TYPE OIL PUMPS MUST NOT BE PROVIDED AND OFFER WITH SUCH PUMPS SHALL NOT BE CONSIDERED.** The manufacturer will have to show either by certified type test results or type tests, witnessed by the purchaser that switching on of all the oil pumps into services, simultaneously, does not operate the Buchholz relay. The pump shall be so designed that upon failure of power supply to the pump motor, the pump impeller will not limit the natural circulation of oil under failure of main oil pump, the changeover from main to stand by oil pump shall be automatic.
- (l) It shall be possible to remove the motor and pump from the oil circuit without having to take the transformer out of service and without having to disturb the pump foundation fixing.
- (m) The pump shall be capable of dealing with the maximum output and head, which may occur in service and head which may occur in service and with the varying head due to changes in the viscosity of oil. Guards shall be provided over all exposed couplings and shafts.

- (n) An oil flow indicator shall be provided for the confirmation of the oil pump operating in a normal state. An indication shall be provided in the flow indicator to indicate reverse flow of oil/loss of oil flow.
- (o) Cooling fans and oil pump motors shall be suitable for operation from 415 volts, three phase and 50 Hz power supply and shall conform to IS:325/ IEC 60034. The motor winding insulation shall be conventional class 'B' type. Motors shall have hose proof enclosure - equivalent to IP:55 as per IS:4691/ IEC 60034-5.
- (p) Each cooling fan and oil pump motor shall be provided with starter thermal overload and short circuit protection.
- (q) Each radiator shall be provided with:-
 - One shut off valve at the top (80 mm size).
 - One shut-off valve at the bottom (80 mm size).
 - Air release device at the top.
 - Main and sampling device at the bottom.
 - Lifting lugs to lift entire cooling assembly.
 - Expansion joints, one each on top and bottom cooler pipe connections.
 - Air release device and oil plug on oil pipe connections.
 - A thermometer pocket fitted with captive screw cap, in the inlet and in the outlet oil pipes.
 - Loose blanking plates for blanking off the main oil connections.
 - Visual oil flow indicators, fitted with the electrical contacts to close when oil is not flowing. Contacts are to be connected in the cooler fail alarm circuit.

N. B.:- The omission of any or the provision of alternative arrangements to the above requirements will not be accepted.

(r) OIL PIPES AND FLANGES:

- All oil piping, necessary for connecting of each transformer to its conservator, cooler banks and oil pumps etc. shall be supplied under this contract.
- The oil piping shall be of approved material with machined flanged joints.
- Copper pipe work is to comply with BS.61.
- Dimensions of steel pipes shall be in accordance with BS. 3600:1973 and the drilling of all pipe flanges shall comply with BS:4504:1969.
- An approved expansion piece shall be provided in each oil pipe connection between the transformer and each oil cooler bank.
- All necessary pipe supports, foundation bolts and all other attachments are to be provided.
- It shall be possible to drain any section of pipe work independently of the rest and drain valves or plugs shall be provided as necessary to meet this requirement

COOLING EQUIPMENT CONTROL (ONAN/ONAF/OFAF COOLING):-

- (a) Automatic operation control (switching in and out) of fans/pumps shall be provided (with temperature change) from contacts of winding temperature indicator. The supplier shall recommend the setting of WTI for automatic change over of cooler control from ONAN to ONAF to OFAF. The setting shall be such that hunting i.e., frequent start operations for small temperature differential do not occur.

- (b) The changeover to standby oil pump in case of failure of service oil pump shall be automatic.
- (c) In addition to the traditional starting of fan and pump by winding & oil temperature, the starting of forced cooling shall be done if the load exceeds a current setting of 0.6 p.u. for 5 seconds. Furthermore, a one-week timer is required to check the healthiness of the cooling system on a routine basis for one hour at a time.

INDICATING DEVICES:-

Following lamp indications shall be provided in cooler control cabinet.

- Fan ‘ON’ Fan ‘OFF’.
- Pump ‘ON’ and Pump ‘OFF’.
- Cooling system ‘On Automatic Control’.
- Cooling system ‘On Manual’.
- No flow/Reverse flow of oil in oil pump.
- Selector switch in ‘auto’ or ‘manual’ for each fan and pump.
- 415 volts cooler supply auto changeover.
- Cooler supply failure for each supply.
- Oil pump failure for each pump.
- Cooling fan failure for each fan.
- Control supply failure for main and stand by.
- No flow/reverse flow of oil in oil pump.
- **Common thermal overload trip**
- One potential free initiating contact for all the above indications shall be wired independently to the terminal blocks of cooler control cabinet exclusively for purchaser’s use.
- A 12-window annunciator shall be provided in the RTCC panel for visual and audible signaling of important functions of cooling equipment and tap changer.

COOLER CONTROL CABINET:

- (a) Each transformer unit shall be provided with a cooler control cabinet.
- (b) The cooler control cabinet shall have all necessary devices, meant for cooler control and local temperature indicators. All the contacts of various protective devices, mounted on the transformer shall also be wired upto the terminal board in the cooler control cabinet. All the secondary terminals of the bushing CTs shall also be wired up to the terminal board at the cooler control cabinet.
- (c) The cooler control cabinet shall have two (2) sections. One section shall have the control equipment, exclusively meant for cooler control. The other section shall house the temperature indicators, auxiliary CTs. and the terminal boards, meant for termination of various alarm and trip contacts as well as various bushing CT Secondaries. Alternatively, the two sections may be provided as two separate panels, depending on the standard practices of the supplier.
- (d) The temperature indicators shall be so mounted that the dials are not more than 1600 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

TERMINAL BLOCK:

- (a) The terminal blocks(‘ELMEX’ Make, Type – OAT 6 or its equivalent), to be provided shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with block and barriers, moulded integrally. Such block shall have washer and binding screws for external circuit wire

connections, a white marking strip for circuit identification and moulded plastic cover. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.

- (b) All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. The terminal blocks shall be 1100 V grade and have 10 Amps continuous rating moulded piece, complete with insulated barriers, non-disconnecting stud type terminals, washers, nuts and lock nuts. Terminal block design shall include a white fibre-marking strip with clear plastic, slipon/clipon terminal cover. Markings on the terminal strips shall correspond to wire number and terminal numbers on the wiring diagrams.
- (c) Terminal blocks for current transformer's secondary leads shall be provided with test links and isolating facilities. Also current transformer secondary leads shall be provided with short-circuiting and earthing facilities.
- (d) At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- (e) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.
 - (i) For all circuits except current transformer circuits, minimum of two nos. 2.5 sq.mm copper.
 - (ii) For all CT circuits, minimum of two nos. 4 sq. mm. copper.
- (f) There shall be a minimum edge-to-edge clearance of 250 mm. between the first row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be minimum of 150 mm.
- (g) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run parallel and in close proximity long each side of the wiring duct to be provided for convenient attachment of internal panel wiring. The side of the terminal block, opposite the wiring duct shall be reserved for the owner's external cable connection. All adjacent terminal blocks shall also share this field-wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cables.
- (h) The number and sizes of the purchaser's multi-core incoming cable will be furnished to the Bidder after placement of the order.

5.4.12.6 **LABELS.**

- a) Labels shall be provided for all the apparatus such as relays, switches, fuses etc., contained in control cabinets/marshalling box.
- b) Description labels for mounting indoor or inside control cabinets/marshalling box shall be of such material that will ensure permanence of lettering. A matt of satin finish shall be provided to avoid dazzle from reflected light. Labels, mounted on dark surfaces shall have white lettering on a black background. All plates shall be of a material, which will not get corroded.
- c) Labeling shall be clear, concise and adequate.
- d) Labels shall be supplied as far as possible in the following four standard sizes
 - (i) Label for fuses and links shall measure approximately 28mm. to 45mm by 13mm. to 19mm. and lettering of 3mm to 6mm. shall be used according to the amount of inscription required. The lettering shall have strokes of approximately 1mm. width.
 - (ii) Labels for relays, contactors, thermal devices and similar apparatus shall measure 65mm. by 20mm. and shall have lettering as specified in (i) above.

- (iii) Labels for controllers and changeover switches shall measure 70mm. by 30 mm and where practicable have 20 mm lettering with 1.5 mm strokes.
- (iv) The labels for the doors of junction boxes, marshalling boxes and similar equipment shall measure 125 mm x 50 mm and have 13 mm, lettering with 1.5 mm wide strokes.
- (e) The labels for mounting outdoor shall be weather and corrosion proof. The letters/diagrams thereon shall be framed by etching or other such process, which will ensure permanence of the lettering/markings.
- (f) Labels shall be attached to panels with brass screws or with steel screws which have received rust preventive treatment.

VOLTAGE SELECTION AND CONTROL:

On load tap changers:

General:

- (a) The OLTC shall be of In Tank, Hi Speed Resistor type.
- (b) OLTC gear shall be motor-operated for local as well as remote electrical operation. An external hand wheel/handle shall be provided for local manual operation.
- (c) On-load tap-changer shall be sourced from reputed manufacturer and it should be type tested as per relevant IEC-60214 and test methods shall be in full conformance to the procedures, indicated in IEC-60214.
- (d) The details of the method of diversion of the load current during tap-changing, the mechanical construction of the gear and control features of OLTC gear shall be submitted with the bid. Information regarding the service experience on the gear and a list of important users shall be furnished. The tap-changer shall change the effective transformation ratio without producing phase displacement.
- (e) The current diverting contacts shall be housed in a separate oil chamber, not communicating with the oil in the main tank of the transformer. On load tap changer shall have maximum rated through current to meet the normal rated load as well as over-load as per standards. The OLTC should also be suitable for an occasional switching at 200% of the OLTC rating as per IEC-60214 which shall be validated with by the type test. The OLTC shall have BIL rating and short circuit withstand current as per relevant IEC standards.
- (f) All terminals shall be clearly and permanently marked with numbers corresponding to the cables connected thereto.
- (g) Tap positions shall be numbered consecutively ranging from one upwards. Tap one being the highest voltage ratio.
- (h) Current rating and voltage steps shall be as specified.
- (i) On-load tap changers shall comply with IEC 214:1976 and BS:4571:1970 and shall be suitable for power flow in both the directions. **Only designs, which have been type tested in accordance with these standards will be accepted. All the type test certificates as per the above standards shall be submitted along with the documents for approval of vendor and GTP-drawings.**
- (j) Current making and breaking switches, associated with the tap selectors shall be contained in a tank in which the head of oil is maintained by means, completely independent of that on the transformer itself.
- (k) Details of maintaining oil separation, oil levels, oil draining/filling/sampling, detection of oil surges and provision of alarm and trip contacts will be

dependent on the design of tap-changer and be to the approval of the purchaser. However, a suitable pressure relief device shall be provided for all on-load tap changer compartments. It should be possible to inspect the diverter switch contacts without having to lower the oil in the transformer. Contact tips should be replaceable.

- (l) Transformer on load tap changers shall be equipped with a fixed resistor network, capable of providing discrete voltage steps for input to the supervisory system.
- (m) The Bidder shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer.
- (n) Any 'DROP DOWN' tanks, associated with the tap changing apparatus shall be fitted with guide rods to control the movements during lifting or lowering.
- (o) All relays and operating devices shall operate correctly at any voltage between the limits specified.
- (p) The OLTC shall be suitably protected through oil surge relay (OSR). This surge relay shall be tested for an oil flow velocity of 1.20 +/-0.20m/s.

MECHANISMS:

- (a) The drive mechanism chamber shall be mounted on the tank in an accessible position. It should be adequately ventilated and provided with anti-condensation metal clad heaters with thermostatic control. All components inside shall be protected against corrosion, deterioration due to condensation, fungi etc. The door shall be pad-lockable.
- (b) The tap change mechanism shall be designed in such a way that when a tap change has been initiated, it will be completed independently of the operation of the control relays and switches. If a failure of the auxiliary supply during tap change or any other contingency would result in that movement, not being completed, an approved means shall be provided to safeguard the transformer and its auxiliary equipment.
- (c) Limit switches shall be provided to prevent over-running of the tap changing mechanism. These shall be directly connected in the operating motor circuit. In addition, mechanical stops shall be fitted to prevent over-running of the mechanism under any condition. For on-load tap change equipment, these stops shall withstand the full torque of the driving mechanism without damage to the tap change equipment. Limit switches may be connected in the control circuit of the operating motor, provided that a mechanical de-clutching mechanism is incorporated.
- (d) Thermal devices or other approved means shall be provided to protect the motor and control circuit.
- (e) A permanently legible lubrication chart shall be provided and fitted inside the tap-changing chamber.

TAP CHANGE CONTROL PHILOSOPHY:-

General:

The following operating conditions are applicable to the on-load tap changer controls:-

- (a) It must not be possible to operate the electric drive when the manual operating gear is in use.
- (b) It must not be possible for two electric control points to be in operation at the same time.
- (c) Operation from a control switch shall cause one tap movement only unless the control switch is returned to the off position between successive operations. Subsequent tap changes shall be initiated only by a new or repeat command.

- (d) It shall not be possible for any transformer operating in parallel with one or more other transformers in a group to be more than one tap out of step with the other transformers in the group. On load tap changers shall be equipped with a time delayed INCOMPLETE STEP alarm, consisting of a normally open contact which closes if the tap changer fails to make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.
- (e) All electrical control switches and local manual operating gear shall be clearly labelled in an approved manner to indicate the direction of tap changing i.e., raise and lower tap number.

Manual Control:

- (a) The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man, standing at ground level.
- (b) The manual control shall be considered as back up to the motor operated control and shall be inter locked with the motor to block motor start up during manual operation. The manual operating mechanism shall be labeled to show the direction of operation for raising the terminal voltage and vice-versa.
- (c) Manual tap position indicator which shall be complete with the following:-
 - (i) Mechanical tap position indicator which shall be clearly visible from near the transformer.
 - (ii) A mechanical operation counter.
 - (iii) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.

Local and Remote Control:

Equipment for local, manual and electrical operation shall be provided in an outdoor cubicle. Electrical remote control equipment shall also be supplied on the tap changer. The following control facilities shall be provided:-

- (a) 'Local - Remote' Selector Switch, mounted in the local OLTC, control cabinet. When the selector switch is in 'local' position, it shall be possible to operate the 'raise-lower' control switches, specified in (b) below. Remote control of the raise-lower functions shall be inhibited. When the selector switch is in 'remote' position, the local OLTC control cabinet mounted 'raise-lower' switch, specified in clause (b) below shall be inoperative. Remote control of the raise/lower function shall be possible from the remote control panel. The 'local-remote' selector switches shall have at least two spare contacts per position, which are closed in that position, but open in the other position.
- (b) A 'raise-lower' control switch/push button shall be provided in the local OLTC control cabinet. This switch shall be operative only when 'local-remote' selector switch is in 'local' position.
 - (c) An 'ON-OFF' tap changer control switch shall be provided in the local OLTC control cabinet of the transformer. The tap changer shall be inoperative in the 'OFF' position. The 'OFF-ON' switch shall have at least one spare contact per position, which is closed in that position, but open in the other position.

Remote group control:-

The offered OLTC control scheme shall have provision of remote electrical group control during the parallel operation of transformer. This is in addition to independent control of OLTC.

- (a) A four position selector switch having 'Master', 'Follower', 'Independent' and 'Off' position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in either 'Master', 'Follower', 'Independent' or 'Off' mode.

- (b) Out of step relays with timer contacts shall also be provided to give alarm and indication in case tap position in all the transformers under group control are not in same position.
- (c) Master Position: If the selector switch is in Master position, it shall be possible to control the OLTC units in the OLTC units in the follower mode by operating the controls of the master unit. Independent operation of the units under Follower mode shall be prevented. However, the units under Independent mode will be controlled independently.
- (d) Follower Position:- If the selector switch is in follower mode, control of OLTC shall be possible only from panel of the Master Unit.
- (e) Independent Position:- In this position of selector switch, control of OLTC of individual unit only shall be possible.

Control Circuits:-

- The control circuits shall comply with following conditions:-
- (a) An interlock to cut off electrical control automatically upon recourse being taken to the manual control.
 - (b) Re-inforcement of the initiating impulse for a tap changer, ensuring a positive completion, once initiated to the next (higher or lower) tap.
 - (c) “Step-by-step” operation ensuring only one tap change from each tap changing impulse and a lockout of the mechanism if the control switch (or push button) remains in the “operation” position.
 - (d) An interlock to cut out electrical control when it tends to operate the gear beyond either of the extreme tap positions.
 - (e) An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for the new position.
 - (f) Tap change in progress indication shall be provided by means of an indicating lamp at the purchaser’s control panel. Necessary contacts for this and for remote tap position indicator at purchaser’s control panel shall be provided by the Bidder.
 - (g) Protective apparatus, considered essential by the Bidder according to specialties of the gear.

Indications:-

Apparatus of an approved type shall be provided on each transformer:-

- (a) To give indication mechanically at the transformer and electrically at the remote control point of the number of the tapping in use.
 - (b) To give electrical indication, separate from that specified above, of tap position at the remote supervisory point. Suitable tap position transducer to be incorporated for indication.
 - (c) To give indication at the remote control point and at the supervisory control point that a tap change is in progress, this indication to continue until the tap change is complete.
 - (d) To give indication at the remote control point and at the supervisory control point when 160 transformers operating in parallel are out of step.
 - (e) To indicate at the tap change mechanism the number of operations, completed by the equipment. A six digit counter should be provided for this.
- (a) Automatic control shall be suitable for control of transformers in parallel.
 - (b) In addition to the methods of control covered above, the following methods shall also be provided:-

- (i) Automatic Independent:- It shall be possible to select automatic independent control for each transformer irrespective of the method of control, selected for any other of the associated transformers.
- (ii) Automatic parallel:- It shall be possible to select any transformer for master or follower control.
- (iii) Automatic control by AVR shall only be possible if HV circuit breaker is closed.
- (iv) It must not be possible to operate any tap changer by supervisory, remote or local, electrical, manual control while the equipment is selected for automatic operation.

VOLTAGE REGULATING RELAYS:-

- (a) Automatic voltage control shall be initiated by a voltage regulating relay of an approved type and suitable for flush mounting. The relay shall operate from the nominal reference voltage, derived from a circuit mounted LV voltage transformer having class B accuracy to BS:3941 and the relay voltage reference balance point shall be adjustable at the Remote location.
- (b) The relay bandwidth shall preferably be adjustable to any value between 1.5 times and 2.5 times the transformer tap step percentage, the nominal setting being twice the transformer tap step percentage.
- (c) The relay shall be insensitive to frequency variation between the limits of 47HZ and 51.5HZ. The relay shall be complete with a time delay element, adjustable between 10 and 120 seconds. The relay shall also incorporate an under voltage blocking facility which renders the control inoperative if the reference voltage falls below 80 percent of the nominal value with automatic restoration of control when the reference voltage rises to 85 percent of nominal value.
- (d) The voltage control relay shall include an adjustable line drop compensation element, supplied from a current transformer, accommodated within the transformer bushing.
- (e) On each transformer, the voltage transformer supply to the voltage-regulating relay shall be monitored for partial or complete failure. The specified indicating lamp and alarm will be inoperative when the circuit breaker, controlling the lower voltage side of the transformer is open and also when the tap changer is on control other than automatic control.

5.4.13.4. LOCAL CONTROL CABINET:-

The local OLTC control cabinet shall house all necessary devices, meant for OLTC control and indication. It shall be complete with the following:-

- (a) A circuit breaker/contactors with thermal overload devices for controlling the A.C. auxiliary supply to the OLTC motor.
- (b) Cubicle light with door switch.
- (c) Space heaters to prevent condensation.
- (d) Padlocking arrangement for hinged door of cabinet.
- (e) Cable terminal glands for power and control cables to the OLTC gear.

5. REMOTE CONTROL PANELS:-

- a) All controls, alarms and indications for transformers shall be incorporated within the appropriate switchgear control panels. The supplier shall provide all indications, relays, switches etc. for remote indication and operation of the transformer from the substation control room. Comprehensive and detailed instructions shall be provided to the purchaser regarding correct installation of this remote panel.
- (b) The remote tap changer control panel shall be mounted in the purchaser's control room. Size and colour of the panel shall be to the approval of the purchaser.

- (c) Operation of remote control scheme shall be entirely suitable for the distance between the transformer and remote control panel. Details of the connection of the remote control panel to the transformer shall be provided by the supplier.
- (d) The standard requirements (which may be varied to suit manufacturer's design) shall be out lined in the following sub-clauses:

INSTRUMENTS:

- (a) Voltmeter (voltage at the low voltage terminals of the transformer).
- (b) Tap position indicator

RELAYS:

- (a) Automatic voltage control.
- (b) Supervisory interface.

CONTROLS:

- (a) Automatic/non-automatic voltage control selector switch.
- (b) Remote/supervisory tap change control selector switch.
- (c) Raise/lower push-buttons.
- (d) Independent/Master/Follower selector switch.
- (e) AVR Voltage reference adjuster.

INDICATIONS AND ALARMS:

- (a) Tap changer on manual control - white lamp.
- (b) Tap change in progress - white lamp.
- (c) Tap change out of step-alarm.
- (d) Cooling equipment running-white lamp.
- (e) Cooling equipment failure-alarm.
- (f) AVR reference voltage failure-alarm.
- (g) Tap changer supply voltage failure-alarm.
- (h) Tap change incomplete step-alarm.

5.4.13.6. **AUXILIARY SUPPLY FOR OLTC CONTROL AND POWER CIRCUIT:-**

Auxiliary supplies as indicated in the specification will be provided by the purchaser at any one place. All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch, housed in the marshalling Kiosk. The design feature for the transfer switch shall include the following:-

- (a) Provision for the selection of one of the feeders as normal source and the other as standby.
- (b) Upon failure of normal source, the loads shall be automatically transferred after an adjustable time delay to the stand by source.
- (c) Indication for failure of the normal source and for transfer to standby source and also for failure to transfer shall be provided locally as well as at the remote control panel.
- (d) Automatic re-transfers to normal source with an adjustable time delay following re-energisation of the normal source.
- (e) Both the transfer and the re-transfer shall be dead transfers and AC feeders shall not be paralleled at any time.
- (f) Necessary isolating switches, MCBs and other components for the above power supply transfer arrangement shall be provided by the supplier.

Auxiliary Power Supply of OLTC, Cooler Control and Power Circuit

1. For Single Phase unit

Two auxiliary power supplies, 415 volt, three phase four (4) wire shall be provided at common marshalling box. All loads shall be fed by one of the two sources through an electrically interlocked automatic transfer scheme housed in the CMB. Power supply to individual phase unit shall be extended from the CMB. Power supply to spare unit shall be extended from nearest CMB only. Suitably rated power contactors, separate MCBs/MCCBs shall be provided in the Common Marshalling Box for each circuit.

For each circuit, suitably rated MCBs/MCCBs as required for further distribution of auxiliary power supply to DM boxes, Online Gases and moisture monitoring system, Online drying system and Fibre optic sensor Box etc. (as applicable), shall be provided by contractor, in individual marshalling boxes /cooler control boxes.

Auxiliary power supply distribution scheme shall be submitted for approval. Supply and laying of Power, Control and special cables from common marshalling box to individual MB/Cooler Control Cubicle (including spare unit) & further distribution from IMB/CCC to all accessories is in the scope of the contractor. Further any special cable (if required) from CMB to Owner's Control Panels/Digital RTCC panels is also in the scope of the contractor.

Connection arrangement for spare unit shall be in such a way that spare unit of transformer can be connected in place of faulty unit without physically shifting and all the control, protection, indication signals of spare unit shall also be brought in common marshalling box of all the banks. Necessary arrangement in schematic of Common marshalling box is required to facilitate change-over of all the signals of faulty units to spare unit of Transformer, to ensure flow of control, protection and indication signals between Purchaser's Control panels / Digital RTCC Panel /SCADA and individual units under operation (i.e. any designated unit for bank or spare unit, if it replace any designated unit). To facilitate change-over of spare unit signals with faulty unit in CMB, male- female plug-in connector or better arrangement shall be provided to reduce the outage time.

2. For Three Phase Transformer

Two auxiliary power supplies, 415 volt, three phase four (4) wire shall be provided by the Purchaser at cooler control cabinet. All loads shall be fed by one of the two sources through an electrically interlocked automatic transfer scheme housed in the cooler control cabinet.

For each circuit, suitably rated power contactors, MCBs / MCCBs as required for entire auxiliary power supply distribution scheme including distribution to DM boxes, Online Gases and moisture monitoring system, Online drying system and Fibre optic sensor Box etc. (as applicable), shall be provided by contractor in cooler control cabinet.

Auxiliary power supply distribution scheme shall be submitted for approval. Supply and laying of Power, Control and special cables from marshalling box to all accessories is in the scope of the contractor. Further any special

cable (if required) from MB to Owner's Control Panels/Digital RTCC panels is also in the scope of the contractor.

SUPERVISORY CONTROL:-

General:-

- (a) Tap change control equipment shall be suitable for supervisory control and indication with make before break multi-way switch-having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches, which may be required in remote tap position indication.
- (b) Transformer on-load tap changer shall be equipped with a fixed resistor network, capable of providing discrete voltage steps for input to the supervisory system.
- (c) Transformer tap change control will be effected from the sub-station control room with facilities for remote control from the supervisory control centre. Provision for such supervisory control shall be included in this contract.
- (d) The supervisory facilities, outlined in the following sub-clauses will be required and control circuit design must make provision for these.

CONTROLS:

- (a) Tap change control remote/supervisory select/deselect:-
N.B.:- Selection of supervisory control shall render voltage control non-automatic.
- (b) Tap position Raise/lower.

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INDICATIONS AND ALARMS:

- (a) Tap change remote/supervisory indication.
- (b) Tap position indication through appropriate transducer.
- (c) Tap change out of step alarm.
- (d) Tap changer auto/non-auto indication.
- (e) Independent/master/follower indication.
- (f) Tap change in progress indication.
- (g) AVR reference voltage failure alarm.
- (h) Tap changing incomplete (TCINCL).
- (i) Tap changer supply failure alarm.
- (j) Cooling equipment running indication.
- (k) Cooling equipment failure alarm.
- (l) All contacts for supervisory alarms and indications shall be potential free.

TERMINAL AND CONNECTION ARRANGEMENTS:

RATING:

Current rating shall be 1.5 times the rated current of the transformer.

OUTDOOR BUSHINGS:

- (a) The electrical and mechanical characteristics of bushings shall be in accordance with IS:2099 & IS:3347 (Part-III/Section-I). Bushings must have been type tested successfully as per IS:2099/IEC-60137.
- (b) Phase windings above 33 KV shall have fully rated porcelain condenser anti - fog type bushings as per IEC-137. These shall be provided with:-
 - (i) Oil-level gauges, clearly readable from ground level.

- (ii) Oil filling plug and drain valve, if not hermetically sealed.
- (iii) Test taps for measurement of capacitance and tan delta.
- (iv) Bushings of identical rating shall be inter-changeable.
- (c) 33 KV and tertiary bushings shall be oil - filled, communicating type, suitably rated.
- (d) When bushings have an under-oil end of re-entrant form, the pull through lead shall be fitted with a gas bubble deflector.
- (e) The bushings shall be removable without disturbing the turret type current transformers.
- (f) Porcelain used in bushing manufacture shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- (g) Glazing of porcelain and bushings shall be of uniform brown colour, free from blisters, burrs and other similar defects. Bushings shall be designed to have ample insulation mechanical strength and rigidity for the condition under which they will be used.
- (h) Special precaution shall be taken to eliminate moisture from paper insulation during manufacture, assembly, transport and erection. The surface of all paper insulation shall be finished with non-hygroscopic varnish which can not be damaged easily.
- (i) Suitable insulating cap (preferably of porcelain) shall be provided on the terminal of bushing of tertiary winding to avoid accidental external short circuit.
- (j) No arcing horns shall be fitted to any bushing.
- (k) Bushing turrets shall be provided with vent pipes which shall be connected to route any gas collection through the Buchholz relay.
- (l) The neutral ends of star connected windings shall be connected at points which are from manholes in the cover and brought out via one outdoor bushing, rated as per IEC-76.
- (m) Maximum Tan delta value for Bushings at 20 deg. C shall not exceed 0.007
- (n) Tan delta measurement at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP & RIP) at Transformer manufacturing works as routine test before dispatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.
- (o) If the bushing Tan delta goes beyond 0.005 or increase is more than 0.001 within the warranty period w.r.t. pre-commissioning values, the contractor shall arrange to replace the defective bushing by new one. No temperature correction factor shall be applicable for tan delta.

TERMINAL CONNECTORS:

- (a) Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors, offered must have been successfully type tested as per IS:5561.
- (b) (i) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. The aluminum alloy castings, if used, shall conform to designation A6 of IS:617.
- (ii) No part of clamp shall be less than 10 mm. Thick.
- (iii) All ferrous parts shall be hot dip galvanised conforming to IS:2633. Spring washers and H.T. bolts shall be dectrogalvanised conforming to IS:1573.
- (iv) For bimetallic clamp, copper alloy linear of minimum thickness of 2 mm. Shall be cast integral with aluminum body.

- (v) Flexible connectors shall be made from tinned copper sheets.
- (vi) Size of terminal/conductor for which the clamp is suitable and rated current under site conditions shall be embossed/punched on each component of the clamp, except hardware.
- (vii) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- (viii) The short time rating of terminal connector shall not be less than the short time rating of respective bushing.
- (ix) Terminal connectors shall be subject to all type, routine and acceptance tests as per IS:5561 (latest).
- (x) Malleable cast iron for terminal connectors or any of its parts and accessories shall not be acceptable.
- (xi) Bolts and Nuts used shall be of stainless steel or galvanized/passivated mild steel.

BUSHING CURRENT TRANSFORMERS:

- (a) Current transformers shall comply with IS:2705/ IEC-61869-1 and 61869-2
- (b) It shall be possible to remove turret mounted C.Ts from the transformer tank without removing the tank cover. Necessary precaution shall be taken to minimise the eddy currents and local heat generated in the turret.
- (c) All secondary leads shall be brought to a weatherproof terminal box near bushing. These terminals shall be wired out to cooler control cabinet/ common marshalling box using separate cables for each core.
- (d) The CT's used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection. Bushing C.T. parameters, indicated in the Specification are tentative and liable to change within reasonable limits. The Bidder shall obtain purchaser's approval before proceeding with design of Bushing C.Ts.
- (e) Additional CTS shall be provided, as may be required for winding temperature indicators for each winding and OLTC for parallel operation of the transformers. CT characteristics shall have to match with purchaser's protected relays, meters and instruments.
- (f) Secondary resistance and magnetising current characteristics of PX class (protection) (as per IEC) CT of same rating shall be similar. This is applicable for Neutral CT (outdoor) also and shall be reviewed during detail engineering.

TERMINAL MARKING:

Transformer terminals are to be provided with phase markings to the requirements of IEC-616 and are subject to the agreement of the purchaser. Transformer terminals shall be silver/tin-plated copper.

5.4.15.6 **NEUTRAL EARTHING:**

The neutral terminals shall be brought to ground level by a brass or tinned copper grounding bar of approved size which shall be supported from the tank with porcelain insulators and connected to purchaser's local earth grid. The supplier must liaise with the purchaser or its approved contractor to finalise the details of installation of this earthing and mounting of the outdoor neutral C.T. on this.

SPECIFICATION FOR CONTROL CABINETS:

- (a) Control cabinets shall be of the free standing floor mounting type.
- (b) Control cabinet of the operating mechanism shall be made out of 3 mm thick sheet steel or 10 mm thick aluminium plate or casting. Hinged door shall be provided with pad locking arrangement. Sloping rain hood shall be provided to

cover all sides. 15 mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection of at least IP-55 as per IS:2147.

- (c) Bus bars shall be of tinned copper of adequate cross-section to carry the normal current without exceeding the permissible temperature rise over an ambient temperature of 50 degree centigrade outside the cubicle. The buses shall be braced to withstand forces corresponding to short circuit current of 25KA.
- (d) Motors rated 1 KW and above being controlled from the control cabinet would be suitable for operation on a 415V, 3 Phase, 50 HZ system. Fractional KW motors would be suitable for operation on a 240V, 1- Phase, 50 HZ supply system.
- (e) Isolating switches shall be group operated units (3 pole for use on 3-MCBS phase supply systems and 2 pole for single phase supply systems) quick make quick break type, capable of breaking safely and without deterioration, the rated current of the associated circuit. Switch handle shall have provision for locking in both fully open and fully closed positions.
- (f) Push button shall be rated for not less than 6 Amps. 415V A.C. or 2 Amps, 220/110V D.C. and shall be flush mounted on the cabinet door and provided with appropriate nameplates. Red, Green and Amber indicating lamps shall be flush mounted.
- (g) For motors upto 5 KW, contactors shall be direct-on-line, air break, single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5 times the full load current of the motor at 0.2 p.f. For motors above 5 KW, automatic star delta type starters shall be provided. 3 Pole contactors shall be furnished for 3 Phase motors and 2 Pole contactors for single phase motors. Reversing contactors shall be provided with electrical interlocks between forward and reverse contactors. If possible, mechanical interlocks shall also be provided. Contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defined in IS:2959. The main contacts of the contactors shall be silver plated and the insulation class for the coils shall be class E or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.
- (h) Contactors shall be provided with a three element positive acting, ambient temperature compensated, time lagged, hand reset type, thermal overload relay with adjustable setting. Hand reset button shall be flush with the front door of the cabinet and suitable for resetting with starter compartment door closed.
- (i) Single phase preventer relay shall be provided for 3 Phase motors to provide positive protection against single phasing.
- (j) Mini starters shall be provided with no volt coils, whenever required.
- (k) Purchaser's power cables will be of 1100/650 Volts grade stranded aluminum conductor PVC insulated, PVC sheathed, single steel wire armoured and PVC jacketed. All necessary cable terminating accessories such as glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in Bidder's scope of supply. Suitable brass cable glands shall be provided for cable entry.
- (l) Wiring for all control circuits shall be carried out with 1100/650 Volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 sq.mm. At least 20% spare terminal blocks for control wire termination shall be provided on each panel. The terminal blocks shall be of non-disconnecting stand type. All terminals shall be provided with ferrules, indelibly marked or numbered and these identifications shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10Amps.
- (m) Separate terminal blocks shall be provided for terminating circuits of various voltage classes. CT loads shall be terminated on a separate block and shall have provision for short circuiting the CT secondary terminals.

- (n) Control cabinet shall be provided with 240V, 1 Phase, 50 HZ, 20 W fluorescent light fixture and a suitably rated 240 V, 1 Phase, 5 Amps, 3 Pin socket for hand lamps.
- (o) Strip heaters shall be provided inside each cabinet complete with thermostat (preferably differential type) to prevent moisture condensation. Heaters shall be controlled by suitably rated double pole miniature circuit breakers.
- (p) Signal lamps, provided shall be of neon screw type with series resistors, enclosed in bakelite body. Each signal lamp shall be provided with a fuse, integrally mounted in the lamp body.
- (q) Electric measuring instruments shall be of moving iron type. Ammeters for measuring current upto 30 Amps shall be directly connected while those for measuring above 30 Amps shall be connected through suitable CTs. Ammeters shall be provided with selector switches.
- (r) Items inside the cabinet, made of organic material shall be coated with a fungus resistant varnish.

INSULATING OIL:-

- (a) The quality of the oil, supplied with the transformer shall conform to IEC 296 (Mineral oil class 1) and IS:335 with latest amendment, if any. The percentage of Napthanic content in the oil will be more than 40 % & Paraffinic content will be less than 56 %. No oil shall be supplied or used at any stage of manufacture or test without a certificate, acceptable to the Purchaser that it has a PCB content of less than 2 mg/kg. No inhibitors shall be used in the oil. The oil samples will be drawn as follows:-
 - (i) Prior to filling.
 - (ii) Before and after heat run test.
 - (iii) Before energising.
 All tests as per relevant IEC & ISS shall be conducted on all samples.
- (b) Sufficient quantity of oil, necessary for first filling of all tanks, coolers and radiators at the proper level along with **10% extra** oil for topping up shall be supplied in non-returnable containers, suitable for outdoor storage.
- (c) The supplier shall dispatch the transformer, filled with oil or in an atmosphere of Nitrogen. In the former case, the Bidder shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangement shall be ensured by the supplier to take care of pressure drop of nitrogen during transit and storage till completion of oil filling during erection. A gas pressure testing valve with necessary pressure gauge and adapter valve shall be provided. **The transformer shall also be fitted with an impact recorder during transportation. This impact recorder is on returnable basis.**
- (d) The Bidders shall ensure that the oil supplied is in accordance with the latest editions of the following specifications with amendments, if any.

Unused inhibited Insulating Oil Parameters

Sl. No.	Property	Test Method	Limits
A	Function		
1a.	Viscosity at 100degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.) 3 mm ² /s
1b.	Viscosity at 40degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)12 mm ² /s
1c.	Viscosity at -30degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)1800 mm ² /s

2.	Appearance	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent and free from suspended matter or sediment
3.	Pour point	ISO 3016 or ASTM D97	(Max.)- 40degC
4.	Water content a) for bulk supply b) for delivery in drums	IEC 60814 or ASTM D1533	(Max.) 30 mg/kg 40 mg/kg
5.	Electric strength (breakdown voltage)	IEC 60156	(Min.)50 kV(new unfiltered oil) / 70 kV (after treatment)
6.	Density at 20 deg C	ISO 3675 or ISO 12185 or ASTM D 4052	0.820 - 0.895 g/ml
7.	Dielectric dissipation factor (tan delta) at 90 deg C	IEC 60247 or IEC 61620 Or ASTM D924	(Max) 0.0025
8.	Negative impulse testing KVp @ 25 deg C	ASTM D-3300	145 (Min.)
9.	Carbon type composition (% of Aromatic, Paraffins and Naphthenic compounds)	IEC 60590 and IS 13155 or ASTM D 2140	Max.Aromatic: 4 to12 % Paraffins :<50% & balance shall be Naphthenic compounds.
B Refining/Stability			
1.	Acidity	IEC 62021-1 or ASTM D974	(Max) 0.01 mg KOH/g
2.	Interfacial tension at 27degC	ISO 6295 or ASTM D971	(Min) 0.04 N/m
3.	Total sulphur content	BS 2000 part 373 or ISO 14596 or ASTM D 2622 or ISO 20847	0.05 % (Max.) (before oxidation test)
4.	Corrosive sulphur	IEC 62535	Non-Corrosive on copper and paper
		ASTM D1275B	Non-Corrosive
5.	Presence of oxidation inhibitor	IEC 60666 or ASTM D2668 or D4768	0.08% (Min.) to 0.4% (Max.) Oil should contain no other additives .Supplier should declare presence of additives, if any.

6.	2-Furfural content	IEC 61198 or ASTM D5837	25 Microgram/litre (Max.)
C Performance			
1	Oxidation stability -Total acidity -Sludge - Dielectric dissipation factor (tan delta) at 90degC	IEC 61125 (method c) Test duration 500 hour IEC 60247	Max 0.3 mg KOH/g Max 0.05 % Max 0.05
2.	Oxidation stability	ASTM D2112 (a)	220 Minutes (Min.)
D Health, safety and environment (HSE)			
1.	Flash point	ISO 2719	(Min.)135deg C
2.	PCA content	BS 2000 Part 346	Max 3%

3.	PCB content	IEC 61619 or ASTM D4059	Not detectable (Less than 2 mg/kg)
E	Oil used (inhibited) for first filling, testing and impregnation of active parts at manufacturer's works shall meet parameters as mentioned below:		
1	Break Down voltage (BDV)		70kV (min.)
2	Moisture content		5 ppm (max.)
3	Tan-delta at 90°C		0.005 (max)
4	Interfacial tension		0.04 N/m (min)
F	Each lot of the oil shall be tested prior to filling in main tank at site for the following:		
1	Break Down voltage (BDV)		70 kV (min.)
2	Moisture content		5 ppm (max.)
3	Tan-delta at 90°C		0.0025 (Max)
4	Interfacial tension		More than 0.04 N/m
G	After filtration & settling and prior to energisation at site oil shall be tested for following:		
1	Break Down voltage (BDV)	IS:1866 / IEC 60422	70 kV (min.)
2	Moisture content at hot condition		5 ppm (max.)
3	Tan-delta at 90°C		0.005 (Max)
4	Interfacial tension		More than 0.04 N/m
5	*Oxidation Stability	Test method as per IEC 61125 method C, Test duration:500hour for inhibited oil	
	a) Acidity		0.3 (mg KOH /g) (max.)
	b) Sludge		0.05 % (max.)
	c) Tan delta at 90 °C		0.05 (max.)
6	*Total PCB content		Not detectable (less than 2 mg/kg total)
	* Separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of BSPTCL.		

CLEANING, PAINTING AND TROPICALISATION:-

- (a) All steel surfaces except galvanized surfaces or where otherwise specified, shall be shot blasted to remove all rust, scale and foreign matters from the surface. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion

cleaning. The surfaces shall then be chemically cleaned and surface treated by phosphating and dried in accordance with IS-6005 - "Code of practice for phosphating of iron and steel". Immediately after phosphating, the surfaces shall be given two coats of high quality zinc chromate primer.

- (b) The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based undercoating, followed by two coats of phenolic based finishing paint to white colour, followed by a final coat of anti-condensation white paint of a type and make to the approval of the Purchaser. A minimum overall paint film thickness of 200 microns shall be maintained throughout.
- (c) All steel work and metal work, after preparation and priming shall be painted with one coat zinc chromate primer, one coat of phenolic based under coating and two coats of micaceous iron oxide paint to an overall thickness of 200 microns to hard gloss finishing Light Grey Shade No. 697 of IS:5. Each successive coat of paint shall be of slightly different shade to enable inspection.
The finished surface shall present a pleasing appearance free from dents or unevenness surfaces.
- (d) It is the responsibility of the supplier to ensure that the quality of paints used shall withstand the tropical heat and extremes of weather conditions. The paint shall not peel-off, wrinkle, be removed by wind, storm and handling on site and the surface finish shall neither rust nor fade during the service life of the equipment.
- (e) After erection at site, the interior surfaces of mechanism chambers and kiosks shall be thoroughly examined and any deteriorated or mechanically damaged surfaces of such shall be made good to the full specification, described above.
- (f) After erection at site, all surfaces of steel works and metal works shall be thoroughly washed down and examined. Any deteriorated or otherwise faulty paint work shall be removed down to bare metal and made good to the full specification described above,
then painted one further coat of phenolic based under coating and one coat phenolic based hard gloss finishing paint to provide an overall minimum paint film thickness of
200 microns.
- (g) All paint work shall be left clean and perfect on completion of the site works.

BOLTS AND NUTS:-

- (a) All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.
- (b) Except for small wiring, current carrying terminal bolts or studs for mechanical reasons shall not be less than 6 mm in diameter.
- (c) All nuts and pins shall be adequately locked.
- (d) Wherever possible, bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position
- (e) All bolts, nuts and washers, placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanizing. Bolts and Nuts below M12 (12mm.) size shall be of stainless steel. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals
- (f) Where bolts are used on external horizontal surfaces and where water can collect, methods of preventing the ingress of moisture to the threads shall be provided.

- (g) Each bolt or stud shall project at least one thread, but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts or nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.
- (h) The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- (i) Taper washers shall be provided where necessary.
- (j) Protective washers of suitable material shall be provided front and back on these securing screws.

WIRING AND CABLING:-

- 1 (a) Cable box/sealing end shall be suitable for following types of cable.
- i) 415 Volt Power 1100 Volt grade PVC Insulated aluminum conductor cable with armour.
 - ii) Control. 1100 Volt grade PVC insulated 7/0.737 mm stranded copper conductor cable with armour.
- (b) Compression type cable connector shall be provided for termination of power and control cables.
 - (c) All controls, alarms, indicating and relaying devices, provided with the transformer shall be wired up to the terminal blocks inside the local control cabinets (both cooler and OLTC control cabinets)
 - (d) All devices and terminal blocks with the cooler control cabinet shall be clearly identified by symbols, corresponding to those used on applicable schematic or wiring diagrams.

EXCLUSION IN SCOPE OF CABLING:

Following cabling works are specifically excluded from the scope of the supplier. However, interconnection drawings for the same are to be submitted by the supplier

- (a) Cabling between Remote OLTC panel to cooler control cabinet.
- (b) Cabling between Remote OLTC panel to local OLTC cabinet.
- (c) Cabling between Remote OLTC to supplier's panel .
- (d) Cabling between cooler control cabinet to supplier's panel.
- (e) Cabling between local OLTC cabinet to supplier's panel.

FITTINGS:

The following fittings shall be provided with each transformer, covered in this specification.

- (a) Conservator for main tank with oil filling hole and cap, air-cell, vacuum application valve, vacuum equalizing valve, isolating valves, drain valve, shut off valve, magnetic oil level gauge with low level alarm contacts, dehydrating breather, with oil seal.
- (b) Conservator for OLTC with drain valve, surge relay (oil flow operated), vacuum application valve, vacuum equalizing valve, magnetic type oil level gauge with low level alarm contacts, oil-level indicator and silica gel breathers.
- (c) Oil preservation equipment.
- (d) Pressure relief devices with alarm/trip contacts.

- (e) (i) Buchholz relay, double float/read type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts (Rating 1 Amp. 220V DC) test cock, gas collection box and gascheck valve at ground level.
- (e) (ii) Separate Buchholz relay with above features to be provided for OLTC chamber.
- (f) Air release plug.
- (g) Inspection openings and covers.
- (h) Bushing with metal parts and gaskets to suit the termination arrangement.
- (i) Winding temperature indicators for local and remote mounting. One RWTI with a four-point selector switch shall be provided.
- (j) Top Oil temperature indicator with maximum pointer along with two sets of contactors.
- (k) Cover lifting eyes, transformer-lifting lugs, jacking pads, towing holes and core and winding lifting lugs.
- (l) Protected type mercury or alcohol in glass thermometer.
- (m) Bottom and top filter valves with threaded male adaptors, bottom sampling valve and drain valve.
- (n) Rating and diagram plates on transformers and auxiliary apparatus.
- (o) Earthing terminals.
- (p) Flanged bi-directional wheels.
- (q) Cooler Control Cabinet with pad locks.
- (r) On load tap changing equipment and OLTC control cabinet with pad locks.
- (s) Drain valve plugs shall be provided in order that each section of pipe work can be drained independently.
- (t) Insulating Oil.
- (u) Terminal marking plate.
- (v) Jacking pads//lugs
- (w) Lifting bollards.
- (x) Haulage lugs.
- (y) Cover lifting lugs.
- (z) Valve schedule plate.
- (aa) Bushing CT
- (bb) Cooling fans
- (cc) Motor pumps
- (dd) Marshalling Box
- (ee) RTCC Panel
- (ff) Bushing Terminal Clamps & Connectors
- (gg) Oil flow indicator
- (hh) Valves, as indicated at Cl.No.5.4.2 of this Specification
- (ii) Wiring upto marshalling box with PVC SWA PVC copper cables, 1100Voltsgade.
- (jj) One Set of hand tools of 'Taparia' or 'GEDORE' Make, packed in a carry bag/box, broadly comprising of double ended spanners (Open jaws, cranked ring, tubular with Tommy bar, of different sizes as used in the Transformer – one set), adjustable wrenches (of different sizes as used in the Transformer –one set), gasket punches (of different sizes as used in the Transformer –one set), pliers (flat nose, round nose and side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle(one), adjustable hacksaw(one) and cold chisel(one) shall be supplied.
- (kk) Thermosyphon Filter

(II) 8(Eight) Probes & 8(eight) Channel Optic Fiber Temperature Sensor System as per this specification

Note:- The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of the above rated Power transformers are deemed to be included.

LIMITS OF TEMPERATURE RISE:-

The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50 degree C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly. For actual maximum temperature at the location of installation, refer perfect synopsis.

<u>Sl. No.</u>	<u>Nature of the part or of the liquid.</u>	<u>Maximum value of</u> Temperature. Temperature rise at a Maximum ambient air Temp. not exceeding 50 degree C.	
1	Contacts in air, silver-faced copper, Copper alloy or aluminium alloy (see Notes (i) & (ii). Bare copper of tinned aluminium alloy.	95	40/45
2	Contacts in oil: Silver-faced copper, copper alloy or Aluminium alloy [see note- (i)].	75 90	25 40
3	Terminals to be connected to external Conductors by screws or bolts silver faced (see note (iii)).	80 105	30 55
4	Metal parts acting as springs.	(See note iv).	(See note iv).
5	Metal parts in contact with insulation of the following classes: Class Y: (for non-impregnated Materials). Class A:(for materials immersed in oil or impregnated. Class E:in air In oil Class B:in air In oil Class F:in air In oil Enamel:oil base Synthetic, in air Synthetic, in oil	90 100 120 100 130 100 155 100 100 120 100	40 50 70 50 80 50 105 50 50 70 50
6	Any part of metal or of insulating Material in contact with coil, except Contacts.	100	50
7	Oil		40

Notes: (i) When applying the temperature rise of 45° C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

(ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as 'bare'.

(iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.

- (iv) The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75°C.

MOTORS & MCBS:

- (a) All motors shall comply with IS:325 and IEC 34 and dimensions with IEC-72. They shall be capable of operating continuously under actual service conditions without exceeding the specified temperature rises, determined by resistance, at any frequency between the voltage and frequency fluctuation, stated in this specification.
- (b) All miniature circuit breakers shall be provided with auxiliary contacts for remote indication of circuit breaker operation. Means shall be provided to prevent the miniature circuit breakers, being inadvertently switched to the 'OFF' Position. Miniature circuit breakers shall be mounted in such a manner so as to give easily visible indication of breaker position and shall be grouped and spaced according to their function in order to facilitate identification and easy replacement.

SPANNERS AND SPECIAL TOOLS (INCLUDED IN THE SCOPE OF THE CONTRACT):-

One Set of hand tools of 'Taparia' or 'GEDORE' Make, packed in a carry bag/box, broadly comprising of double ended spanners (Open jaws, cranked ring, tubular with Tommy bar, of different sizes as used in the Transformer –one set), adjustable wrenches (of different sizes as used in the Transformer –one set), gasket punches (of different sizes as used in the Transformer –one set), pliers (flat nose, round nose and side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle (one), adjustable hacksaw (one) and cold chisel (one) shall be supplied for each Transformer.

LIST OF MANDATORY SPARES FOR EACH UNIT OF TRANSFORMER

- (a) The supplier shall provide the mandatory spares, detailed below and shall, where considered necessary, provide a list of recommended spare parts together with their individual prices. The purchaser may order all or any of the spare parts, listed at the time of contract award and the spare parts, so required by the purchaser, shall be supplied as part of this contract. Additional spares may be ordered at anytime during the contract at the rates, stated in the purchase order.

Sl.No.	Description.	Quantity. (As per BOQ)
1	HV. Bushing with metal parts and gaskets.	
2	HV/LV Bushing with metal parts and gaskets	
3	Tertiary Bushing with metal parts and gaskets.	
4.	Neutral Bushing with metal parts and gaskets.	
5.	Local and remote winding temperature indicators with contacts.	
6	Oil temperature indicator with contacts.	
7	Pressure relief device.	
8	Magnetic oil level gauge with low oil level alarm contacts.	
9	Oil flow indicator with contacts.	
10	Cooler pump with motor.	
11	Cooler fans with motor.	
12	Buchholz relay.	

13	Set of starter, contactor relays and switches (1 No. of each type and size).	
14	Tap position indicator (Local and remote).	
15	Expansion joint (complete replacement for transformer).	
16	Fuses (control) (complete replacement for transformer).	
17	Lamps (Indicative) (complete replacement for transformer)	

N.B.:-

- (a) The Supplier shall ensure that sufficient spare parts and consumable items are available for his own use during commissioning of the transformer. The spares, provided with the transformer shall not be used by the supplier without the written consent of the Purchaser and any spares, used during the commissioning of the transformer shall be replaced by the supplier at his own expense.
- (b) The Supplier shall provide a list in the schedule, of additional recommended spare parts together with their individual prices. The Purchaser may order at a later date, at a price, indicated on the schedule, such additional spare parts, listed at the time of contract award.
- (c) Spares shall be available during the life of the equipment and the Supplier shall give 12 months notice of his or any Sub-Suppliers, intention to cease manufacture of any component used in the equipment.
- (d) Any spare apparatus, parts and tools shall be subject to the same Specification, tests and conditions as similar material, supplied under this contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts, supplied with the transformer and must be suitably marked and numbered for identification and prepared for storage by greasing and painting to prevent deterioration.
- (e) All spare apparatus or materials, containing electrical insulation shall be packed and delivered in cases, suitable for storing such parts or material over a period of years without deterioration. Such cases shall have to be affixed to both the underside and topside of the lid a list detailing its contents. The case will remain as the property of the Purchaser.

5.5 **CENTRE OF GRAVITY:**

The center of gravity of assembled transformers shall be as low and as near the vertical center line as possible. The transformer shall be stable with and without oil. The location of the center of gravity, relative to track shall be clearly marked in the out line drawing, accompanying bid.

INSPECTION AND TESTING:-

TESTING FACILITIES:-

Bidders shall submit along with the bid, the details of testing facilities, available at their works for carrying out all the routine and type tests, as specified.

In case, the test facilities for any particular test are not available at the bidder's works, this shall be clearly brought out in the additional information schedule and proposed arrangement of carrying out that test shall be clearly indicated.

All the measuring systems, used for the tests have certified, traceable accuracy and are subjected to periodic calibration, according to the rules of 4.11 of ISO 9001 [Ref- CL.No.10 (Tests) of IEC-60076-1]

GENERAL:-

Inspection and testing shall be carried out on the transformer as detailed here and generally in accordance with IEC 76 and IS:2026. The Purchaser shall have the right to reject a transformer, if test results do not comply with the standards/values, specified and informations/data, given in the schedules. For the purpose of determining when type tests are required, a transformer is considered to be representative of others only if it is fully identical in design, rating and construction.

Before and after acceptance testing, samples of oil shall be taken from the transformer and analysed for dissolved gases, using the procedures, specified in IEC Publications 567 and

599. Results of the analysis of gases, dissolved in the oil shall be immediately submitted to the Purchaser and included in the Acceptance Test Report. On completion of acceptance testing, the Supplier shall provide the Purchaser with seven copies of the complete test reports.

Full details of the proposed methods of testing including connection diagrams shall be submitted by the Supplier for approval at least one month before testing. All tests will be witnessed by the Purchaser.

The Purchaser shall have full access at all times to the works and all other places of manufacture of the transformers. The Supplier shall report to the Purchaser monthly or other period, as agreed between the two on manufacturing progress. The Supplier shall give the Purchaser on award of contract a complete manufacturing inspection program to allow the Purchaser, at its discretion, to inspect at all stages of transformer manufacture.

STAGE INSPECTION:-

Stage inspection on core, windings, tank, OLTC and all other accessories etc. will be carried out by the Supplier in the presence of BSPTCL's representative on free of cost to BSPTCL before tanking of the core and windings. The bidder should preferably have in-house core-cutting facility for proper monitoring and control on quality and also to avoid any possibility of mixing of prime material with defective/second grade material. However, the core-cutting operation may be witnessed by BSPTCL's representatives at the works of the manufacturer and specific loss, other tests will be conducted on samples of core materials, selected at random by BSPTCL's representative. All the measurements will be taken on the above components, so as to ensure their compliance to the above Specification and the Guaranteed Technical Particulars. The possible routine tests like measurement of D.C. resistance, no load current and no load loss, determination of Knee Point Voltage, specific core loss, tank tests etc. will be conducted during stage inspection. For determination of number of turns in the windings, the manufacturer shall provide dummy core, so as to accommodate the LV winding and determining the ratio between the unknown No. of turns (winding) and known No. of turns, wrapped around the LV winding. The purchaser's representative at his discretion may choose small strips of core for testing at CPRI/ERDA. Also, a small piece of conductor for each type of winding and core material shall be made available to the purchaser's representative. Apart from the above, the purchaser at his discretion reserves the right to carry out the stage inspection at other stages also, for which advance intimation shall be given and all necessary co-operation shall be rendered by the manufacturer. The Supplier shall give at least three weeks notice in advance for deputing Inspecting Officer(s) to their works. Type Tests and routine tests on the transformer shall be conducted only if the stage inspection report and the pre-tanking tests are found to be in order as per this Specification.

FINAL INSPECTION & TESTING:-

Before offering for final inspection, type tests and routine tests, the Supplier shall furnish the factory test results (except dielectric tests) of the offered transformer(s)

along with list of equipments/meters/instruments, to be used, during testing (both routine and type tests) as per Annex of this Specification along with calibration certificates of measuring instruments. The Purchaser may direct the Supplier for use of better equipments/meters during inspection/testing. The calibration of all the meters/instruments to be used during testing should have been done in Government approved laboratory.

TYPE TESTS & SPECIAL TESTS:-

The followings shall be regarded as type tests and shall be carried out, if required by the Purchaser in presence of Purchaser’s representative.

(a) **Temperature Rise Test:-**

Test of temperature rise (IEC Publ. 76.2): This test shall be carried out on the tap giving the worst combination of loading on the transformer windings. The transformer shall be tested by feeding the tested losses or quoted losses, whichever is higher. The supplier, before carrying out such tests, shall submit detailed calculations, showing the alternatives possible on various taps and for the three different ratings (ONAN/ONAF/OFAF) of the transformer and shall recommend the combination that results in highest temperature rise for the test. Temperature rise shall be measured at ONAN, ONAF & OFAF ratings. Gas chromatographic analysis on oil shall be carried out before and after the temperature rise test and the results recorded in the test report. Sampling shall be in accordance with IEC 60567. For evaluation of the gas analysis in temperature rise test, the procedure shall be as per IS:9434 (based on IEC:60567) and the results will be interpreted as per IS:10593 (based on IEC-60599). These results shall be treated as reference during future maintenance of Transformers. The calibration of OTI and WTI shall be done by transformer manufacturer and these calibrated OTI; WTI shall be used during testing of the transformer. The Sr.No.of WTI and OTI should be recorded during testing of the Transformer and only these OTI & WTI shall be supplied with the Transformer. The Optic Fiber Temperature Sensor System shall be operational during temperature tests and be demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified and temperature data for all probes (hourly readings) recorded and reported in the test report. The final hot spot temperature rise of the windings above ambient temperature after completion of last one hour before taking shut-down for hot resistance measurement shall not exceed 54 deg. C (for ONAN, ONAF & OFAF ratings) and the top oil temperature rise above ambient temperature shall not exceed 40 deg. C (for ONAN , ONAF & OFAF ratings ratings).

(b) **Measurement of Zero Sequence Impedance:-**

Measurement of open circuit and short circuit zero sequence impedances of the primary and secondary windings.

(c) **Auxiliary Power Consumption:-**

Measurement of power taken by fan and oil pump motors.

(d) **Vacuum Test:-**

One transformer tank of each size shall be subject to full vacuum and tested at an internal pressure of 3.33 KN/Sq.m. (25 Torr) for one hour. The permanent deflection of plates after the vacuum has been released shall not exceed the values, specified below and the performance of the transformers shall not be affected in any way.

<u>Horizontal length of flat plate (mm.)</u>	<u>Permanent deflection (mm.)</u>
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5

2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

The purchaser at his discretion may opt for vacuum test for the tanks of all the transformers, by paying extra cost to the supplier at their quoted price(s).

(e) **Pressure Test:-**

One transformer tank of each size together with its radiators, conservator vessel and other fittings shall be subjected to a pressure, corresponding to twice the normal head of oil or to the normal pressure plus 35KN/Sq.m. whichever is lower. The applied pressure shall be measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after excess pressure has been released shall not exceed the values, specified in (d).

The purchaser at his discretion may opt for pressure test for the tanks of all the transformers, by paying extra cost to the supplier at their quoted price(s).

(f) **IP-55 Test:-**

One cooler control cabinet and OLTC cabinet for each type of transformer shall be tested for IP-55 protection in accordance with IS-2147/IEC-529.

- (g) Test reports towards all type tests as per IEC-214:1976 and BS:4571:1970 for the offered OLTC along with approved drawings to be submitted. Purchaser at his discretion may insist on repetition of some or all the applicable type tests as per above IEC & BS.

- (h) Measurement of power taken by fans and oil pumps (Not applicable for ONAN): Losses of each fan and pumps including spare shall be measured at rated voltage and frequency. Fans and Pumps shall be mounted with cooler bank as per approved drawing during measurement. Serial No, Applied voltage, measured current, frequency and make shall be furnished in the test report.

(i) **Dynamic Short circuit withstand test (If specified in TS)**

- (j) Measurement of transferred surge on LV or Tertiary as applicable due to HV lightning impulse and IV lighting impulse (as applicable): Following tests shall be carried out with applying 20% to 80% of rated Impulse & Switching impulse (upto 60% for IV, Sr. No. 7 & 8 of below table) voltage. Finally, measured value shall be extrapolated for 100% rated voltage.

Table for Transfer surge (Impulse) at Max, Nor. and Min. Voltage Tap

Sr. No.	Impulse Type	Voltage applied	Earthed Points	Open / not earthed point	Measurement Point
1	FW	1.1	2.1, N & 3.2	-	3.1
2	FW	1.1	2.1, N & 3.1	-	3.2
5	FW	2.1	1.1, N & 3.2	-	3.1
6	FW	2.1	1.1, N & 3.1	-	3.2

Similar tests to be conducted for switching surge transformer at Max, Nor. and Min. Voltage Tap.

Where

1.1	:HV Terminal
2.1	:IV Terminal
3.1 & 3.2	:LV or Tertiary Terminal

Acceptance criteria

Transfer surge at Tertiary should not exceed 250kVp at any conditions for 400kV Voltage class Transformer. For other transformer it shall be below the impulse level of LV winding.

- (k) Lightning impulse test for the neutral terminals (LIN)

ROUTINE TESTS:-

The followings shall be regarded as routine tests and shall be conducted on each transformer in the presence of purchaser's representative. No extra cost shall be paid for these tests.

- Gas-in-oil analysis
- Appearance, construction and dimension check
- Short duration Heat run test
In addition to the type test for temperature rise conducted on one unit, each cooling combination shall routinely be subjected to a short term heat run test to confirm the performance of the cooling system and the absence of manufacturing defect such as major oil flow leaks that may bypass the windings or core.

DGA samples shall be taken at intervals to confirm the gas evolution.

For OFAF cooling, the short term heat run test shall be done with the minimum number of pumps for full load operation in order to shorten the temperature build up. Each short term heat run test is nevertheless expected to take about 3 hours.

For OFAF cooled transformers an appropriate cross check shall be performed to prove the effective oil flow through the windings. For this purpose the effect on the temperature decay by switching the pumps off/ on at the end of the heat run

should demonstrate the effectiveness of the additional oil flow. Refer to SC 12, 1984 cigre 1984 SC12-13 paper by Dam, Felber, Preiniger et al.

Heat run test may be carried out with the following sequence:

- Heat run test with pumps running but oil not through coolers.
- Raise temperature to 5 deg less than the value measured during temperature rise test.
- Stop power input and pumps for 6 minutes and observe cooling down trend
- Restart pumps and observe increased cooling trend due to forced oil flow

This test is applicable for the Transformer without Pump also (ONAN or ONAFrating).

For such type of transformer test may be carried out with the following sequence:

Arrangement shall be required with pump of suitable capacity (considering the oil velocity) without cooler bank. Raise the oil temperature 20-25 deg C above ambient. Stop power input and pumps for 6 minutes and observe cooling down trend. Restart pumps and observe increased cooling trend due to forced oil flow.

- -High voltage with stand test on auxiliary equipment and wiring after assembly

- -Line terminal AC withstand voltage test (LTAC)
- -Measurement of insulation power factor and capacitance between winding and earth and Bushings
- Induced voltage test with PD measurement (IVPD)
- Core assembly dielectric and earthing continuity test: After assembly each core shall be tested for 1 minute at 2000 Volts between all yoke clamps, side plates and structural steel work (core to frame, frame to tank & core to tank).

The insulation of core to tank, core to yoke clamp (frame) and yoke clamp (frame) to tank shall be able to withstand a voltage of 2 kV (DC) for 1 minute. Insulation resistance shall be minimum 1 GΩ for all cases mentioned above.

- Measurement of insulation resistance

(a) Measurement of winding resistance.:

After the transformer has been under liquid without excitation for at least 3 h, the average liquid temperature shall be determined and the temperature of the winding shall be deemed to be the same as the average liquid temperature. The average liquid temperature is taken as the mean of the top and bottom liquid temperatures. Measurement of all the windings including compensating (in case terminal is available at outside) at normal and extreme taps.

In measuring the cold resistance for the purpose of temperature-rise determination, special efforts shall be made to determine the average winding temperature accurately. Thus, the difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by a pump.

(b) Voltage- ratio measurement and check of vector group.

- (c) Measurement of capacitance and dielectric dissipation factor.** (Before and after the series of dielectric tests). The capacitance test shall be carried out with the

help of ampere turn bridge method on fully assembled transformer (filled with oil) to determine capacitance and tan delta between winding and earth as under:

- HV and IV winding with LV winding and tank earthed.
- LV winding with IV and HV winding and tank earthed.
- HV, IV and LV windings with tank earthed.

- (d) Measurement of Polarization Index:-** This measurement shall be made with ten minute and one minute IR tests and should be repeated after all other tests.

(e) Impulse Test:

- Full Wave Impulse Voltage withstand Test:- The test voltage shall be applied to each line. The applied voltage shall be the relevant lightning impulse voltage, specified in the schedule of requirements. This test shall be applied to each HV, IV & LV Phase terminal.
- Chopped wave impulse voltage withstand test:- The test voltage shall be applied to each line terminal. The applied voltage shall be 100% of the specified relevant lightning impulse voltage. This test shall be applied to each HV, IV & LV Phase terminal.

- (iii) Switching Impulse Tests, if applicable as per relevant IEC shall be applied on each phase terminal.
- (iv) An impulse test on transformer neutrals as per IEC-76-3 Clause 12.3.2 shall be carried out.
- (v) Measurement of transferred surge on LV (tertiary winding) due to HV lightning Impulse and IV lightning Impulse.

Tests (i) and (ii) shall be combined in a single sequence as follows for each line terminal:-

1. One reduced full impulse (calibration).
2. One 100% full impulse.
3. One or more reduced chopped impulse(s).
4. Two 100% chopped impulses.
5. Two 100% full impulses.

The sequence for test (iii) shall be as follows:-

1. One reduced full impulse at 50-75% of full level.
2. Three 100% full impulses.

In carrying out the above tests, the two extreme taps and another tap to be selected by the purchaser with each of the three phases, being tested on a different tap.

(f) Separate source voltage withstand test:-

The applied voltage shall be the specified/relevant power frequency voltage.

(g) Induced over-voltage withstand test:-

Test shall be carried out as per IEC-76-3, clause 11.4 (Method 2). The firm shall have to submit the over-potential diagram with details of calculation and explanation along with the offer for inspection.

(h) Partial discharge test:-

This test shall be carried out using a broad band instrument. The voltage time envelope shall be as described in clause 11.4 of IEC 76-3. The apparent charge (q) shall be in accordance with IEC 76-3.

(i) Measurement of Impedance voltage on all taps.

(j) **Measurement of the load loss** at normal tap and extreme taps. (To be carried out by three wattmeter method with low power factor wattmeters at full rated current).

(k) Measurement of no load loss, no load current and determination of kneepoint voltage:-

This test is to be carried out with three wattmeter method by using low power factor wattmeters, three power factor meters, phase sequence meters, three low range ammeters and three each of average value and RMS value voltmeters. The test voltage from 10% voltage to 121% voltage shall be applied and currents, voltages (Average value and RMS value), wattmeters, power factor and frequency meter readings in all the three phases are to be recorded during the test. A saturation characteristic curve between the no load voltage (rms) vs. Measured current is to be plotted on the graph sheet, so as to determine the voltage at which increasing voltage by 10% (ten percent), the excitation current shall not increase by more than 50% (fifty percent). The knee point voltage as per specification will be complied if the excitation

current at 121% of rated no load voltage shall not exceed by not more than 50% over the excitation current, obtained at 110% of the rated no load voltage. During the no load test, supplier's own generator set shall be used for feeding the above no load voltages at rated frequency. If the applied frequency is greater than the rated frequency, then proportionate voltage as per the rated frequency will be fed during the above no load test and following frequency correction formula along with the formula, stipulated at Clause No 16.5 of IS:2026(Part-I) shall be used.

$$K = 0.5 [(f/f_1) + (f/f_1)^2]$$

Where f = rated frequency and f_1 = applied frequency.

For Example:- If measured loss = X Watts, correction factor due to r.m.s. and average

voltage as per ISS = K_1 and frequency correction factor = K as per above formula, then corrected loss will be calculated as = measured loss $\cdot K_1 \cdot K$.

If applied frequency is less than the rated frequency, no frequency correction formula will be applied. Rated voltage at that frequency will be fed during the no load test.

- N.B.:- 1) If power analyser is to be used for determination of no load loss, no load current, Impedance Voltage, short circuit losses etc., its manual of operation, calibration certificate and the relevant standard for its use shall be produced prior to one month of test offer for studying its feasibility and reliability.
- 2) C.Ts. and P.Ts. of accuracy class 0.2 or better as per IS:2705 are to be used during determination of no load losses and short circuit losses which involves financial implication. The calibration certificates of these C.Ts. & P.Ts. from independent Government approved laboratory shall be produced along with the traceability while offering for inspection. The accuracy class of reference standard C.T. & P.T. used for determination of the errors of the above C.Ts. & P.Ts. shall be 0.05 or better as per Clause No.2.9 of IS:1248 (Part-9).
- (l) **Measurement of Harmonic level** (1st to 24th Harmonic) in no-load current in all three phases at 90%, 100% and 110% of no-load voltage. The magnitudes of no load currents for all the three phases at the above excitation levels shall also be recorded and reflected in the test report for measurement of harmonic levels. (in type test)
- (m) **Measurement of capacitance and dielectric dissipation factor** [Repeat (c) above].
- (n) **Measurement of polarisation Index** (Repeat (d) above).
- (o) **Tests on no-load tap-changer** (as per IS:2026. Besides, following tests shall be carried out in accordance with IS:8468/IEC 214):- (Ten complete cycle before LV test)
- i) Mechanical test of diverter switch insert.
 - ii) Sequence test (switching time).
 - iii) Pressure test of the Tap selector switch oil compartment.
 - iv) Mechanical test of Tap selector with motor drive.
 - v) Operation test of the complete Tap changer.
 - vi) Dielectric test of the Motor Drive Unit.
- (p) **Transformer noise measurement:-** (in type test)

Noise level measurement in accordance with IEC Publication 551 using a precision sound level meter conforming to IEC Publication 651.

- (q) **Auxiliary circuit tests:-**
All auxiliary circuits shall be subjected to application of 2KV (rms) withstand test voltage. Correct operation of all auxiliary control circuits will be tested.
- (r) **Core earth test:-**
A test voltage of 2KV shall be applied between the core and the earthed structural steel work to prove that the core is earthed through the removable link, at one point only.
- (s) **Oil BDV test.**
- (t) Measurement of Neutral current during load loss test which shall not be more than 2% of the rated current of the transformer.
- (u) **Magnetic balance test. (for three phase Transformer only)**
- (v) **DGA test before and after all the tests.**
- (w) **Oil Leakage test on transformer tank:-**
All tanks and oil-filled compartments shall be tested for oil tightness by completely filling with oil of viscosity, not greater than that of insulating oil, conforming to IS:335 at the ambient temperature and applying a pressure, equal to the normal pressure plus 35KN/Sq.m., measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours, during which time, no leakage shall occur. Bidder shall arrange for witnessing the leakage test of each tank.
- (x) **Pressure Relief Device Test:-**
The pressure relief device of each size shall be subjected to increasing oil pressure. It shall operate before reaching the test pressure, specified at Cl.No.5.4.4 of this specification. The operating pressure shall be recorded. The device shall seal off after the excess pressure has been relieved. The following functional checks shall be conducted as acceptance tests on each of the pressure relief devices.
- i) Air- Pressure Test.
 - ii) Liquid Pressure Test.
 - iii) Leakage Test.
 - iv) Contact Test.
 - v) Di-electric Test.
- (y) **Frequency Response Analysis (FRA) test:-**
The supplier shall conduct the test at the time of final testing of the transformer and record the amplitude and phase shift results on CDS for subsequent analysis. The test shall also be carried out by the supplier before commissioning at site and compare this result with the results, obtained before dispatching the transformer and submit the report along with the above results in CDs for future analysis. Each transformer is subjected to FRA test and frequency responses, recorded as above and analysed in any of the following:-
- i) Shift in the response of the winding.
 - ii) Differences between the responses of all the phases of the transformer.
- (z) **Dew point measurement test before dispatching:-**
Positive Gas pressure is generally maintained at 0.175 Kg/m² during transportation and during storage. To ensure the same, dew point measurement shall also be carried out at site. The procedure and acceptance limits are as per CBIP Manual Pub. No.295 (2006) or latest.

Besides the above, the OLTC manufacturer shall conduct the following routine tests fully in compliance with IEC:60214 on every unit, as given below, for which no extra cost

will be payable by BSPTCL. BSPTCL will authorize its representative(s) for witnessing the said routine tests on any or some or all the OLTCs for the Transformers as per contract. It is the responsibility of the supplier to offer the OLTCs for following routine tests, to be conducted at the works of OLTC Manufacturer.

Sl.no.	Test Description	Acceptance level
01.	60214 I. No.5.3.1 Mechanical Endurance Test	Minimum 1000 operations
02.	60214 Cl. No.5.3.2 Sequence Test	Switching operation with timing less than 50 m-secs.
03.	60214 Cl. No.5.3.4 Pressure Test	10PSI (0.7kg/sq.cm.) for 8hours at room Temperature.
04.	60214 Cl. No.5.3.4 Vacuum Test	Vacuum level, as guaranteed by manufacturer
05	Special Test Gas tightness Test,	Helium based or any other mutually agreed method.
06	60214 Cl. No.5.3.4 Auxiliary Circuits Insulation Test	Should withstand 2kV relative to earth for 1 Minute
	Special Test Contact resistance	< 2 milli- Ohms
	Special Test Physical & Dimensional Checks.	As per approved drawing

All the relevant Test reports shall be submitted for BSPTCL's approval

N:B- The Purchaser reserves the right to have the tests carried out on the transformer(s) at his own cost in an independent Government approved laboratory to ensure that the Transformer complies with the requirements of this Specification.

6.4.3 **TESTS ON SITE:-**

The following site tests shall be performed on all units:-

- (a) General mechanical checks.
- (b) Core and winding insulation tests (Earth fault check on arrival at site).
- (c) Ratio and HV magnetisation current tests.
- (d) Vector group check.
- (e) Motors - Overload protection tests.
- (f) Motor pumps and motor/fans - Direction of rotation check for correct flow.
- (g) Buchholz device tests.
- (h) Silicagel breather check.
- (i) Temperature instrument calibration and tests.
- (j) Operational tests on tap change equipment.
- (k) Electric strength tests on insulating oil.
- (l) Bushing tests.
- (m) Impedance voltage at highest, rated and lowest voltage taps.
- (n) Zero sequence impedance at rated voltage tap.
- (o) DC resistance at all voltage taps.
- (p) Correct operation of all C.Ts
- (q) On-load tests.

TEST REPORTS:-

- (a) Six (6) sets of certified test reports and oscillograms shall be submitted for approval prior to the dispatch of the equipment. The equipment shall be dispatched only when all the required type and routine tests have been carried out and test reports have been approved by the Purchaser.
- (b) Each test report shall contain the following information:-
 - (i) Complete identification, date, including serial number of the transformer.
 - (ii) Method of application, where applied, duration and interpretation of test results for each test.
- (c) Four (4) copies of the test reports for the tests carried out on the ancillary apparatus be furnished to the Purchaser for approval prior to dispatch.
- (d) All auxiliary equipments/accessories shall be tested as per the relevant standards for the tests, as mentioned in this Specification. Test Certificates for the same shall be submitted to the Purchaser in four copies for scrutiny and record.

8.0 LIST OF TRANSFORMER ACCESSORIES AND TEST CERTIFICATES REQUIRED FOR THEM:-

Before offering for stage inspection of the Transformer, the supplier shall have to furnish the test certificates for the Transformer accessories, as enumerated below, wherever required.

<u>Sl. No.</u>	<u>Accessory</u>	<u>Ref. Standard</u>	<u>Test Certificates required.</u>
1.	Condenser Bushing	IS-2099	1. Appearance, construction and dimensional check. 2. Test for leakage of internal filling at a pressure of 1.Kg/Cm ² for 12h. 3. Insulation resistance measurement with 2 KV megger. 4. Dry power frequency voltage withstand test. 5. Dry power frequency voltage withstand test for test tap

			insulation.
			6. Partial discharge measurement upto 1.5UN/ 1.732KV
			7. Measurement of tan delta and capacitance.
2.	Bushings.	IS-2099	<ol style="list-style-type: none"> 1. Appearance, construction and dimensional check. 2. Insulation resistance measurement with 2 KV megger. 3. Dry power frequency voltage withstand test.
3.	OLTC	IS-8468	<ol style="list-style-type: none"> 1. Oil tightness test for the diverter switch oil chamber at an oil pressure of 0.5 Kg/Cm² at 100 degree C for 1 h. 2. Mechanical operation test. 3. Operation sequence measurement. 4. Insulation resistance measurement using 2 KV Megger. 5. Power frequency voltage withstand test on diverter switch to earth and between even and odd contacts. 6. Power frequency voltage withstand test on tap selector between maximum and minimum taps, between phases and supporting frames, between phases. 7. Operation test of complete tap changer. 8. Operation and dielectric test of driving mechanism.
4	Winding temperature indicator.		<ol style="list-style-type: none"> 1 Calibration test. 2 Dielectric test at 2 KV for one minute. 3 Accuracy test for indication and switch setting scales. 4 Test for adjustability of switch setting. 5 Test for switch rating. 6 Measurement of temperature rise with respect to the heater coil current.
5	Oil temperature indicator.		<ol style="list-style-type: none"> 1 Calibration test. 2 Dielectric test of 2 KV for one minute. 3 Accuracy test for indication and switch setting scales. 4 Test for adjustability of switch setting. 5 Test for switch rating.
6	Pressure Relief Valve.		<ol style="list-style-type: none"> 1 Functional test with compressed air to check bursting, pressure indication, flag operation and switch operation. 2 Dielectric tests at 2 KV for one minute. 3 Switch contact testing at 5A, 240V AC.
7	Cooling fan.	IS:2312	<ol style="list-style-type: none"> 1. Insulation resistance measurement. 2. Dielectric test at 2 KV between winding and body for 1 minute. 3. Operation check. 4. Appearance, construction and Dimensional check.
8	Buchholz ` Relay.	IS-3637	<ol style="list-style-type: none"> 1. Leak test with transformer oil at a pressure of 3 Kg. /Cm² for 30 minutes at ambient temperature for relay casing. 2. Insulation resistance measurement with 500 VMegger. 3. Dielectric test at 2 KV for 1 minute.

			<ol style="list-style-type: none"> 4. Elements' test at 1.75 Kg/ Cm² for 15 minute using transformer oil at ambient temperature. 5. Loss of oil and surge test. 6. Gas volume test. 7. Mechanical strength test. 8. Velocity calibration test. 9. Appearance, construction and dimensional check.
9.	Oil level Indicators.		<ol style="list-style-type: none"> 1 Test for oil levels. 2 Switch operations for low level alarm. 3 Switch contact test at 5A, 240V, A.C. 4 Dielectric tests at 2 KV for 1 minute. 5 Appearance, construction and dimensional check.
10	Pressed Steel Radiators.		<ol style="list-style-type: none"> 1. Air pressure test at 2 Kg/ Cm² under water for 15 minutes. 2. Appearance, construction and dimensional check.
11	OLTC Control Cubicle/cooler control cubicle.		<ol style="list-style-type: none"> 1 Appearance, construction and Dimensional check. 2. Electrical operation. 3. Insulation resistance measurement using 500 V megger at ambient temperature. 4. Dielectric test at 2 KV for 1 minute.
12	Bushing current transformer.	IS-2705	<ol style="list-style-type: none"> 1. Appearance, construction and dimensional check. 2. Polarity check. 3. Measurement of insulation resistance. 4. High voltage power frequency test. 5. Determination of ratio error and phase angle of measuring and protection BCTS. 6. Determination of turns ratio error for PS Class BCTS. 7. Inter-turn insulation withstand test. 8. Excitation current characteristic test. 9. Secondary winding resistance measurement. 10. Knee-point voltage measurement for PS Class BCT.
13	Pressure gauges/ differential pressure gauges.		<ol style="list-style-type: none"> 1. Appearance, construction and dimensional check. 2. Calibration test. 3. Alarm contact setting test.
14	Transformer Oil Pump	IS-325 & IS-9137	<ol style="list-style-type: none"> 1. Insulation resistance measurement. 2. Cold resistance measurement at ambient temperature. 3. Motor efficiency at full load. 4. No load voltage, current, power input, frequency and speed. 5. Locked-rotor readings of voltage, current

- and power input.
6. Water pressure test for pump casing at 5Kg/Cm² for 10 minutes at ambient temperature.
 7. Transformer oil pressure test for the pump set assembly at 2Kg/ Cm² for 30 minutes at 80° C.
 8. Measurement of head discharge, current, power input to motor and overall efficiency of the pump set at rated voltage.
 9. Appearance, construction and dimensional check.
 1. Observation of flow with respect to requirement.
 2. Switch contact test at 5A, 240V A.C.
 3. Dielectric test at 2KV for 1 minute.
- 15 Oil flow Indicator.
4. Appearance, construction and dimensional check.

INSPECTION:-

GENERAL:-

- (i) The purchaser shall have access at all times to the works and all other places of manufacture where the transformer is being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting necessary tests, as detailed herein.
- (ii) The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of the manufacture of the equipment in its various stages so that arrangements could be made for inspection.
- (iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.
- (iv) The acceptance of the equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection of such equipment, if found to be defective later.

INSPECTION PROGRAMME:-

- (a) The supplier shall chalk out a detailed inspection and testing programme for manufacturing activities for the various components. An indicative programme of inspection as envisaged by the purchase is given below. This is not however intended to form a comprehensive programme, as it is supplier's responsibility to draw up and carry out such a programme, duly approved by the Purchaser. Stage inspection on core and winding will be carried out before tanking of core. For this, the supplier shall give at least three weeks notice in advance. **The purchaser reserves the right to carry out the stage inspection, final inspection & testing by a third party.**
- (b) Additional tests, if required, are deemed to be included in the scope of work.
- (c) Stages of inspection and purchaser's participation would be defined and tied up at the time of award of contract within 15 days of issue of the Purchase order.
- (d) The supplier shall arrange all his tests in such a fashion that the inspection and testing shall not exceed 5 (five) days for the above transformer.
- (e) On site testing, if any discrepancies will occur, the supplier will be asked immediately for its rectification and the supplier shall depute his representative for rectification without any delay.

- (f) At the time of final inspection, the supplier shall identify each & every item/accessories of the particular Transformer under testing. Unless all items are identified, the manufactures will not be treated as complete. Serial No. of bushings, Tap-changer, WTI, OTI and other details shall be entered into the Test reports to ensure that these items are not being applied to the subsequent Transformer units while testing. Various tests as per the specification shall be performed in the presence of BSPTCL Engineers or when the inspection waiver has been given, in such a case, the testing as per the specification shall be done at the manufacturers works and same should be confirmed by documentary evidence by way of Test Certificate, which shall be got approved by BSPTCL.
- (g) In case, for any reason(s), inspection is not completed or the equipment is not found to be complete with all accessories as per confirmation, given with the inspection call, the purchaser reserves the right to recover the complete cost of deputation of inspection team to the works of the manufacturer.
- (h) The supplier shall submit the test certificates of the bought-out items and Raw materials at the time of the routine testing of the fully assembled equipments.
- (i) It may be noted that “No change in any accessory or associated equipment after passing all the tests successfully shall be allowed and if this is subsequently detected, it shall be binding on the supplier to replace with the same item with which the initial tests were conducted at his works, failing which the entire test shall become null & void. The purchaser at his discretion may consider for rejection of the units, thus supplied. The entire cost for replacement of such rejected units, thus supplied and for repeating acceptance tests shall be borne by the suppliers.

TANK AND CONSERVATOR:-

- (a) Certification of chemical analysis and material test of plates.
- (b) Welder’s qualification and welding procedure.
- (c) Testing of electrodes for quality of base materials and coatings.
- (d) Inspection of major weld preparation.
- (e) Crack detection of major strength weld seams by dye penetration test.
- (f) Measurement of film thickness of:
 - (i) Oil insoluble varnish.
 - (ii) Zinc chromate paint.
 - (iii) Finished coat.
- (g) Check correct dimensions between wheels, demonstrate turning of wheels through 90 degree and further dimensional check.
- (h) Check for physical properties of materials for lifting lugs, jacking pads etc. All load bearing welds including lifting lug welds shall be subjected to N.D.T.
- (i) Leakage test of the conservator.
- (j) Certification of all test results.

CORE:

- (a) Sample testing of core material for checking specific loss, bend properties, magnetisation characteristics and thickness.
- (b) Check on quality of varnish, if used on the stampings.
 - (i) Measurement of thickness and hardness of varnish on stamping.
 - (ii) Solvent resistance test to check that varnish does not react in hot oil.
 - (iii) Check overall quality of varnish by sampling to ensure uniform shining colour, no bare spot, no over-burnt varnish layer and no bubbles on varnished surface.
- (c) Check on the amount of burrs.
- (d) Bow-check on stampings.

- (e) Check for overlapping of stampings, corners of the sheets are to be apart.
- (f) Visual and dimensional check during assembly stage.
- (g) Check for interlaminar insulation between core sections, before and after pressing.
- (h) Check on completed core for measurement of iron loss, determination of knee point voltage and check for any hot spot by exciting the core so as to induce the designed value of the flux density in the core.
- (i) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- (j) High voltage test (2 KV for one minute) between core, its bolts and clamps.
- (k) Certification of all test result.

INSULATING MATERIAL.

- (a) Sampling check for physical properties of materials.
- (b) Check for dielectric strength.
- (c) Visual and dimensional check.
- (d) Check for the reaction of hot oil on insulating materials.
- (e) Dimensional stability test at high temperature for insulating material.
- (f) Tracking resistance test on insulating materials.
- (g) Certification of all tests results.

WINDING:

- (a) Sample check on winding conductor for mechanical properties and electrical conductivity.
- (b) Check insulating distance between high voltage connection, cables and earth and other live parts.
- (c) Check insulating distance between low voltage connection and earth and other parts.
- (d) Check for proper cleanliness and absence of dust.
- (e) Visual dimensional checks on conductor for scratches, dent marks etc.
- (f) Sample check on insulating paper for PH value, electric strength.
- (g) Check for the bonding of insulating paper on the conductor.
- (h) Check for absence of short circuit between parallel strands.
- (i) Check for brazed joints wherever applicable.
- (j) Measurement of voltage ratio to be carried out when core/yoke is completely restacked and all connections are ready.
- (k) Certification of all test results.

CHECKS BEFORE DRYING PROCESS:

- (a) Check condition of insulation on the conductor and between the windings.
- (b) Check insulating distances between high voltage connections, cables and earth and other live parts.
- (c) Check insulating distances between the low voltage connection and earth and other parts.
- (d) Insulation test of core earthing. Insulation of the core shall be tested at 2KV/min. between core to clamp plates and core bolts.
- (e) Check for proper cleanliness and absence of dust etc.
- (f) Certification of all test results.

CHECKS DURING DRYING PROCESS:

- (a) Measurement and recording of temperature, vacuum and drying time during vacuum treatment.
- (b) Check for completeness of drying by measuring IR value and TAN DELTA. Polarisation index of the winding i.e., ratio of IR value taken at 10 minutes

to 1 minute shall be taken. The P.I. Value should not be less than '1.5' or more than '5'.

- (c) Certification of all test results.

ASSEMBLED TRANSFORMER:

Check completed transformer against approved out line drawings, provision for all fittings finish level etc. Jack test with oil on the assembled transformers. DP test shall be carried out after jacking test.

OIL

Site test shall be performed on oil samples before and after filling in the transformer. Oil parameters shall conform to relevant IEC & IS prior to filling at site and oil samples taken from the tank top, bottom and cooling system after filling shall possess characteristics as per above standards. The supplier shall warrant that oil furnished is in accordance with the relevant clause of this specification. The purchaser at his discretion may send oil sample(s) to Govt. approved laboratory for determination of quality of oil including confirmation on percentages of naphthenic and paraffinic content, as specified at Cl. No.5.4.17 (a) of this Specification

The makes of all major bought out items shall be subject to purchaser's approval. The supplier shall also prepare comprehensive inspection and testing programme for all bought out/sub-contracted items and shall submit the same to the purchaser for approval. Such programme shall include the following components.

- (a) Buchholz Relay.
- (b) Axles and wheels.
- (c) Winding temperature indicators for local and remote mounting.
- (d) Oil temperature indicators.
- (e) Bushings.
- (f) Bushing current transformers.
- (g) Cooler control cabinet.
- (h) Cooling equipments.
- (i) Oil pumps.
- (j) Fans/Air blowers.
- (k) Tap changing switch.
- (l) Terminal connectors.

PRE-SHIPMENT CHECK AT SUPPLIER'S WORKS:

- (a) Check for proper packing and preservation of accessories like radiators, Bushings, explosion vent, dehydrating breather, rollers, Buchholz relay, fans, control cubicle, connecting pipes, conservator etc.
- (b) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
- (c) Gas tightness test to conform tightness.
- (d) Deviation of leakage rate and ensure adequate reserve gas capacity.
- (e) Items must be clearly identified by assigning a number, which needs to be tallied with challan.

RECOMMENDED COMMISSIONING CHECKS:

- (a) Check the colour of sillicage gel breather.
- (b) Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.
- (c) Check the bushing for conformity of connection to the lines etc. and tan delta test for bushings at 10 KV (min.)
- (d) Check for correct operation of all protection and alarm.

- (i) Buchholz Relay.
- (ii) Excessive winding temperature.
- (iii) Excessive oil temperature.
- (iv) Low oil flow.
- (v) Low oil level indication.
- (vi) Fan and pump failure protection.
- (e) Check for the adequate protection of the electric circuit supplying the accessories.
- (f) Check resistance of all windings on all the taps.
- (g) Insulation resistance measurement of:
 - (i) Control wiring.
 - (ii) Tap changer motor and control.
 - (iii) Cooling system motor and control.
 - (iv) Main windings.
- (h) Check for cleanliness of the transformer and the surroundings.
- (i) Continuously observe the transformer operation at no load for 24 hours.
- (j) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise, noise level etc.
- (k) Phase sequence and vector group test.
- (l) Ratio tests on all taps.
- (m) Magnetising current test.
- (n) Tan delta measurement of windings.
- (o) 2 kV for 1 minute test between bushing CT terminal and earth.
- (p) Frequency response analysis (FRA). FRA equipment shall be arranged by purchaser.
- (q) DGA of oil just before commissioning and after 24 hours energisation at site.
- (r) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.
- (s) Continuously observe the transformer operation at no load for at least 24 hours.
- (t) Contractor shall prepare a comprehensive commissioning report including all commissioning test results as per Pre-Commissioning Procedures forward to Purchaser for future record.

QUALITY ASSURANCE PLAN:

The Bidder shall invariably furnish following information along with his offer, failing which the offer shall be liable for rejection.

- (i) Statement giving list of important raw materials, names of Sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw material in presence of Bidder's representative, copies of test certification.
- (ii) Information and copies of test certificates as in (i) above in respect of bought out items.
- (iii) List of manufacturing facilities available.
- (iv) Level of automation achieved and list of areas where manual processing exists.
- (v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.
- (vi) Special features provided in the equipment to make it maintenance free.
- (vii) List of testing equipments available with the Bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type,

special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in 'Schedule of Deviations'.

The supplier shall within 30 days of placement of order, submit the following information to the purchaser.

- (i) Name of the raw materials as well as bought-out accessories and the names of sub-suppliers selected from those furnished along-with the offer.
- (ii) Type test certificates of the raw material and bought out accessories.
- (iii) Quality Assurance Plan (QAP) with hold points for purchaser's inspection. The QAP and hold points shall be discussed between the purchaser and the supplier before the QAP is finalised. The QAP shall include all the quality checks as stipulated in this specification.

The supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the fully assembled transformer.

DOCUMENTATION:

All drawings shall conform to relevant International Standards Organisation (ISO) specification. All drawing shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I.Units.

The Bidder shall furnish along-with the bid dimensional drawings of transformer and all other accessories. These drawing shall include the following informations.

- (a) Dimensions.
- (b) Tolerances on dimensions.
- (c) Material designation used for different components with reference to standards.
- (d) Fabrication details such as welds, finishes and coatings.
- (e) Catalogue or part members for each component and the total assembly with bill of materials.
- (f) Identification marking.
- (g) Weight of individual components and total assembled weight.

The supplier shall, within 15 (fifteen) days of placement of order submit four sets of final version of all the following drawings/ documents for purchaser's approval.

- a) Outline dimensional drawings of transformer and accessories.
- b) Table of fittings for OGA.
- c) Combined Rating and Diagram plate.
- d) OIP HV Bushing.
- e) OIP IV Bushing.
- f) LV Bushing.
- g) HVN Bushing.
- h) Twin Bi-directional Roller.
- i) Valve schedule plate
- j) Foundation plan along with weights of foundations.
- k) Oil filling Instruction plate.
- l) Thermo Syphon Filter.
- m) Schematic control and wiring diagram for all auxiliary equipments including OLTC cooler control etc.
- n) GA of Marshalling Kiosk.
- o) General Arrangement of RTCC panel.
- p) Assembly of core with details of stacks dimensions and weights etc.
- q) Details of winding arrangement, conductor cross-section & weights etc.

- r) CT rating plate.
- s) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding Longitudinal and cross-sectional view showing the duct sizes, cooling pipes etc. for the transformer/ heat exchanger, drawn to scale shall be furnished.
- t) Inter connection-cabling diagram between transformer and all panels.
- u) Constructional details and sectional views of on-Load Tap Changer.
- v) Complete bill of materials.
- w) Detailed dimensions, assembly and description of auxiliaries.
- x) Constructional details of tank including material, dimensions thickness, reinforcing members, used, if any.
- y) Galvanising and painting procedure.
- z) Factory Test procedures, lay-out of testing equipments/circuits and Test schedules for tests.
- aa) Commissioning test procedure and report.
- bb) Operation and Maintenance Manual.
- cc) QAP during manufacturing and during erection of the transformer.
- dd) Any other drawings(s) as required by the purchaser.

The purchaser shall communicate his comments/ approval on the drawings/documents to the supplier within reasonable period. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for purchaser's approval within one week from the date of comments. After receipt of purchaser's approval the bidder shall, within one week, submit 15 prints and one good quality reproducible of the approved drawings for purchaser's use.

11.3.2 **DESIGN REVIEW:-**

Transformers shall be designed, manufactured and tested with best International Engineering Practices under strict Quality Control to meet the requirements, stipulated in the Technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric, electrical stresses and electrical clearances shall be maintained during design, selection of raw materials, manufacturing process etc. so that the Transformer provides long life with least maintenance.

The design review will commence after placement of award with successful Bidder and shall be finalized before final drawing approval. **The supplier shall depute their design engineer(s) to BSPTCL for design review and finalisation of drawings. However, the entire responsibility of design shall rest with the manufacturer.**

The representative of the purchaser may visit to the manufacturer's works to inspect design, manufacturing and testing facilities.

The design review shall be conducted generally following the "Guidelines for conducting design reviews, prepared by CIGRE SC12 working Group

12.22. Guidelines for conducting design reviews for power transformers working group A2.36 Task Force 2 (Replaces TB 204).

The manufacturer shall provide all necessary informations and calculations during design review to demonstrate that the Transformer meets the requirements for short circuit strength and durability. The latest recommendations of IEC and CIGRE SC12 shall be applied for short circuit withstand

evaluation.

The manufacturer will be required to demonstrate the use of adequate safety margin for thermal, mechanical, dielectric and vibration etc. to take into account the uncertainties of his design and manufacturing processes.

The scope of such a design review shall at least include the followings:-

- i) Core design
- ii) Winding, tapping and Insulation design
- iii) Short-circuit withstand capability
- iv) Electrical clearances between windings to core (both axially and radially) between windings, outer windings to tank etc.
- v) Thermal design including areas, prone to hot spots including thermal modeling for placement of the Optic Fiber Temperature Sensors.
- vi) Cooler design
- vii) Over-load capacity
- viii) Over-fluxing
- ix) Magnetising Inrush current
- x) Eddy current losses
- xi) Seismic design
- xii) Insulation co-ordination
- xiii) Tank & Accessories
- xiv) Bushings & barrier design
- xv) Tap-changer
- xvi) Protective devices
- xvii) Fans & radiators
- xviii) Oil & oil preservation system
- xix) Corrosion protection
- xx) Electrical and physical interfaces with sub-station
- xxi) Earthing
- xxii) Processing and assembly
- xxiii) Testing capabilities
- xxiv) Inspection and Test plan
- xxv) Transport and storage
- xxvi) Sensitivity of design to specified parameters
- xxvii) Accoustic noise
- xxviii) Spares, inter-changeability and standardization
- xxix) Maintainability
- xxx) Any other design aspect, as deemed necessary
- xxxi) Sensors and protective devices– its location, fitment, securing and level of redundancy
- xxxii) PRD and SPR (number & locations)
- xxxiii) Conservator capacity calculation
- xxxiv) Winding Clamping arrangement details with provisions for taking it “in or out of tank”
- xxxv) Conductor insulation paper details
- xxxvi) Location of Optical temperature sensors
- xxxvii) The design of all current connections
- xxxviii) Location & size of the Valves

The supplier shall also furnish five copies of bound manuals for each transformer covering erection, commissioning, operation and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices. Marked erection drawings shall identify the component parts of the equipment as shipped to enable purchaser to carry out erection with his own personnel. Each manual shall also contain one set of all the approved drawings, type test reports as well as acceptance reports of the corresponding consignment dispatched.

The manufacturing of the equipment shall be strictly in accordance with this Specification, approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection the equipment prior to the approval of the drawings shall be at the supplier's risk.

However, approval of the drawings by the purchaser shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices. The Transformer shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering and the purchaser shall have the power to reject any material, which in his judgement is not in full accordance therewith.

The validity of Type tests of Transformer shall be as per latest CEA guidelines as on the date of opening of part-I of bid, provided that offered transformer is of same or higher voltage class as that of type tested transformer and active materials like – CRGO, copper conductor and insulation material are of same or better grade with respect to type tested unit. Failing which, type testing of transformer shall be carried out by the contractor at his own cost. Further, type test report of Transformer from the same manufacturing plant shall only be acceptable. With regard to Validity of Dynamic short circuit test, refer clause 11.7 below.

Dynamic Short Circuit Test requirement

For 400 kV Class Auto transformer (not applicable in instant tender)

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit test on 315MVA, 400/220/33kV Auto transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report/certificate along with bid. In case bidder has not successfully tested 315MVA, 400/220/33kV Auto transformer for Dynamic Short Circuit test, their bid shall be considered technically non responsive. Further, design review of offered 400 kV Class Auto transformer shall be carried out based on the design of short circuit tested 315MVA Auto transformer.

For 220 kV Class Transformer (not applicable in instant tender)

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit Test on any rating of 220 kV or above voltage class transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report / Certificate along with bid. In case bidder has not successfully tested 220 kV or above voltage class transformer for Dynamic Short Circuit Test, their bid shall be considered technically non-responsive. Further design review of offered 220 kV class transformers shall be carried out based on design of short circuit tested 220 kV or above voltage class transformer.

For 132 kV Class Transformer:

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit Test on any rating of same or above voltage class transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report / Certificate along with bid. In case bidder has not successfully tested 132 kV or above voltage class transformer for Dynamic Short Circuit Test, their bid shall be considered technically non-responsive. Further design review of offered 132 kV class transformers shall be carried out based on design of short circuit tested 132 kV or above voltage class transformer. **(Conducting dynamic short circuit shall be decided by BSPTCL and amount shall be reimbursed on actual basis)**

Vendor and design of transformer will be approved only after submission of Dynamic Short circuit test reports of similar reference transformer as per Annexure-J of latest CEA guidelines (File no. CEA-PS-14-169/2/2019-PSETD Division) and subsequent amendment.

Measurable Defects

The following shall constitute as Measureable Defects for the purpose of Defect Liabilities as per relevant clauses of GCC / SCC of the bidding document:

- a) Repair, inside the Transformer and OLTC (including oil migration) either at site or at factory is carried out after commissioning.
- b) The concentration of any fault gas is more than values of condition-1 indicated in clause no 6.5 of IEEE-C57.104-2008, which are as detailed below.

H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
100	120	1	50	65	350	2500	720

- c) The winding tan delta goes beyond 0.005 or increase more than 0.001 within a year w.r.t. pre-commissioning values. No temperature correction factor shall be applicable for tan delta.
- d) The moisture content goes above 12 ppm at any temperature during operation including full load.

TEST REPORTS:

- (i) Four copies of type test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser to the supplier.
- (ii) Four copies of routine test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only thereafter shall the materials be dispatched.
- (iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- (iv) All test reports for tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

TRANSPORTATION, PACKING AND FORWARDING:-

The supplier shall dispatch the transformer, filled with oil or in an atmosphere of nitrogen or dry air at positive pressure. In the former case, the supplier shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangement shall be ensured by the supplier to take care of pressure drop of nitrogen or dry air during transit and at site of installation. The nitrogen or dry air cylinder, provided to maintain positive pressure can be taken back by the supplier after oil filling. A gas pressure-testing valve with necessary pressure gauge and adapter valve shall be provided. Generally, the duration of the storage of transformer at site with dry air, shall preferably be limited to three months, after which the Transformer shall be processed as per the recommendation of manufacturer if not filled with oil. The dry air cylinder(s) provided to maintain positive pressure can be taken back by the contractor after oil filling. In case turret, having insulation assembly, is transported separately then positive dry air pressure shall be ensured. Transformer shall also be fitted with at least one “Electronic Impact Recorder” (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions, which can be withstood by the equipment during transportation and handling in all three directions, (shall not exceed “3g” for 50mSec (20Hz) or as per contractor standard, whichever is lower), shall be submitted by the supplier during detailed engineering. The recording shall commence in the factory before dispatch and must continue till the unit is received/installed at destination sub-station. The data of electronic impact recorder(s) shall be downloaded at site and a soft copy of it shall be handed over to Engineer-in-charge. Further, within three weeks, the supplier shall communicate the interpretation of the data.

The equipment shall be suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate handling during transfer, loading and unloading. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Whenever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

Each consignment shall be accompanied by a detailed packing list containing the following informations:-

- (a) Name of the consignee.
- (b) Details of consignment.
- (c) Destination.
- (d) Total weight of consignment.
- (e) Sign showing upper/lower side of the crate.
- (f) Handling and unpacking instructions.
- (g) Bill of materials indicating contents of each package.
- (h) Two sets of approved copies of drawings, instruction and commissioning manuals, approved test certificates and certificates of bought out items, approved copies of guarantee certificate.

The supplier shall ensure that the packing and bill of materials are approved by the purchaser before dispatch.

The Contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities for the transportation of the equipment. The dimension of the equipment shall be such that when packed for transportation, it will comply with the requirements of loading and clearance restrictions for the selected route. It shall be the responsibility of the contractor to coordinate the arrangement for transportation of the transformer for all the stages from the manufacturer's work to site.

The contractor shall carry out the route survey along with the transporter and finalise the detail methodology for transportation of transformer and based on route survey; any modification/ extension/ improvement to existing road, bridges, culverts etc. if required, shall be in the scope of the contractor.

The inland transportation of the Transformer shall be on trailers equipped with GPS system for tracking the location of transformer at all times during transportation from manufacturer works to designated site. The contractor shall intimate to Employer about the details of transporter engaged for transportation of the Transformer for tracking the Transformer during transit. Requirement of **Hydraulic trailer** is envisaged for 400kV class Transformers.

13.0 SUPERVISION OF ERECTION, TESTING AND COMMISSIONING (ET&C):

The erection, testing and commissioning of the transformers shall be supervised by trained personnel (Engineer) of the supplier. The Engineer shall direct the sequence of ET& C. The Engineer shall correct in the field, any errors or omissions on the part of the supplier, in order to make the equipment and material properly perform in accordance with the intent of this specification. The Engineer shall also instruct the plant operators in the operation and maintenance of the commissioned equipment. The supplier shall be responsible for any damage to the equipment, on commissioning the same, if such damage results from faulty or improper ET&C procedure. Purchaser shall provide adequate number of skilled/semi-skilled workers as well as all ordinary tools and equipment and cranes required for equipment erection, at his own expenses. Apart from the above, the purchaser shall not be responsible for any other expenses such as Engineer's salary, insurance against personal injuries to the Engineer etc. Special tools, if required for erection and commissioning, shall be arranged by the supplier at his cost and on

commissioning, these shall be supplied to the purchaser, free of cost for future use. The supervision of erection, testing and commissioning charges will be borne by the Purchaser as per tender .

QUANTITY AND DELIVERY REQUIREMENTS:

- (i) This is set out in Annexure -I of this Specification.
- (ii) The scope of supply shall also include supply of 2.5% extra quantity of bolts, nuts, washers, split pins, cotter pins and such other small loose items, free of cost in addition to the materials/equipments as spelt out in this specification.

15.0 Values quoted in the G.T.P. and in details of loss calculations shall not differ. In case if it differs, then values quoted in the G.T.P. will be taken as final for all purposes.

METHOD OF TECHNICAL EVALUATION:

Bids will be evaluated in the following manner.

- (a) To check the flux density at the rated voltage i.e., 132KV/33KV rated frequency i.e., 50 Hz and maximum stacking factor as 0.97.
- (b) To check the data furnished in the GTP as correct as per the Technical Specification. If on calculation, GTP data will be different from the calculated data, then the bid will not be considered or owner may take any other decision. GTP furnished in incomplete shape may not be considered for evaluation.
- (c) If HI-B or better grade sheet steel for core material has not been quoted and specific loss and B-H curve for the said material alongwith the materials name and test report has not been furnished, the bid will be rejected. Details of HIB core particulars like length, Breadth, thickness of each stack alongwith core dia., L.V. & H.V. No of turns and lamination thickness, weight of core shall be submitted alongwith the bid failing which tender will be liable for rejection.
- (d) Bid will be rejected, if firm will not accept all the specified Technical terms and conditions.
- (e) The Bidder shall submit alongwith the bid the graph depicting the saturation characteristic curve between the no load voltage (RMS) vs.-measured excitation current starting from 10% of rated no load voltage to 125% of the same, failing which the tender is liable for rejection. The knee point voltage shall have to satisfy the specified value as per the criteria stipulated at Clause No.4 (18) of this Specification.
- (f) The Bidder shall submit alongwith the bid the graph depicting the saturation characteristic curve between the no load voltage (RMS) vs.-measured excitation current starting from 10% of rated no load voltage to 125% of the same, failing which the tender is liable for rejection. The knee point voltage shall have to satisfy the specified value as per the criteria stipulated at Clause No.4 (18) of this Specification.

Bidders are required to be careful in choosing the maximum flux density, best possible core materials (HIB or better) and type of corner joints of the core etc.so as to quote the practicable no-load current at different percentages of rated no-load voltage as per given GTP format and submit a linear graph along with the tender, confirming to achieve the specified minimum knee point voltage i.e.110% of the rated voltage during no-load test as per the method, stipulated at CL.No.6.4.2 (k) of this Technical Specification, which will be confirmed through testing both during stage inspection and final inspection.

17.0 VENDOR SELECTION FOR MOUNTING ACCESSORIES:

S. No.	Item Description	Proposed make
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1.	Core	Core materials to be procured directly from authorized dealer of CRGO manufacturer
		POSCO, Korea
		NIPPON, Japan
2.	Winding	JFE, Japan
		HINDALCO
		Hindustan Copper
	Sterlite	
CTC Conversion	Asta India, Vadodara	
	KSH International, Chakan	
3.	Transformer Oil	Precision Wires, Silvassa
		Sri Cables & Conductors (P) Ltd., Bhopal
4.	Paper Insulation for Conductor	APAR Industries, Silvassa
		Weidman Electrical, Switzerland
5.	Pre-compressed Board	Smurift Munksjo, Sweden
		ABB, Sweden
		H Weidman, Switzerland
		Senapathy Whiteley, Bangalore
6.	Un-impregnated Densified Wood	Raman Boards, Mysore
		Permali Wallace, Bhopal
7.	Bushing CT	Western India Plywood, Cannanore
		Mahindra Electricals, Mumbai
		BHEL, Bhopal
		Pragati Electricals Pvt. Ltd., Thane
8.	Tank	A.U. Electric Machines, Allahabad
		Self manufacturing as well as out sourced
	Tank fabricator	SAIL, RINL, TISCO, IISCO
		Jyoti fabricators, Allahabad
9.	OIP Bushing	Satyam Industries, Bhopal
		CGI, Nasik/Aurangabad
		Precision Engineers, Mumbai
10.	Porcelain Bushing Insulator	Alstom
		CJI, Khurja
		W S Industries, Chennai
		Jayashree Insulators, Halol
11.	Rubber Gasket	BHEL, Bangalore
		Nu Cork Products, Bhiwadi

		Bombay Oil Seal Mfg Co., Mumbai
12.	Marshalling Box	BHEL, Bhopal
		Pyrotech, Udaipur
		C&S, Noida
		United Industrial Components Co., Navi Mumbai
		Ashoka Electronic, Bhopal
		Own make subject to valid type test report
13.	Terminal Connector	Nootan, Vadodara
		Milind Engineering, Mumbai
14.	Buccholz Relay	Sukrut Electric, Pune
		ASPE, Italy
		Instrument & Control, Vadodara
		A J Services (Prayog), Mumbai
15.	OTI/WTI	Perfect Control, Chennai
		Precimeasure, Bangalore
16.	OLTC	BHEL, Bhopal
		CTR, Pune
		ABB, Sweden
		Easun MR, Chennai
17.	Radiators	CTR, Pune
		TARANG Engineering, Nagpur
		Hi Tech Radiators, Mumbai
		Thermal Transfer, Bangalore
		Gururaj Radiators Pvt. Ltd., Naini
18 a.	Silicagel Breather (Maintenance free)	ABB
		MESSKO
		Qualitrol
18 b.	Silicagel Breather	Yogaya Enterprises, Jhansi
19.	Fibre Optic Sensor	Lumasense, Canada
		Noeptix Ino, Canada
		Opense Ino, Canada
		FISO, Canada
20.	Valves	Leader Valves, Jalandhar
		GG Valves Ltd, Udaipur
		Petson Valves, Coimbatore
21.	PRV (Pressure Release Valve)	Sukrut, Pune
		Qualitrol Company, USA

		MESSKO, Germany
22.	Cooling fan	Marathon, Kolkata
		Khaitan, Kolkata
		CGL

ANNEXURE-I

Name of the bidder:-

Address:-

MAXIMUM FLUX DENSITY AND CORE WEIGHT CALCULATION:-

Type and Grade of Core:-

Thickness [in mm]:-

<u>Step No</u>	<u>Width of steps [mm]</u>	<u>Stack thickness [mm]</u>	<u>n</u>
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12.			
13			
14			
15 to			

$$E = 4.44 \times f \times B \text{ max.} \times A_i \times N$$

Where E = L.V. winding rated voltage / phase = 33000 volts.

f = Rated frequency = 50 HZ.

B max. = Maximum flux density in Tesla.

A_i = Net iron area in sq.m = Gross iron area x stacking factor in sq.m

N = Number of L.V.winding turns/phase B max. = $E/4.44 \times f \times A_i \times N$

N

Core weight calculation:-

Core dia [in mm] =

Window height [in mm] =

Limb center [in mm] =

Weight of core = $[3 \times \text{window height} + 4 \times \text{limb centre} + 2 \times \text{max. width}] \times \text{Net iron area} \times \text{Density of core}$

NB:- 1 Specific loss vs. flux density graph for the type of core lamination to be used has to be furnished.

2. VA/Kg. Vs flux density graph for the core lamination to be used has to be furnished.

3. Any other factor assumed for above calculation to be explained with reasons.

N.B.:- The bidder may use its own method of calculation towards determination of maximum flux density and weight of the core. But the same shall be supported with proper explanation and justification.

Place

Bidder's name:

Date

Signature, designation, seal

ANNEXURE-II

DETAILS OF LOSS CALCULATIONS FOR AUTO / POWER TRANSFORMER

1. Name of the Firm
2. Flux density at
 - i 245/145/36 KV and 48.5 Hz [Tesla]
 - ii 220/132/33 KV & 50.0Hz [Tesla]
3.
 - i Core weight in Kg.
 - ii Gross core area [mm²]
 - iii. Stacking factor.
 - iv. Net core iron area [mm²] [ii x iii]
- 4[a] Specific losses [W/Kg.]
 - i At maximum flux density corresponding to 245/145/36 KV and 48.5 HZ.
 - ii At maximum flux density corresponding to 220/132/33 KV and 50Hz.

[b] Volt ampere/Kg

 - (i) At maximum flux density corresponding to 245/145/36 KV and 48.5 Hz.
 - (ii) At maximum flux density corresponding to 220/132/33 KV and 50 Hz.
5. Calculated/guaranteed iron loss in KW at:-
 - i Rated voltage and rated frequency
 - ii Maximum system voltage and lowest system frequency
6. Current density [A/Sq. mm] for
 - i HV
 - ii IV
 - iii Regulating
 - iv LV
7. Conductor size [in mm²]
 - A HV [series winding]
 - i Bare
 - ii Insulated
 - iii No of conductors in parallel
 - B IV [common winding]
 - i Bare
 - ii Insulated
 - iii No of conductors in parallel
 - C Regulating winding
 - i Bare
 - ii Insulated
 - iii No of conductors in parallel
 - D L.V. winding
 - i. Bare
 - ii. Insulated.
 - iii. No. of conductors in parallel.
8. Copper weight
 - i Series windings
 - ii Common windings
 - iii Regulating windings
 - iv LV windings
 - v For Tap connections, star connection and any other [please specify]

- vi Total copper weight [i]+[ii]+[iii]+[iv]+[v]
- 9. Series winding resistance in ohms at 75°C/Phase.
- 10. Common winding resistance in ohms at 75°C/Phase.
 - a At normal tap position
 - b At maximum tap position
 - c At minimum tap position
- 11. LV winding resistance in ohms at 75°C Per Ph ase.
- 12. Stray losses and eddy current losses [in KW] at 75°C
 - a At normal tap position
 - b At maximum tap position
 - c At minimum tap position
- 13. Resistivity of copper to be used for winding
- 14. I²R loss at 75°C
 - i At normal tap position [in KW]
 - ii At maximum tap position [in KW]
 - iii At minimum tap position [in KW]
- 15. Calculated guaranteed copper losses [in KW] at 75°C [I²R loss + stray losses]
 - i At normal tap position
 - ii At maximum tap position
 - iii At minimum tap position
- 16. Guaranteed cooler loss [in KW]
- 17. Computed/guaranteed total loss in KW at rated voltage and rated frequency [Copper loss + cooler loss + Iron loss]
 - i At normal tap position
 - ii At maximum tap position
 - iii At minimum tap position

NB:- 1 Approximate values in weight and losses etc. are not allowed.
 2 Tolerance of + 5% in weights may be quoted without any approximation

Place:
 Date

Bidder's name:
 Signature, designation, seal

ANNEXURE-III

GUARANTEED TECHNICAL PARTICULARS [TO BE FILLED IN BY THE BIDDER]

Sl.	Description	132/33 Power Transformer
No		
1	Name of the Manufacturer	
2	Installation [indoor/outdoor]	
3	Reference standards	
4	Continuous Ratings	
	a	Type of cooling
	b	Rating [MVA]
	i	With ONAN cooling
	ii	With ONAF cooling
	iii	With OFAF cooling
	c	Rated voltage
	i	HV [KV rms.]
	ii	IV [KV-rms.]
	iii	LV [KV-rms.]
	d	Highest system voltage
	i	HV [KV rms.]
	ii	IV [KV-rms.]
	iii	LV [KV-rms.]
	e	Rated frequency with $\pm\%$ variation
	f	Number of phases
	g	Current at rated full load and on principal tap
	i	HV [Amps]
	ii	IV [Amps]
	iii	LV [Amps]
5	Connections	
		HV
		IV
		LV
6	Connection symbol and vector group	
7	Temperature rise	
	a	Temperature rise of oil above reference peak ambient temperature i.e.50 °C [by thermometer] [°C]
	i	At full ONAN rating [°C]
	ii	At full ONAF rating [°C]
	iii	At full OFAF rating [°C]
	b	Temperature rise of winding above reference peak ambient temperature [by resistance method][°C]
	i	At full ONAN rating [°C]
	ii	At full ONAF rating [°C]
	iii	At full OFAF rating [°C]
	c.	Temperature gradients between windings & oil.
	d.	Limit of Hot spot temperature for which the Transformer is designed [°C]

- e Period of operation of transformer at full load without calculated winding hot spot temperature exceeding 150°C and with
 - i 50% Coolers
 - ii 100% Coolers

- 8 Type of ON load tap changing switch
- 9 Tapping on windings for
 - i Constant flux/variable flux/combined regulation.
 - ii Tapping provided at
 - iii Number of steps
 - iv Range of tapping for variation [+ percent to- percent]
- 10 i No load loss at rated voltage and frequency at principal tap [KW]
 - ii No load loss at the voltage corresponding to highest tap [KW]
- 11 Load loss at rated output, rated frequency, ONAN ONAF OFAF corrected for 75 °C winding temperature at:-
 - [Copper loss + cooler loss]
 - i Principal tap [In KW]
 - ii Highest tap [In KW]
 - iii Lowest tap [In KW]
- 12 Auxiliary losses at rated output, normal ratio, rated voltage, rated frequency and ambient temperature [KW]
- 13 Total losses at normal ratio inclusive of auxiliary equipment losses [KW]
- 14 Positive sequence impedance on rated MVA HV to IV HV to LV IV to LV base at rated current and frequency at 75° Centigrade winding temperature at
 - i Principal tap [%]
 - ii Highest tap [%]
 - iii Lowest tap [%]
- 15 Zero sequence impedance at reference temperature of 75°C at principal tap [%]
- 16 % reactance at rated MVA base at rated current and rated frequency at HV to IV HV to LV IV to LV
 - i Principal tap [%]
 - ii Highest tap [%]
 - iii Lowest tap [%]
- 17 % resistance at rated MVA base at rated current HV to IV HV to LV IV to LV and rated frequency at
 - i Principal tap [%]
 - ii Highest tap [%]
 - iii Lowest tap [%]
- 18 % Impedance at rated MVA base at rated current HV to IV HV to LV IV to LV and rated frequency at
 - i Principal tap [%]
 - ii Highest tap [%]
 - iii Lowest tap [%]
- 19 a. Polarisation index i.e. ratio of Megger values at 600 secs to 60 secs, (H.V. to E,I.V. to E, L.V. to E, H.V. to I.V., H.V. to L.V.& I.V.to L.V.
 - b. Regulation at full load and 75°C winding temperature expressed as a percentage of normal voltage
 - i At unity power factor [%]
 - ii At 0.8 power factor [lagging][%]

- 20 Efficiency at 75°C winding temperature as derived from guaranteed loss figures at
 Unity power factor 0.8 pf
- a At full load [%]
 - b At ¾ load [%]
 - c At ½ load [%]
- 21
- i Maximum efficiency [%]
 - ii Load at which maximum efficiency occurs [% of full load]
- 22 Time in minutes for which the transformer can be run at full load without exceeding the maximum permissible temperature at reference ambient temperature when supply to:-
- i Fans is cut off
 - ii Fans & pumps is cut off
- 23 Short time thermal rating of
- i Tertiary winding in kA and duration in seconds
 - ii IV winding in KA and duration in seconds
 - iii HV winding in KA and duration in seconds
- 24 Permissible over loading:-
- a HV winding
 - b IV winding
- 25 Terminal arrangement
- a High voltage [HV]
 - b Intermediate voltage [IV]
 - c Low voltage (LV)
 - d Neutral
- 26 Insulating and cooling medium
- 27 [A] Test voltage
- | | | | |
|--|-----------|-----------|-----------|
| | <u>HV</u> | <u>IV</u> | <u>LV</u> |
|--|-----------|-----------|-----------|
- i. Lightning impulse withstand test voltage [KVP]
 - ii Power frequency withstand test voltage [dry and wet] [for 1 minute] [KV-rms.]
 - iii Switching impulse test voltage [KVP]
- [B] Design value of surges transferred on tertiary terminals:
- I For 1300[900] KVP, 1.2/50 micro second surge striking HV terminal and with
 - a) Both the tertiary terminals open [KVP]
 - b) One terminal earthed [KVP]
 - II For 900[550] KVP, 1.2/50 micro second surge striking IV terminal and with
 - a) Both the tertiary terminals open [KVP]
 - b) One terminal earthed [KVP]
28. Partial discharge level as per relevant IEC/ISS
29. Noise level when energized at normal voltage, frequency without load and with all cooling fans, oil pumps in running condition.
30. External short circuit withstand capacity [MVA] and duration [seconds]
31. Over-fluxing withstand capability of the Transformer
32. DETAILS OF CORE
- a. Type of core construction
 - b. Type of corner joints of the core
 - c. Maximum flux density at
 - i Rated voltage [~~220~~/132/33 KV] & rated frequency 50 Hz][in Tesla]
 - ii Highest system voltage [~~245~~/145/36 KV] and lowest system frequency [48.5Hz.][in Tesla]
 - d. No load current, no load loss and no load power factor at normal ratio and frequency [Amp/KW/p.f.]

- i 10 percent of rated voltage
- ii 25percent of rated voltage
- iii 50 percent of rated voltage
- iv85 percent of rated voltage
- v 100 percent of rated voltage
- vi105percent of rated voltage
- vii 110 percent of rated voltage
- viii 112.5 percent of rated voltage
- ix115 percent of rated voltage
- x 120 percent of rated voltage
- xi121 percent of rated voltage
- xii125 percent of rated voltage
- e. Core laminations:-
 - i Material of core lamination [HIB/Laser grade]
 - ii Grade of core laminations
 - iii Thickness of core lamination [mm]
 - iv Specific loss [watt/Kg.] at rated voltage and rated frequency
 - v Specific loss [watt/Kg.] at highest system voltage and lowest system frequency
 - vi Whether specific core loss graph [flux density vs. watt/Kg.submitted
 - vii VA/Kg at rated voltage and rated frequency
 - viii VA/Kg. at highest system voltage and lowest system frequency
 - ix Whether VA/Kg. Vs. flux density graph submitted.
 - x Insulation of core laminations
- f. CORE ASSEMBLY:-
 - i Core diameter [mm]
 - ii Core window height [mm]
 - iii Core leg centre [mm]
 - iv Gross core cross-sectional area [m²]
 - v Whether details of core widths, stacks and calculation furnished as per enclosed annexure
 - vi Distance between centres [mm]
 - vii Total height of core [mm]
 - viii Core bolt size [mm]
 - ix Core bolt Insulation [mm]
 - 1) Details of core belting.
 - 2) Material, grade & type.
 - 3) Width.
 - 4) Thickness.
 - 5) Fixing method.
 - x Details of top end frame.
 - xi Details of Bottom end frame.
 - xii Details of clamp plate [Material, thickness, Insulation]
 - xiii Details of clamp plate [material, thickness, Insulation]
 - xiv Total core weight [kg]
 - xv Core loss basing on core loss graph at operating flux density [rated voltage and rated frequency] [kw]
 - xvi Core stacking factor

- xvii Net core area Sq. m.
- xviii Margin towards corner joints, cross fluxing etc [kw]
- xix Total core loss at rated voltage and rated frequency [xv+xviii] [kw]
- xx Dielectric loss at rated voltage and rated frequency [KW]
- xxi No load loss at rated voltage and rated frequency [xix+xx] [KW]
 - g. Describe location/method of core grounding
 - h. Details of oil ducts in core
 - i. Peak value of magnetising Inrush current (% of HV rated current).

33

DETAILS OF WINDINGS.

		HV (Series Winding)	IV (Common winding)	Regula -ting winding	LV winding
a	Type of winding				
b	Material of the winding conductor.				
c	Maximum current density of windings [at rated current] and conductor area	Conductor [cm ²]	area	Current density [A/cm ²]	
i	HV				
ii	I.V.				
iii	Regulating				
iv	L.V.				
d	Whether HV/IV windings are interleaved.				
e	Whether windings are pre-shrunk?				
f	Whether adjustable coil clamps are provided for H.V., I.V. and L.V. windings?				
g	Whether steel rings are used for the windings? If so, whether these are split?				
h	Whether electrostatic shields are provided to obtain uniform voltage distribution in the windings?				
l	Winding insulation	Type & class	Graded or	Ungraded	
i.	H.V. & Regulating				
ii	IV				
iii	LV				
j	Insulating material used for				
i	H.V. & Regulating winding.				
ii	IV Winding				
iii	L.V Winding				
iv	For core bolts washers and end plates.				
v	Tapping connection.				
k	Insulating material used between				
i	H.V. and I.V. winding				
ii	I.V. and Regulating winding.				
iii	Regulating winding and H.V.winding.				

- iv Core and L.V winding.
- v L.V. Winding and core.
- vi I.V.Winding and core
- vii Regulating winding and core
- viii H.V.winding and core
- ix H.V. to H.V.winding [between phases]
- I Type of axial coil supports.
 - i H.V. winding
 - ii IV winding
 - iii Regulating winding
 - iv LV winding
- m Type of radial coil supports
 - i HV winding
 - ii IV winding
 - iii Regulating winding
 - iv LV winding
- n Maximum allowable torque on coil clamping HV IV Regulating LV bolts _____
- o Bare conductor size (mm).
- p Insulated conductor size (mm).
- q No. of conductors in parallel (Nos.).
- r No. of turns/phase
- s No. of discs/phase
- t No. of turns/disc
- u Gap between discs. (mm).
- v Inside diameter (mm).
- w Outside diameter (mm).
- x Axial height after shrinkage (mm).
- y D.C.RESISTANCE
 - i L.V winding at 75 ° C (Oh ms).
 - ii H.V. winding at 75 ° C (Oh ms).
 - iii IV winding and Regulating winding at normal tap at 75° C (Oh ms).
 - iv IV winding and Regulating winding at highest tap at 75° C (Oh ms).
 - v IV winding and regulating winding at lowest tap. (Ohms).
 - vi Total I²R losses at 75 ° C. for normal tap. (KW).
 - vii Total I²R losses at 75 ° C. for highest tap. (KW)
 - viii Total I²R losses at 75 ° C for lowest tap.(KW).
 - ix Stray losses including eddy current losses in winding at 75°C (KW).
 - a Normal tap position
 - b Highest tap position
 - c Lowest tap position.
 - d Any special measures taken to reduce eddy current losses and stray losses, mention in details.
 - x Load losses at 75°C [I²R + stray].
 - a Normal tap position [KW].

- bHighest tap position [KW].
- cLowest tap position [KW].
- zDetails of special arrangement provided to improve surge voltage distribution in the windings

34 **BUSHINGS.** HV IV LV Neutral

- a Make and type
- i Rated voltage class [KV-rms.]
- ii Rated current [Amps.]
- b. Lightning Impulse withstand test voltage [1.2/50 micro second][KVP]
- c Switching surge withstand test voltage [KVP]
- d Power frequency withstand test voltage
 - i Wet for 1 minute [KV-rms]
 - ii Dry for 1 minute [KV-rms]
- e. Power frequency visible corona discharge voltage [KV-rms.]
- f Partial discharge level [PC]
- g Minimum creepage distance in mm
- h Minimum creepage distance in mm [protected]
- i Whether test-tap is provided?
- j Quantity and grade of oil in bushing and Specification of oil used [Kg.]
- k Weight of assembled bushing [Kg.]
- l Minimum clearance height for removal of bushing [mm]
- m Under oil flashover or puncture impulse voltage [KVP]
- n. Under oil flashover or puncture power frequency voltage (KV-rms).
- o. Phase to earth clearance in air of live parts at the top of bushings.
- p. Maximum tan delta value at 20 deg.C

35 **Minimum clearance [mm]** Between Windings Phase to ground

(A) Out of Oil

- HV
- IV
- LV

(B) In Oil

- (i) Tertiary to Core
- (ii) Tertiary to top yoke
- (iii) Tertiary to bottom yoke
- (iv) Tertiary to IV (radially)
- (v) IV to HV (radially)
- (vi) HV to Regulating (radially)
- (vii) IV to top yoke
- (viii) IV to bottom yoke

- (ix) HV to top yoke
- (x) HV to bottom yoke
- (xi) Regulating to Top yoke (xii)
Regulating to bottom yoke
- (xiii) Outer winding to Outer
winding
- (xiv) Outer winding to
Tank (a) Length
wise (b) Breadth
wise (c) Width
wise

- 36** **Weight [Tolerance + 5%]**
 [Approximate value is not allowed]
- a Core [Kg.]
 - b Core with clamping [Kg.]
 - c H.V. [series] winding insulated conductor [Kg.]
 - d I.V. [common] winding
insulated conductor [Kg.]
 - e Regulating winding insulated conductor [Kg.]
 - f L.V. winding insulated conductor [Kg.]
 - g Coils with insulation [Kg.]
 - h Core and winding [Kg]
 - i Oil required for first filling [Liter/Kg.]
 - j Tank and fittings with accessories [Kg.]
 - k Untanking weight [Kg.]
 - l Total weight with oil and fittings [kg.]

37 **DETAILS OF TANK**

- a Material for Transformer tank
- b Type of tank
- c Thickness of sheet
[No approximate value to be mentioned]
- i Sides [mm]
- ii Bottom [mm]
- iii Cover [mm]
- iv Radiators [mm]
- d Inside dimensions of main tank
 - i Length [mm]
 - ii Breadth [mm]
 - iii Height [mm]
- e Outside dimensions of main tank
[No approximation in dimensions to be used]
 - i Length [mm]
 - ii Breadth [mm]
 - iii Height [mm]
- f. Thickness of spray galvanisation of tank
bottom.
- g. Vacuum recommended for hot oil
circulation [torr]

- [No approximation in dimensions to be used]
- h. Vacuum to be maintained during oil filling in Transformer tank [torr]
- i. Vacuum to which the tank can be subjected without distortion [torr]
- j. No. of bi-directional wheels provided
- k. Track gauge required for the wheels
 - i Transverse axis
 - ii Longitudinal axis
- l. Type and make of pressure relief device and minimum pressure at which it operates [Kpa]

38

CONSERVATOR

- a Total volume [Liters]
- b Volume between the highest and lowest visible oil levels [Litres]
- c Power required by heaters [if provided][KW]
- d. Conservator sheet thickness

39

OIL QUALITY

- a Governing standard
- b Density in gms/cu-cm
- c Kinematics viscosity in CST
- d Inter facial tension at 27°C in N/m
- e Flash point in °C
- f Pour point in °C
- g Acidity [neutralization value] in mg of KOH/gm
- h Corrosive sulfur in %
- i Electric strength [breakdown voltage]
 - i As received [KV-rms.]
 - ii After treatment [KV-rms.]
- j Dielectric dissipation factor [tan delta] at 90°C
- k Saponification value in mg of KOH/gm
- l Water content in ppm
- m Specific resistance
 - i At 90°C [oh m-cm]
 - ii At 27 °C [oh m-cm]
- n N- dm analysis CA%
CM%
CP%
- o Oxidation stability
 - i Neutralization value after oxidation
 - ii Total sludge after oxidation
- p Characteristic of oil after ageing test as per ASTM D-1934
 - i Specific resistance at

- 27°C [ohm-cms]
- 90°C [ohm-cms]
- ii Tan delta
- iii Sludge content
- iv Neutralization number
- v. % of Napthanic Content
- vi. % of Paraffinic Content
- vii. Details of oil preserving equipment offered

40

RADIATORS

- a Overall dimensions lxbxh [mm]
- b Total weight with oil [Kg.]
- c Total weight without oil [Kg.]
- d Thickness of radiator tube [mm]
- e Types of mounting
- f Vacuum withstand capability
- g Total radiating surface in sq.m
- h Type and make of material used for the radiators
- i Total number of radiators/Banks for Transformer and dimensions of tubes.

j.Thickness of hot dip galvanization of radiators.

41

motor

COOLING EQUIPMENT

Fan motor

Pump

- a Make and type
- b No. of connected units
- c No. of stand -by units
- d Rated power input
- e Capacity [cu-m/min. or] [liters/min]
- f Rated voltage [volts]
- g Locked rotor current [Amps.]
- h Efficiency of motor at full load [%]
- i Temperature rise of motor at full load [°C]
- j BHP of driven equipment
- k Temperature range over which control is adjustable [° C]
- l Whether the fans and pumps are suitable for continuous operation at 85 % of their rated voltage.
- m Estimated time constant in hours for
 - iNatural cooling
 - iiForced air cooling
 - iiiForced oil cooling

42

GAS AND OIL OPERATED RELAY

- a Make
- b Type
- c Size
- dWhether supervisory alarm and trip contacts provided and their sizes and Nos.

43[I]TEMPERATURE INDICATORS

Oil Temp.
Indicator

Winding Temp.
Indicator

- a Make and type
- b Permissible setting ranges for alarm and trip
- c Number of contacts
- d Current rating of each contact
- e Whether supervisory alarm contacts provided?
- f Size [lxbxd]
- g Nos.
- h Ratio and type of CT used for winding Temperature indicators.

[II] OPTIC FIBER TEMPERATURE SYSTEM

- a. MAKE & TYPE
- b. Whether the offered Optic Fiber Temperature System fulfills the stipulations for the same as per this Specification
- c. Whether the end-user's certificate for offered Optic Fiber Temperature System, from Indian Utilities furnished
- d. Whether, the Bidder has got past experience of supply of Transformers with Optic Fiber Temperature System [YES/NO]
- e. If 'YES', please state the No. of such Transformers, supplied along with the name(s) of Organisation(s), to whom supplied with
Make of the Optic Fiber Temperature System, supplied and performance of the same.

44 APPROXIMATE OVERALL DIMENSIONS OF TRANSFORMER INCLUDING COOLING SYSTEM, TAP CHANGING GEAR ETC.

- a Length [mm]
- b Breadth [mm]
- c Height [mm]

45

- a Minimum clearance height for lifting core and winding from tank [mm]
- b Minimum clearance height for lifting tank cover [mm]

46

SHIPPING DETAILS

- a Approximate weight of heaviest package [Kg.]
- b Approximate dimensions of largest Package [Kg.]

47

Transformers will be transported with oil/gas.

48

Size of rail recommended for the track.

49

Details of current transformers including CT for separate mounting in neutral connection to earth

- a Quantity

- b Type and voltage class
 - c No. of cores
 - d Ratio
 - e VA burden
 - f Accuracy class
 - g Minimum knee point voltage [volts]
 - h Maximum magnetization current at minimum knee point voltage [mA]
 - i Maximum secondary winding resistance at 75°C[oh ms]
- 50** **LIFTING JACKS:-**
- a Governing standard
 - b No. of jacks in one set
 - c Type and make
 - d Capacity [tonnes]
 - e Pitch [mm]
 - f Lift [mm]
 - g Height in closed position [mm]
 - h Mean diameter of thread [mm]
- 51** **MARSHALLING KIOSK**
- a Make and type
 - b Details of apparatus proposed to be housed in the kiosk
- 52 Details of anti-earthquake device provided, if any
- 53 Separate conservator and Buchholz relay provided
- 54** **TAP CHANGING EQUIPMENT**
 [These details refer to the basic rating of O.L. T.C. as guaranteed by OLTC manufacturers]
- a Make
 - b Type
 - c Power flow [Uni.-directional/bi - directional/restricted bi-directional]
 - d Rated voltage to earth [KV]
 - e Rated current [Amps.]
 - f Step voltage [volts]
 - g Number of steps
 - h Control - manual/local-electrical/remote-electrical
 - j Line drop compensation provided/not provided
 - k Parallel operation
 - l protective devices
 - m Auxiliary supply details
 - n Time for complete tap change [one step][Sec.]
 - o Diverter selector switch transient time [cycles]
 - p Value of maximum short circuit current [Amps]
 - q Maximum impulse withstand test voltage with 1.2/50 micro seconds full wave between switch assembly and ground [KVP]
 - r Maximum power frequency test voltage between switch assembly and earth [KV-rms]

- s Maximum impulse withstand test voltage with 1.2/50 micro-seconds across the tapping range [KVP]
 - t Approximate overall dimensions of tap changer [WxBxD] in mm.
 - u Approximate overall weight [Kg.]
 - v Approximate mass of oil [Kg.]
 - w Particulars of the OLTC control panel for installation in control room
- 55 DRIVING MECHANISM BOX
- a Make and type
 - b Details of apparatus proposed to be housed in the box
- 56 Types of terminal connectors and drawing No
- a HV
 - b IV
 - c LV
- 57 Details of painting, galvanization conforms to this Specification [Yes/No]
- 58 Type of oil level indicator and whether Supervisory alarm contact for low oil level provided [Yes/No]
- 59 Type and size of thermostat to be used
- 60 No. of breathers provided [Nos.]
- 61 Type of dehydrating agent used for breathers
- 62 Valve sizes and numbers
- a Drain valves- mm-Nos.
 - b Filter valves- mm-Nos.
 - c Sampling valves- mm-Nos.
 - d Radiator valves- mm-Nos.
 - e Other valves- mm-Nos.
63. a) Type and make of PRV.
b) No. of each type of devices per transformer
c) Min. pressure at which device operates.
64. Please enclose the list of accessories and fittings, being provided on transformer. Please confirm, these are as stipulated in the tender.
65. Whether the transformer, covered is fully type tested and if so, whether copies of type test certificates, enclosed with the tender.
66. Whether tenderer can supply transformer, wound on vertical coil winding machine. Preference shall be given to the tenderer who will ensure supply of transformer wound on vertical winding machines.
67. In case Sl.No.66 is not confirmed, what are the additional pre-cautions which shall be taken by the tenderer to justify that the coil, wound on horizontal machine shall be equivalent in all respects to that which are wound on vertical winding machine.
68. What are the arrangements, available for jointing the winding. Preference shall be given to the tenderer using high-frequency brazing machines. In case other jointing be recorded. Please note that bolted joints in the winding are not acceptable. This should be confirmed here.

69. Please confirm that you will guarantee maximum Impedance variation between phases within the limit of 2% only.
70. a) Please confirm techniques that are transform used, adequacy shall of be the same is to dried by vapour-phase drying method. Please specify level of dryness.
 b) In case, other methods of drying are used, the level of dryness, so achieved should be identical to that by VPD. Adequacy of such system should be justified.
71. Please confirm whether the In-House facilities for all routine tests as per this Tender Specification are available with the tenderer and the tenderer shall agree to conduct these tests on the transformer in the event of order.
72. **Whether the Tenderer has got In-House core-cutting facility for cutting core materials for the transformer ratings as offered. (YES/NO)**
73. **If 'YES', following informations /confirmations are required:-**
- a. Name of the manufacturer of HIB Grade core material from whom core materials will be directly imported or through their accredited marketing organization of repute. If to be imported through the accredited Marketing Organisation, Please state the name of such Marketing Organisation and please enclose the relevant documents with the Tender Offer regarding accreditation of the said Marketing Organisation by the manufacturer of the HIB core material.
 - b. Grade, Trade Name and Thickness of the core material, to be imported
 - c. Whether agreed for witnessing of core materials by BSPTCL's representative(s)
 - d. Whether, the Bidder has past experience towards direct import of core materials. If 'YES', the copies of recent past Import documents to be furnished with the Tender Offer (Please state, whether the said import documents are enclosed with the Tender Offer)
 - e. Whether, the Bidder has got In-House CNC Machine facility for cutting of core materials
 - f. Whether the Bidder is agreed to follow the procedures, as stipulated at Cl.No.5.4.8 (o), (p) &(q) of this Technical Specification, as applicable for those, who have got In-House core-cutting facility
74. **If the Bidder has no In-House core-cutting facility, the following informations/confirmations are required:-**
- a. Name of the core manufacturer of core materials from whom core materials will be directly imported or through their accredited marketing organization of repute. If to be imported through the accredited Marketing Organisation, Please state the name of such Marketing Organisation and please enclose the relevant documents with the Tender

Offer regarding accreditation of the said Marketing Organisation by the manufacturer of the HIB core material.

b Grade, Trade Name and Thickness of the core material, to be imported

c. Name of the core-cutting vendor and whether the said vendor has got In-House CNC Machine facility for cutting of core materials and whether the said vendor has been accredited by ISO

d. Whether, the Bidder has past experience towards direct import of core materials. If 'YES', the copies of recent past Import documents to be furnished with the Tender Offer (Please state, whether the said import documents are enclosed with the Tender Offer)e. Whether the Bidder is agreed to follow the procedures, as stipulated at Cl.No.5.4.8 (o), (p) &(q)(1), (2), (3), (4), (5),(6) & (7)of this Technical Specification, as applicable for those, who have got no In-House core-cutting facility.

75. Please confirm that the facility for partial discharge test

Is available with the tenderer and the tenderer shall agree to conduct This test on transformer in the event of order.

Place
Date

Bidder's name:
Signature
Designation

ANNEXURE – IV

CHECK-LIST TOWARDS TYPE TEST REPORTS.

Name of the Type Test.	Date of Test	Name of the Laboratory where the test has been conducted.	Whether Laboratory is Govt. Approved .	Name of the Govt. Organisation Which has witnessed the type test.	Whether the test report is valid as per Clause No.6.4.1 of TS	Whether the copy of test report in complete shape along with the drawings	Whether the type Tested 80 MVA transformer fulfills the technical requirements	Sl
1	2	3	4	5	6	7	8	9

Place

SIGNATURE OF THE
TENDERER WITH SEAL AND
DATE

Dated:

CIVIL WORK

(Separate TS shall be provided)