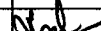




BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-594-316-101	Rev. No.	00		Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	VP	SK	RS/DM
TITLE 765/400/33kV AUTO TRANSFORMER				SIGN			
				DATE	31.05.17	02.06.17	03.06.17
				GROUP	TBEM	W.O. No	86009
CUSTOMER	Tamilnadu Transmission Corporation Limited (TANTRANSCO)						
PROJECTS	765/400kV AIS S/S Ariyalur						

CONTENTS

Section	Description	No. of Sheets
1.	Scope, Specific Technical Requirements & Quantities Section-1 Annexure M	06 01
2.	Equipment Specification Amendment Section 2A	23
3.	Detailed Equipment Specification Section 2B	111
4.	Project Details And General Technical Requirement Section 3	16
5.	Guaranteed Technical Particulars (To be submitted at Contract Stage) Section-4	20
5.	Check List (To be submitted at Tender Stage) Section 5	07
	Attachment:	
	Check list for TE	01
	Technical Requirement	02

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS				
				Distribution	TBMM	TBQM	TBCM	TBTS	
				Copies	-	-	01	-	

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TECHNICAL REQUIREMENT

Name of Project : - 765/400kV AIS S/S ARIYALUR **Name Of Item :** - 765/400/33kV Auto Transformer

Sr. No	Technical Requirement	Supporting documents	Reference of attached documents
1.	The manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number of three phase Transformer of at least 500 MVA capacity (Or A bank of three (3) single phase Transformers, each Transformer having a capacity of at least 166 MVA). These transformer(s) should have been in satisfactory operation for at least two (2) years on the date of award of contract (i.e.31.03.2017). OR	1 .Bidder to Provide Compliance/Confirmation of fulfilling SL No.1 Technical Requirement. 2. Performance certificate /Letter /MOM etc. issued by end customer for Satisfactory operation 3. PO Copy 4. Inspection/ dispatch clearance 5. LR details 6. Commissioning Report/ Handing over Documents Etc.	
2.	The manufacturer must have manufactured type tested 715 kV or higher voltage class one (1) number of three phase Transformer of at least 500 MVA capacity (OR A bank of three (3) single phase Transformers, each Transformer having a capacity of at least 166 MVA). These Transformer(s) should have been supplied as on the	1 .Bidder to Provide Compliance/Confirmation of fulfilling SL No.2 of Technical Requirement. 2. Performance certificate /Letter /MOM etc. issued by end customer for Satisfactory operation of parent	

TECHNICAL REQUIREMENT

	date of award of contract (i.e. 31.03.2017) as mentioned above based on technological support of parent company / collaborator(s) / subsidiary provided that; i) Parent company / collaborator(s) / subsidiary meets the Technical Experience criteria stipulated in 1 above. ii) A confirmation letter from the parent company / collaborator/subsidiary along with the bid stating that parent company / collaborator/subsidiary shall furnish performance guarantee for an amount of 10% of the cost of such equipment(s). This performance guarantee shall be in addition to contract performance guarantee. Note: satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remarks.	company / collaborator(s) / subsidiary Company 3. PO Copy Bidder 4. Inspection/ dispatch clearance Bidder 5. LR details Bidder 6. Commissioning Report/ Handing over document of parent Company 7. Confirmation letter from parent company / collaborator(s) / subsidiary Company for additional Performance Guarantee of 10% of the Cost of equipment's. 8. Authorization letter from parent company Etc.	
--	--	--	--

Signed with Seal of Bidder.

Date

CHECKLIST FOR TECHNICAL EVALUATION

Along with the Technical Bids of the offers, the Bidder should submit this checklist confirming the inclusion of the enclosures as listed below. (Shall tick as ✓)

Sr No	Documents to be enclosed	Bidder to check & confirm
1	Copy of Unpriced BOQ as enclosed in the Technical Specification to confirm that bidder has quoted in the same format as per Section-1	
2.	Schedule of Technical Deviation format duly signed.	
3.	Supporting documents as asked in the Technical Requirement documents as per clause no. 1.5 of Section-1	
4.	Checklist of Technical parameters as per Section-5 duly filled and signed.	
5.	Compliance to Technical specification as per TS	

NOTE:- If the Bidder fails to submit any of the documents as asked in the above check list, their bid is likely to be rejected / not evaluated.

The above checklist is verified for:-

NIT Ref No. :

Name of Equipment :

Name of Project :

Name of Bidder :

Signed with Seal of Bidder.

Date

SECTION-1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES

1.1 SCOPE

This specification covers design, type testing, engineering, manufacture, testing at factory, packing and forwarding arranging insurance cover towards transit, delivery at site including all materials, accessories, spares, supervision of unloading, handling, proper storage, erection, testing, and commissioning of the single phase 500MVA, 765/400/33kV Auto Transformer (ICTs) with OLTC, Bushing monitoring system and Digital RTCC.

The scope shall encompass and include all the activities listed above.

This section covers the specific technical requirements, scope and quantities. The specific technical requirements for the above item as specified by the TANTRANSCO are given in Section-2A & 2B. The offered equipment shall also comply with the general technical requirements for the project as detailed under section-3 of this specification.

500MVA, 765/400/33kV Auto Transformer is required for the following project:

Name of the Customer : **Tamilnadu Transmission Corporation Limited (TANTRANSCO)**

Name of the Project : **765/400kV AIS S/S Ariyalur**

This specification comprises of following sections:

- Section-1 : Scope, Specific Technical Requirements & Bill of Quantities
- Section-2A : Amendment of Technical Specification of Autotransformer
- Section-2B : Technical Specification of Autotransformer
- Section-3 : Project Details & General Technical Requirements
- Section-4 : Guaranteed Technical Particulars
- Section-5 : Technical Checklist

In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

1.2.1 Specific Technical Requirements for Auto Transformer

For 500MVA, 765/ $\sqrt{3}$ / 400/ $\sqrt{3}$ / 33 kV Auto Transformer				
A.	Voltage ratio (kV)	765/ $\sqrt{3}$ / 400/ $\sqrt{3}$ / 33 kV		
B.	Rated frequency (Hz)	50 Hz $\pm$ 5%		
C.	Max. Design Ambient Temp. (°C)	50 °C		
D.	Windings	HV	IV	LV
	(i) System Fault level (KA) for 1s	50	63	-----
	(ii) Lightning: Impulse Withstand voltage kVp (1.2/50 micro sec)	1950	1300	250
	(iii) Switching impulse : withstand voltage kVp (250/2500 micro second)	1550	1050	--
	(iv) One minute power frequency voltage kV (rms)	--	--	95
	(v) Winding connection	Star	Star	Delta
	(vi) Neutral	Solidly grounded	Solidly grounded	Ungrounded
	(vii) Insulation	Graded	Graded	Uniform
	(viii) Vector Group (3-ph)	YNaOd11		
E.	Seismic Coefficient for design	0.3g		

1.2.2 Maximum Permissible Losses for Auto Transformer at Rated Voltage ratio & frequency at 75°C

Transformer Rating	Max. No Load Loss (kW)	Max. Load Loss (kW)	Max. Auxiliary Loss (kW)
500MVA, 765/ $\sqrt{3}$ / 400/ $\sqrt{3}$ / 33 kV, 1-Ph Auto Transformer	80	575	14

Note:

Bidder is required to offer the Transformer with above specified losses at rated voltage ratio & frequency and rated output at 75°C for the auto Transformer. In case the losses are found to be more than above specified during testing factory /site the transformer shall be summarily rejected.

Please refer Section-2A for amendments of section 2B and Section 2B for detailed specific Technical requirements of Auto Transformer.

1.3 GENERAL TECHNICAL REQUIREMENTS

1.3.1 Paint System and Procedure

Bidder to follow paint system and procure as per **Clause 7.11 Section-2B**.

1.3.2 Grounding / Earthing work

As per Clause no. 10.9 of Section 2B.

1.3.3 Cabling work

Cabling including glands, lugs, ferruling between OLTC drive mechanisms Box to individual, MB/CCC, Common MB are in bidder Scope.

1.3.4 Auxiliary Supply

Terminals in marshalling box for external power supply coming into marshalling box shall be suitable to requirement.

1.4 BILL OF QUANTITIES

Sr. No.	Description of Item	Unit	Quantity
1.	765/400/33KV, 500MVA , single phase Interconnection Transformer with OLTC complete in all respect as per Specification	Nos.	6
2.	Online complete tan delta Bushing monitoring system as per clause no. 34 of section 2B complete with PC, Communication System, Software ,Cables etc.	Set*	2
3.	Supply of Digital RTCC Panel	Set*	2
4.	Supervision of Erection , Testing and commissioning of 765/400/33KV, 500MVA , single phase Interconnection Transformer with OLTC	Nos.	6
5.	Supervision of Erection , Testing and commissioning of Online complete tan delta Bushing monitoring system as per clause no. 34 of section 2B complete with PC, Communication System, Software ,Cables etc.	Set*	2
6.	Supervision of Erection , Testing and commissioning of Digital RTCC Panel	Set*	2
7.	Oil Sampling bottles of capacity 1Liter	Nos.	5

*1Set is equal to bank of 3 nos. Single Phase 765/400/33KV, 500MVA ICT.

Note:

- Quantity is subject to change by $\pm 20\%$.
- Ten percent (10%) extra oil shall also be supplied for topping up, in non-returnable containers suitable for outdoor storage. The cost of the same should be included in the quoted price and no price implication will be accepted at later stage.
- All required foundation bolt, nut and washer of ICT shall be in bidder Scope.
- Suitable clamping devices for prevent Auto transformer movement shall be in scope of bidder .

5. Supply of ultra-high vacuum oil treatment plant is not in bidder scope.
6. Bushing turrets CT of ICT as per specification requirement will be in bidder scope.
7. Neutral formation and delta formation of ICT not in bidder scope. Necessary support insulator may be mounted on transformer tank for neutral connection to 3" Al tube (Exact requirement shall be intimated during details engineering stage).
8. Any special cable other than power and control cable between Digital RTCC and transformers is in bidder scope.
9. Terminal connection for bushing of ICT are not in bidder scope.
10. Fire Prevention System by injecting Nitrogen Gas (NIFPS) is not in Bidder Scope. However provision (interface point of view) of should be there in supplied transformers.
11. Refer Section 2A for amendment of ICT.
12. On line insulation oil drying system & on line DGA is not applicable for ICT.
13. Plinth level of switchyard is 500mm above FGL.
14. Bushing CT shall be provided as per **Annexure-M**
15. Quantity of spare relay in Digital RTCC panel to provide as 1Set which comprised 1no. of each type of numerical relay /IED/Controller for RTCC panel.

1.5 TECHNICAL REQUIREMENT

1.5.1 The manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number of three phase Transformer of at least 500 MVA capacity (Or A bank of three (3) single phase Transformers, each Transformer having a capacity of at least 166 MVA). These transformer(s) should have been in satisfactory operation for at least two (2) years on the date of award of contract (i.e.31.03.2017).

(OR)

1.5.2 The manufacturer must have manufactured type tested 715 kV or higher voltage class one (1) number of three phase Transformer of at least 500 MVA capacity (OR A bank of three (3) single phase Transformers, each Transformer having a capacity of at least 166 MVA). These Transformer(s) should have been supplied as on the date of award of contract (i.e. 31.03.2017) as mentioned above based on technological support of parent company / collaborator(s) / subsidiary provided that;

- i) Parent company / collaborator(s) / subsidiary meets the Technical Experience criteria stipulated in 1.5.1 above.
- ii) A confirmation letter from the parent company / collaborator/subsidiary along with the bid stating that parent company / collaborator/subsidiary shall furnish performance guarantee for an amount of 10% of the cost of such equipment(s). This performance guarantee shall be in addition to contract performance guarantee.

Note: satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remarks.

1.6 TYPE TESTING

1.6.1 Main Item

Bidder shall submit valid type test reports (As per relevant IEC/IS standard) for the tests carried out within last ten years **from the date of opening of the tender** (i.e. 30.09.2016). The reports should have been conducted on identical or similar equipment/components to those offered. In case type test reports are more than 10 years old (from the date of opening of the tender) or the reports of type tests are found to be technically unacceptable , the type test shall be conducted by the vendor without cost and delivery implication to BHEL. The type test if conducted shall be witnessed by BHEL/Customer.

1.6.2 Type Test for bought out Components

Bidder are requested to furnish type test certificate for the bought out components in full shape as conforming to relevant IS/IEC standards of latest issue obtained from a Government/Government Recognized Laboratory.

The above type test should have been conducted not earlier than **five years (5 years)** as on date of tender opening date (i.e. 30.09.2016).

1.6.3 In addition to above please refer Section 2A and Clause no. 27, 39, 39.4, 39.5 & 40 of Section 2B for Type /Special /Routine/Factory Test /Testing.

Note:

- 1. The first unit of each rating shall be tested for measuring No-load and load losses concurrently at manufacturer premises which should be NABL accredited Lab in the presence of representative of CPRI or any other Government recognised High Voltage testing laboratory. The arrangement connected towards testing shall be made by supplier.**
If the Losses are found to be higher than the guaranteed values, transformer will be rejected.
- 2. Please refer for details of Type /Special /Routine/Factory Test /Testing/test procedure as per section 2A along with as per Clause no. 27, 39, 39.4, 39.5 & 40 of Section 2B .**

1.7 Further, a legally enforcement undertaking by manufacturer (in case of bidder comply Technical requirement through 1.5.1) shall be furnished during contract stage for guarantee quality, timely supply, performance and supervision of erection, testing and commission of the 765kV/400kV Inter connecting transformer.

1.8 Further, a legally enforcement undertaking by parent company / collaborator/subsidiary (in case of bidder comply Technical requirement through 1.5.2) shall be furnished during contract stage for guarantee quality, timely supply, performance and supervision of erection, testing and commission of the 765kV/400kV Inter connecting transformer.

1.9 INSPECTION AND TESTING AT WORKS

The Bidder shall carry out a comprehensive inspection and testing programme during manufacture of the equipment as detailed in **section-2A, Section 2B and Section 3**.

1.10 QUALITY PLAN

The contractor shall carry out contract works in accordance with sound quality management principles which shall include such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Contractor shall submit detailed Quality Plan for BHEL / customer's approval within 1 week of P.O. placement.

1.11 ERECTION, TESTING AND COMMISISONING AT SITE

The Bidder shall supervise a comprehensive erection, testing and commissioning programme at site duly TANTRANSCO approved as detailed in **section-2A and section2B for amendment**.

1.12 STANDARDS

The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the originally scheduled date of bid opening (i.e.**30.09.2016**) of standard specified under Clause no. 3 of **Section-2A & 2B** unless specifically mentioned in the specification.

-----XXX-----

ICT BUSHING CT DETAILS**765kV SIDE BUSHING CT (On Each Single Phase Transformer)(HV)**

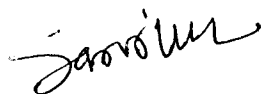
Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000/1 A	-	3000	20	12	PS	REF + Diff.
2	1500/1 A	30	-	-	-	0.2, ISF ≤ 5	Metering
3	3000/1 A	-	3000	20	12	PS	REF + Diff.

400kV SIDE BUSHING CT (On Each Single Phase Transformer)(IV)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000/1 A	-	3000	20	12	PS	REF + Diff.
2	3000/1 A	30	-	-	-	0.2, ISF ≤ 5	Metering
3	3000/1 A	-	3000	20	12	PS	REF + Diff.

NEUTRAL SIDE BUSHING CT (On Each Single Phase Transformer)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000/1 A	-	3000	20	12	PS	REF + Diff.
2	3000/1 A	-	3000	20	12	PS	REF + Diff.

33kV side bushing CT(LV)- As per technical specification , Annexure-I , sl. No. 22


SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
16	Technical Specification	Section-22	SAS, CONTROL AND RELAY PANELS	280 of 330	cl.XVII	DIGITAL FAULT RECORDER CUM PMU CUM FL	not in present scope of supply. Requirement of compatibility of DFR at Ariyalur with other-end DFR is not clear. Please clarify.	Please refer Annexure II
17	Technical Specification/Price schedule-Civil				General	-	Please provide following. 1. Soil Report 2. Contour Map	Please refer Annexure III
	500MVA ,765/400kV Auto Transformer							
18	General Section 2B					Losses(NL/LL/AL) – 80/575/14 KW	Kindly note that, although required level of losses is furnished. However it is requested to clarify whether any capitalization rate shall be applicable for evaluation purpose of bid.	Capitalization rate not feasible

Section 2.A
Amendments of Section 2.B

Note :- Section-1 to Read as Section 2B in Section 2A.

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
19	VI/Tech. Spec./Section-1/765 kV ICT/1.1/139					This specification covers design, engineering, manufacture, inspection, testing at manufacturer's works, packing and forwarding arranging insurance cover towards transit and storage, delivery at site including all materials, fittings, Accessories and associated equipment's detailed herein, unloading, proper storage at site, erection, testing and commissioning of the single phase 500 MVA 765/400KV ICTs with nitrogen injection system for fire protection.	Kindly note that required auto transformer is asked with nitrogen injection system for fire protection and online bushing monitoring system. No online DGA & insulating oil drying system is asked for auto transformer. However as per clause no. 25.22 & 25.23 of Shunt Reactor, Online DGA & Oil drying system is asked. Hence it is requested to review & clarify the same.	Online DGA and insulating oil drying system are not required for ICT and shunt reactor.

Attn

* Section 2 to be Read as Section 2B

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
20	VI/Tech. Spec./Section-1/765 kV ICT/4.2/145 VI/Tech. Spec./Section-1/765 kV ICT/16.2					 The forced cooling equipment shall come in to operation by preset contacts of winding temperature indicator and the transformer shall operate as a forced cooling unit initially as ONAF1 up to specified load and then as OFAF/ODAF/ONAF2. Cooling Equipment Control ONAN/ONAF1/(OFAF or ODAF or ONAF2) Cooling	Please note that the two referred clauses are contradictory to each other. We understand that the Cooling required is ONAN/ONAF/OFAF type. Please confirm.	Cooling required : ONAN/ONAF/(OFAF or ODAF) OR ONAN/OFAF1/ONAF2
21	VI/Tech. Spec./Section-1/765 kV ICT/4.4/145					 That is, the transformer operating at 1.1 times of 765/√3 kV voltage and at minimum tap the maximum flux density shall be within 1.9 tesla.	Please note that the two referred clauses are contradictory to each other.	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.

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
22	VI/Tech. Spec./Section-2/Auto Transformer Erection / Annexure-I/5/244					Maximum flux density at normal voltage and frequency – 1.9 Tesla	Please note that the two referred clauses are contradictory to each other. We understand that the maximum flux density at 1.1 times rated voltage & minimum tap shall be 1.9 Tesla. Please confirm.	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.
23	VI/Tech. Spec./Section-1/765 kV ICT/7.11/151					Paint system and procedures	Please note that the transformer has to go Vapour Phase Drying (VPD) process and paint has to be suitable for this VPD process. BHEL has developed the painting process for transformer tank suitable for VPD. We shall furnish the detailed painting process during contract stage for approval	Accepted.
24	VI/Tech. Spec./Section-1/765 kV ICT/13.0/166 VI/Tech. Spec./Section-1/765kV ICT/13.6/170					Unused Inhibited insulating Oil No inhibitors shall be used in the Oil	Please note that the two referred clauses are contradictory to each other. Please confirm the type of oil required i.e. Inhibited or Un-inhibited.	Type of insulating oil:EHV grade with no inhibitors shall be used

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
25	VI/Tech. Spec./Section-1/765 kV ICT/27.0, 9 (11,19,29)/195					Factory Test Measurement of transferred surge on LV (tertiary) due to HV lightning impulse and IV lighting impulse. Measurement of transferred surge on LV (tertiary) due to HV switching impulse and IV switching impulse. Short duration heat run test (Not Applicable for unit on which temperature rise test is performed). Overload testing in short-circuit method.	Please note that this test is Design proving test and should be done on 1 transformer only shall be conducted as type test on one transformer. Please note that Switching impulse is a long duration impulse and winding capacitance effect is ended in this period and the voltages developed across different windings of the transformer are approximately proportional to the ratio of numbers of turns. (refer Cl.15.1, pg-65, IEC:60076-3:2000) Hence, Measurement of transfer surge on LV due to HV switching impulse and IV switching impulse is not required and does not serve any purpose. Moreover such kind of test is not mentioned in international/ National standards. Hence, customer may kindly note that this test will not be performed on the Transformers. Kindly confirm Please note that there is no such test called in any of the national/international standard. Hence, no such tests shall be	Please refer ANNEXURE IV

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
26	VI/Tech. Spec./Section-1/765 kV ICT/31/199 VI/Tech. Spec./Section-2/Auto Transformer Erection / Annexure-I/5/244					Technical Parameters TYPE, RATING AND TECHNICAL REQUIREMENTS 765/√3/400/√3/33KV SINGLE PHASE AUTO TRANSFORMER	Kindly note that both the referred clause deals with technical parameters of 500 MVA. 765 KV, 1 Phase Auto Transformer with different values. Hence it is requested to clarify the technical parameters of transformer shall be as per which clause? Kindly clarify.	
27	VI/Tech. Spec./Section-1/765 kV ICT/39.4 & 39.5/214					The first unit of each rating shall be tested for measuring No-load and load losses concurrently at CPRI or any other Government Recognized High Voltage testing laboratory. The arrangements connected towards testing shall be made by the supplier. If the losses are found to be higher than the guaranteed values, transformer will be rejected.	It may please be noted that Auto Transformer is a large power device and testing facility may not be available at CPRI. Further, all the Guaranteed parameters shall be tested at BHEL works and shall be final and binding to Customer. After dispatch from our works, if due to some transport issues, or Oil quality, Testing agency issues etc. any failure of the transformer at CPRI will not be the responsibility of the BHEL and BHEL guarantee shall not be applicable. BHEL has the in-house NABL accredited lab, where Power Transformer and Shunt Reactor upto 800 kV class are tested in-house and accepted to all the Customers of Indian and abroad. In view of above, testing of Power Transformer at CPRI or any other agency is neither required nor recommended. This requirement may be deleted. Kindly	As per specification

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
28	VI/Tech. Spec./Section-1/765 kV ICT/40.0 f)/215					Type/Special/Routine Tests Zero sequence impedance test	Please note that Zero sequence impedance test is not applicable for Single phase Transformers. Kindly confirm.	Zero sequence impedance test is not applicable for single phase transformers.
29	VI/Tech. Spec./Section-1/765 kV ICT/40.3 (f)/216					Dielectric Tests (Short duration Power frequency withstand voltage test and Induced over voltage withstand test with line/leakage current measured)	Please note that Short duration Power frequency withstand voltage test (ACSD) test is not applicable for 765 kV class Transformers as per IEC:60076, Hence, shall not be applicable. Kindly confirm	As per relevant IEC/IS
30	VI/Tech. Spec./Section-1/765 kV ICT/40.3 (l)/216					Measurement of Neutral unbalance current	Please note that there is no such test defined in any of the National/international test and procedure is also not known. Hence, no such tests shall be carried out. Kindly confirm.	Not applicable for single phase transformers

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
31	VI/Tech. Spec./Section-2/Auto Transformer Erection/ Annexure-I- Cl. 6/244					TYPE, RATING AND TECHNICAL REQUIREMENTS 765/$\sqrt{3}$/400/$\sqrt{3}$/33KV SINGLE PHASE AUTO TRANSFORMER Rated voltage (KV)- Rated Min Max (a) H.V. winding- 765 745 785 (b) I.V. winding- 400 412 388	The Rated voltage specified for Min and Max tap are not matching with the Voltages to be arrived as per tapping range indicated for HV. We understand the same as typographical error, hence not applicable. Kindly confirm.	Rated Voltages may be read as follows: HV: 765KV IV:400KV LV:52 KV Nuetral:36 KV Min and max voltages as per tapping range
	80MVar, 765kV Shunt Reactor							
32	General					Losses or Capitalization Rates	Kindly note that in transformer/reactor industry generally losses or capitalization rates are furnished on the basis of which offer is evaluated. For transformer required loss level is furnished. However for reactor neither loss nor capitalization rates are furnished. Hence it is requested to furnish the limiting loss level or capitalization rate on the basis of which bid shall be evaluated.	As per relevant IEC/IS standards Capitalisation rate not feasible.

DESIGN, DETAILED ENGINEERING, FABRICATION, MANUFACTURE, SUPPLY, ERECTION, TESTING AND COMMISSIONING OF 765/400KV AIS SUB STATION WITH ASSOCIATED AUTO TRANSFORMERS, SWITCHGEARS, REACTORS, ACCESSORIES, CONTROL PANELS, SUBSTATION AUTOMATION SYSTEM, CONTROL ROOM AND CIVIL WORKS COMPLETE AT ARIYALUR INVILLUPURAM DISTRICT, VILLUPURAM REGION - TENDER SPECIFICATION NO. T-1966

S No	Vol/Sec	Page No	Clause No	Description	Query	TANTRANSCO REPLY
1	General	-	-	Project Funding	Please note that there is no detail about Funding authority in the tender documents. Kindly clarify.	Domestically funded project with direct payment to the contractor from the funding Agency
2	SECTION - 01 765 KV AUTO TRANSFORMER	150	6.1	Capitalization Losses	Kindly note that transformer losses capitalization details are not provided in the tender document. We assume that the offered transformer losses should not exceed the losses given in clause 6.1 and capitalization of losses is not applicable. Kindly clarify.	Capitalisation of loss not applicable.
3	SECTION - 31 DISTRIBUTION TRANSFORMERS	775	44	Schedules-A to Schedules-H	Please note that there is no detail of the schedules mentioned in the document. Kindly clarify.	Details shall be furnished during detailed Engineering.
4	General	-	-	Approach road - (Approx.) 2.5m width of road up to 2 KM is available from Ariyalur main road to site premises which is not suitable for heavy material transportation.	We presume that construction of road for 2.5km or whatsoever from Ariyalur main road to site will be done by M/s. TANTRANSCO. Please clarify and confirm	Please refer Annexure-III

S No	Vol/Sec	Page No	Clause No	Description	Query	TANTRANSCO REPLY
12	Part-II, Section-II	670	-	The number of Protection interface cards required is furnished in the Schedule-A.	Please provide Schedule-A for Protection interface cards	Please refer Annexure-II
13	Part-II, Section-II	676	-	Configuration of PDH Multiplexer: Ethernet interface card 4 channels (Layer-1 type)- 1 no. or as per Mfr.standard.	We are providing Ethernet interface cards along with SDH unit as per standards. Please confirm the same.	Please refer Annexure-II
14	Part-II, Section-II	676	-	ELEMENT MANAGEMENT SYSTEM (EMS):	We understand that specification is generic, and EMS is not envisaged in current scope of work. Please confirm our understanding.	Please refer Annexure-II
15	Part- II Technical Specification Section-I	619	-	Integration and Testing of SAS data at Remote LDC end	1. Kindly confirm the scope of "Integration and Testing of SAS data at Remote LDC end" is included 2. 2. If yes, Kindly confirm the OEM of Remote LDC	Please refer Annexure-II
16	Technical Specification Section-06	384	6.0 B)	In the specification of 390kV LA, the pressure relief mentioned is 63kA rms. This pressure relief (i.e., 63kA rms) is related to polymer type LA. But in the specification the type of LA recommended is Porcelain type. For supply of 390kV Porcelain LA, the pressure relief is 50kA rms.	Kindly confirm whether the requirement is Porcelain or Polymer type LA.	As per specification
17	SECTION- 01 765 KV AUTO TRANSFORMER	183	17.4	DIGITAL REMOTE TAP-CHANGER CONTROL PANEL	The quantity requirement of digital RTCC Relays per transformer or 3-ph bank and also let us know if any spare relay is required, Please Confirm	The quantity requirement of digital RTCC Relays is per single phase transformer

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S No	Vol/Sec	Page No	Clause No	Description	Query	TANTRANSCO REPLY
18	SECTION- 01 765 KV AUTO TRANSFORMER	-	-	General	Please furnish current density limitations, if any	As per relevent IEC/IS.
19	SECTION- 01 765 KV AUTO TRANSFORMER	171	15.1.2	Bushing for voltage of 800 kV shall be of porcelain type and hermetically sealed Oil filled condenser type.	Whether 400kV and 52kv bushings are OIP Condenser type or RIP Bushing with composite insulator ,Please Confirm	As per specification
20	SECTION- 01 765 KV AUTO TRANSFORMER	194	27	Factory Tests	Please furnish the test procedures of over excitation test, short duration heat run test and overload testing in short circuit method	Test procedures given as new annexure in setion-IV
21	SECTION- 01 765 KV AUTO TRANSFORMER	147	4.13.2	The tertiary winding shall be designed for an equivalent 3- phase rating of 500 MVA. However, the cooling for continuous thermal rating of the tertiary winding shall be of at least 5 MVA capacity.	The design rating of Tertiary winding whether it is to be designed at 5MVA or 167MVA. Please Confirm	As per clause 31 of section-01
22	SCHEDULE II: Supply of Electrical Equipments/Materi als 'XVI PANELS	42	81	Supply of 415 V,3 ϕ ,4 WIRE,1500 A,20 KA FOR 1 SEC Three phase and neutral -distribution Change over panel with Bus section provision with change over provision - for- 2 EB incoming and DG-1 incoming	The Rating in the SLD is given as 415 V,3 ϕ ,4 WIRE,2500 A,25 KA FOR 1 SEC whereas the Price schedule denotes the different rating please clarify.	As per the price schedule.

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Pre-bid Queris

765/400KV AIS SUB STATION WITH ASSOCIATED AUTO TRANSFORMERS, SWITCHGEARS, REACTORS, ACCESSORIES, CONTROL PANELS, SUBSTATION AUTOMATION SYSTEM, CONTROL ROOM AND CIVIL WORKS COMPLETE AT ARIYALUR IN VILLUPURAM DISTRICT				
Sr. No.	Volume / Section	Clause No.	Bidder's Query	TANTRANSCO REPLY
17	Section-I, 765KV Auto Transformer	Clause No. 16.1.2 (page 173)	Each radiator shall have shutoff valve, lifting lugs, air release plug, a drain valve and thermometer pockets with screw cap on the inlet and outlet. Cooling fan, oil pump & flow indicator cannot be provided with each radiator. These will be provided with each radiator bank (3 X 33.3%-Main + 1 x 33.3% Stand-by). Kindly confirm the acceptance.	Shall be decided during detailed engineering
18	Section-I, 765KV Auto Transformer	Clause No. 39.4 (page 214)	We have NABL certified testing laboratory at our works. We shall conduct no-load and load loss measurement tests for all transformers as per technical specification at our factory. We request you to kindly accept the same.	The required tests mentioned in the specification can be conducted at the manufacturer premises which should be NABL accredited lab in the presence of representatives of CPRI or any other Govt. Recognised High voltage Lab
19	Section-3, 765kV Shunt Reactor	Clause No. 2.2(b) (page 265)	3 limb core construction shall be followed instead of single phase constructions in separate banks or 5 limb core constructions. We request you to confirm the acceptance of the same.	As per specification
21	Section-3, 765kV Shunt Reactor	Clause No 44.8 (page 319)	Kindly provide exact impedance value at rated short time and continuous current.	As per relevant IEC/IS
22	Section-3, 765kV Shunt Reactor	Clause No 45.0 (page 320)	Kindly provide the Magnetizing current of PS class bushing CTs.	As per relevant IEC/IS
23	Section-3, 765kV Shunt Reactor	Clause No 48.0 (page 326)	Please confirm, if we can provide any other reputed equivalent make instead of Dobbie.	Any reputed equivalent make is acceptable

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Pre-bid Queris

765/400KV AIS SUB STATIONWITH ASSOCIATED AUTO TRANSFORMERS, SWITCHGEARS, REACTORS, ACCESSORIES, CONTROL PANELS, SUBSTATION AUTOMATION SYSTEM, CONTROL ROOM AND CIVIL WORKS COMPLETE AT ARIYALUR IN VILLUPURAM DISTRICT				
Sr. No.	Volume / Section	Clause No.	Bidder's Query	TANTRANSCO REPLY
9	Price Schedule	Item No. 131	In price schedule, Accesories of electrical equipment are separately mentioned. Kindly confirm these items are not included in busbar material mentioned in price schedule.	Item no.131 is exclusively for spare .
10	Price Schedule	item no. 45, Schedule-II	Earthing quantity breakup, for Main Mat and flats , pits and rods is required as price is different for these items. Kindly provide.	As per price schedule
11	Price Schedule	General	Connectors for Hexa Zebra for 765kV Lines Surge Arrestor , CVT etc are not provided in price schedule. Kindly include the same.	New item added in price schedule .PI Refer Annexure-I .
12	Section-I, 765KV Auto Transformer	Clause No. 4.4 & 4.12 (page 145)	Knee point voltage requirement for Auto-transformer is not specified in IS 2026 and IEC:60076. So, It is not being considered. Hence we request you to accept the same.	As per IS/IEC
13	Section-I, 765KV Auto Transformer	Clause No 10.8.1 (page 159)	OTI & WTI shall be provided with micro switch based contacts. Kindly confirm the acceptance	Acceptable
14	Section-I, 765KV Auto Transformer	Clause No. 12.11.1 (page 164)	High Voltage winding can be intershield or interleaved continuous disc type. We request you to kindly accept either of the type of the winding.	As per specification
15	Section-I, 765KV Auto Transformer	Clause No. 13.1, Annexure-I & Clause No.18 (page 166)	As per Clause 13.1, The insulating oil shall be virgin high grade inhibited,confirming to IEC-60296. However as per Annexure-I, Clause 18, Insulating oil shall be virgin EHV grade transformer oil conforming to IS:335.We request you to confirm the grade of Insulating Oil.	Type of insulating oil:EHV grade with no inhibitors shall be used
16	Section-I, 765KV Auto Transformer	Clause No. 17.2.2(b) (page 179)	It will not be possible to access OLTC contacts for inspection without lowering main tank. Kindly confirm acceptance of the same.	As per specification

Pre-bid Queris

765/400KV AIS SUB STATIONWITH ASSOCIATED AUTO TRANSFORMERS, SWITCHGEARS, REACTORS, ACCESSORIES, CONTROL PANELS, SUBSTATION AUTOMATION SYSTEM, CONTROL ROOM AND CIVIL WORKS

sr. No	Volume / Section	Clause No.	Bidder's Query	
34	Section-1, Autotransformer	Clause no. 34.0	As per cluase 34.0, Online tan delta monitoring system for HV bushing with proper communication facility to be provided.To continuously monitor the HV(765KV,3Nos.) and IV (400KV,3 Nos.) bushing of the auto transformer with expert system capable of detecting abnormalities in the bushing insulation and issuing alerts locally and remotely. So, we understand that Total 1 Nos. Online tan delta monitoring system shall be required to monitor the bank of three single phase autotransformer.	Yes

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Section 01

performance guarantee for an amount of 10% of the cost of such equipment(s). This performance guarantee shall be in addition to contract performance guarantee.

Note :

#satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remarks.

DEFECT LIABILITY(GUARANTEE) PERIOD FOR 765KV LINE REACTOR

- (i) The Defect Liability Period for 765kV Class line reactor(3x80 MVAR) shall be **Sixty (60) months** from the date of Taking Over/Completion of Facilities (or any part thereof). For the purpose of this clause, the Measurable Defects as per the Technical Specifications shall also be considered for Reactor.

Upon correction of the defects in the Reactor by repair/ replacement, such repair/ replacement shall have the Defect Liability Period of the said Reactor extended by a period of 2 years from the time of such repair/ replacement of the said Reactor to rectify the defect, or up to the expiry of period mentioned in (i) above whichever is later.

Further, a legally enforceable undertaking jointly by the bidder and manufacturer shall be furnished along with the bid to guarantee quality, timely supply, performance and supervision of erection, testing, and commissioning of the 765KV Line/Bus Reactor.

III.SECTION 01(AUTO TRANSFORMER):

1)Digital RTCC Panel:

The requirement of digital RTCC Relay is one number for 3-ph bank.

2)Neutral Formation and Earthing Arrangement.

FOR INFORMATION & INTERFACE

The contractor shall connect the neutrals of three (3) 1-phase transformers by overhead connection to operate in three phase banks. The neutral terminals of winding of the three (3) single phase transformers shall be connected to an overhead common 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare transformer can be disconnected or connected to either of the three phase banks unless approved otherwise. All material like Bus post

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insulator, Aluminium tube, conductor, clamps & connectors, earthing materials, support structure, hardware etc required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor.

3)Tertiary Delta Formation (NOT IN SCOPE. FOR INFORMATION & INTERFACE)

The contractor shall connect 33kV of single-phase auto-transformers in DELTA configuration by overhead connection to operate in 3-Ph Bank. The Delta shall be formed by approximate size of 3" IPS Al tube, which shall be insulated with heat shrinkage insulating sleeve (Raychem/3M make kit or other POWERGRID approved make) of atleast 52kV class of adequate thickness and shall be supported by structure mounted bus post insulators at suitable intervals. The minimum phase to phase horizontal spacing for delta formation shall be 1.5 meter. All associated materials like bus post insulators, Aluminium tube, conductor, clamps & connectors, support structures, hardware etc. required for tertiary delta formation shall be provided by the contractor.

4)Extension of station supply from tertiary winding (NOT IN SCOPE)

Line materials required for extending supply from tertiary winding for station supply is also covered under the scope of this tender.

5)Transformer Oil

The insulating oil, to be used and supplied with the transformer, shall be of EHV grade conforming to IS:335 of latest issue. No inhibitors shall be used in the oil.

6)OLTC Equipment

The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contacts shall be replaceable.

IV.SECTION03 (REACTOR)

1. Neutral Formation and Earthing Arrangement.

The contractor shall connect the neutrals of three (3) 1-phase shunt reactor by overhead connection to operate in three phase banks. The neutral terminals of winding of the three (3) single phase shunt reactors shall be connected to an overhead common 3" IPS Al tube. The neutral formation shall be such that neutral

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ANNEXURE-IV

ICT Test Procedures

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 (rms) for 1 minute. Insulation resistance shall be minimum 2 GΩ for all cases mentioned above.

2. 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.

For ODAF or 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 ODAF or 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.

Short term 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 specified full load temperature.

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

3. Over excitation test

A routine over excitation test at 1.05 p.u voltage for 12 hours shall be done on the tap position giving the highest flux.

This test shall be carried out immediately after the routine short-term heat run test on the transformer.

The rate of gas development during the test shall be evaluated using IEEE /IEC/CIGRE guidelines.

4. Temp. Rise Test as per IEC: 60076

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 on the windings of the transformer (3-winding Loss). The Contractor before carrying out such test shall submit detailed calculations showing alternatives possible, on various taps and for the three types of ratings of the transformer and

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shall recommend the combination that results in highest temperature rise for the test.

The Temperature rise type test results shall serve as a "finger print" for the units to be tested only with short term heat run test.

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 3x33.3% cooler bank, tests shall be done on the maximum current tap for a minimum of 12 hours for ONAN/ONAF 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. Loading on tertiary on any cooling combination shall be considered as 5 MVA active.
- 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

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- 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)
- Colour photographs of the four sides and top of the transformer together with the corresponding series of thermal images (colour) during starting of the test then after every two hours till the temperature stabilised and finally during temperature stabilised for each rating (ONAN/ONAF/OFAF or ONAN/ONAF1/ONAF2)

Notes:

The probes may be left in position provided the reliability and integrity of unit will not be jeopardized during its long life expectancy.

v. Winding temperature rise test

- Record the weight of conductor in each winding, and the losses in watts per kilogram, the 'cold' resistance of each winding and the simultaneous top oil and ambient air temperatures, together with the time required for the effect to disappear.

- Record the thermal time constant of the winding.

- Log the half –hourly readings of the quantities as for the top oil temperature rise test.

- Provide a table of readings, after shut-down of power, giving the following information ;

a) Time after shut- down:

b) Time increment:

c) Winding resistance:

d) Resistance increment:

e) X, where x is the time after shut-down divided by the thermal time constant of the winding; and

f) Y, where $Y = 100 (1 - e^{-x})$

- (Any graphical/computer method used to determine the temperature of a winding by extrapolation to the instant of power shut-down shall produce a linear curve.)

- Provide a record of all calculations, corrections and curves leading to the determination of the winding temperatures at the instant of shut-down of power.

- Record any action taken to remedy instability of the oil surge device during initiation of the oil circulating pumps.

Temperature measurements as per special probes or sensors (fibre optic) placed at various locations shall also be recorded.

5. Overload testing in short-circuit method.

The test shall be carried out on the tapping position that will cause the highest current under normal conditions. Hot spot temperature measurement shall be done by using temperature probes or sensors in approved locations.

The transformer shall be fully erected as for service with all cooling equipment.

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i. Testing option 1:

Pre-load the unit with 100% of full load current for a period long enough to stabilise the top oil temperature with cooling as for service conditions.

- Increase the loading to 120% overload rating. Forced cooling shall be activated as per service conditions.
- Scan and record infra-red images of all four sides and the top of the transformer at the interval of every 15 minutes.
- Hold the overload current for a period of 4 hours.
- Measure and record the hotspot temperatures.

ii. Testing option 2:

Pre-load the unit with 100% of full load current for a period long enough to stabilise the top oil temperature with 100% cooling as per service conditions.

- Increase the loading to 130% overload rating.
- Scan and record infra-red images of all four sides and the top of the transformer every 15 minutes.
- Hold the current at 130% for a period of 2 hours.
- Measure and record the hotspot temperature.

iii. Acceptance criteria:

Winding hotspot temperatures shall not exceed 130°C for option 1 and 135 °C for option 2.

The temperature rise recorded by infra-red shall be not more than 10°K above top oil temperature or 15°K above the local oil temperature.

The rate of gas development as determined from oil samples shall be determined. Samples shall be taken before and after the test and acceptance criteria shall be in accordance with IEC/IEEE guidelines.

iv. Test records:

Full details of the test arrangements, procedures and conditions shall be supplied with the test certificates and shall include the following:

- Purchaser's reference number and site designation
- Manufacturer's name and transformer serial number
- MVA rating and voltage ratio
- Vector group
- Altitude of test bay
- Designation of terminals supplied and terminals strapped

Colour photographs of the four sides and top of the transformer together with the corresponding series of thermal images shall taken during starting of the test then after every two hours and at before end of the test.

v. Overload test:

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

- time
- voltage between phases
- current in each phase
- power in each phase and total power
- ambient temperature
- top oil temperature

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- cooler inlet and outlet temperatures
- average winding temperatures
- hot spot temperatures (make use of probes)
- Infra-red photographs/ colour photographs.

Notes:

Measurement methods for hot spots, their location and the number of sensors shall be agreed with Purchaser prior to the test. The probes may be left in position provided the reliability and integrity of the unit will not be jeopardized during its long life expectancy.

6. Measurement of transferred surge on LV (tertiary) due to HV & IV switching and Lightning impulse

Following tests shall be carried out with applying 70-80% of rated Impulse & Switching impulse (50%-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
3	SW	1.1	1.1 N & 3.2	2.1	3.1
4	SW	1.1	1.1 N & 3.1	2.1	3.2
5	FW	2.1	1.1, N & 3.2	-	3.1
6	FW	2.1	1.1, N & 3.1	-	3.2
7	SW	2.1	2.1 N & 3.2	3.2	3.1
8	SW	2.1	2.1 N & 3.1	3.1	3.2

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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 Terminal

Acceptance criteria

Transfer surge should not exceed 250kVp at any conditions for single-phase unit.

7. Tank Tests

i. 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.

ii. Vacuum Test

All transformer tanks shall be subjected to the specified vacuum. The tank designed for full vacuum 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

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 one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

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S No	Vol/Sec	Page No	Clause No	Description	Query	Reply
10	Part- II Technical Specification Section-I	619	-	Integration and Testing of SAS data at Remote LDC end	1. Kindly confirm the scope of "Integration and Testing of SAS data at Remote LDC end" is included 2. If yes, Kindly confirm the OEM of Remote LDC	Integration works at Remote Load dispatch centre is not in this tender scope. However the necessary technical support such as ensuring protocol interoperability towards the remote LDC is inclusive of tender scope of SAS.
11	Technical Specification Section-06	384	6.0 B)	In the specification of 390kV LA, the pressure relief mentioned is 63kA rms. This pressure relief (i.e., 63kA rms) is related to polymer type LA. But in the specification the type of LA recommended is Porcelain type. For supply of 390kV Porcelain LA, the pressure relief is 50kA rms.	Kindly confirm whether the requirement is Porcelain or Polymer type LA.	As per specification
12	SECTION-2B 765 KV AUTO TRANSFORMER	183	17.4	DIGITAL REMOTE TAP-CHANGER CONTROL PANEL	The quantity requirement of digital RTCC Relays per transformer or 3-ph bank and also let us know if any spare relay is required, Please Confirm	1 set comprised 1no of each type of Numerical relay /IED/Controller for RTCC panel is required for Spare for RTCC panel.

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SECTION- 2B

765 KV AUTO TRANSFORMER

TECHNICAL SPECIFICATION FOR AUTOTRANSFORMER

1.0 General

1.1 This specification covers design, engineering, manufacture, inspection, testing at manufacturer's works, packing and forwarding arranging insurance cover towards transit and storage, delivery at site including all materials, fittings, accessories and associated equipments detailed herein, unloading, proper storage at site, erection, testing and commissioning of the single phase 500 MVA 765/400KV ICTs with nitrogen injection system for fire protection.

1.2 The equipment shall be manufactured in the manner set out in this specification or where not set out, to the reasonable satisfaction of the purchaser. The transformers shall conform in all respects to high standards of engineering, design and workmanship and latest revisions of relevant standards at the time of offer, and the purchaser shall have the power to reject any work or material, which, in his judgment is not in full accordance therewith.

1.3 All fittings and accessories or apparatus which may not have been specifically mentioned below, but which are necessary and essential for the efficient working of the equipment, shall be deemed to be included in the contract. All outdoor apparatus including bushing insulators with their mountings shall be designed so as to avoid any accumulation of water.

1.4 External or internal Transformers shall not be used to achieve the HV/LV and IV/LV impedance specified.

1.5 Transportation

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 autotransformer for all the stages from the manufacturer's work to site.

All metal blanking plates and covers which are specifically required to transport the transformer shall be considered part of the transformer and handed over to the Purchaser after completion of the erection. Bill of quantity and relevant drawings of these items shall also be included in the manual to enable the Purchaser to have it re-manufactured, if required. The details of the proposed method of transportation shall be submitted for approval.

The scope of any necessary modification/ extension/ improvement to existing road, bridges, culverts etc. shall be included in the scope of the bidder. The contractor shall carry out the route survey along with the transporter and submit the detail proposal and methodology for transportation of autotransformer for approval of Purchaser within three months from the date of award.

The Contractor shall despatch the transformer filled with oil or in an atmosphere of nitrogen or dry air at positive pressure. In the former case, the contractor shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangements shall be ensured by the contractor to take care of pressure drop of nitrogen or dry air during transit and storage till completion of oil filling during erection. The total duration of storage at site with dry gas shall preferably be limited to three months after which the Auto Transformer shall be processed and filled with oil.

The nitrogen or dry air cylinder provided to maintain positive pressure can be taken back by the contractor after oil filling. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.

Auto Transformer shall also be fitted with sufficient number of Electronic impact recorders 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 shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory before despatch and must continue till the unit is installed on its foundation. The data of electronic impact recorder(s) shall be down loaded at site and a soft copy of it shall be handed over to Engineer-in-

charge. Further, within three weeks the contractor shall communicate the interpretation of the data.

The Shock/Impact recorders for ICTs have to be sealed after fixing in the concerned equipments at manufacturer works and the same shall be downloaded at the project site and a soft copy as well as hard copy of the same has to be handed over to TANTRANSCO before taking back the Shock/ Impact recorders. The manufacturer has to submit the findings of the Shock/Impact recorder within 3 days of removal of the Shock/Impact recorder. The acceptable value of the Shock/Impact recorders shall be indicated in the concerned drawings and get it approved from TANTRANSCO before shifting the equipments from the manufacturer works. After getting the approval from TANTRANSCO for the Shock/Impact recorder, the equipments shall be allowed for erection.

2.0. CLIMATIC CONDITIONS

The climatic conditions at site under which the equipment shall operate satisfactorily, are

(a) Atmosphere	: Polluted
(b) Maximum ambient air temperature	: 50° C.
(c) Minimum ambient air temperature	: 20° C.
(d) Maximum daily average ambient air temperature	: 45° C.
(e) Maximum yearly average ambient air temperature	: 32 ° C
(f) Maximum Humidity	: 100%
(g) Average thunder storm days per annum	: 50
(h) Average dust storm days per annum	: Occasional
(i) Average rainy day per annum.	: 65
(j) Average annual rainfall	: 750 mm.
(k) Number of months during which tropical monsoon conditions prevails	: 3
(l) Maximum wind pressure	: 150kgf/sq.m.
(m) Altitude above M.S.L	: <1000 M

3.0 Codes and Standards

The following standards contain provisions that, through reference in the text, constitute this Specification.

This specification may contain references to older versions of IEC, but since all standards are subject to revision, bidder shall offer equipment based on this Specification are required to apply the latest revision of IEC standards

Where this Specification fails to give specific guidelines or rules, preference shall be given to those published by IEC or Cigre. If these are also not available the provisions of IEEE/NEMA shall be used.

Any deviation shall be clearly brought out in the relevant bid price schedule.

Normative References

IEC 60076	Power transformers
IEC 60076-1	Part 1 : General
IEC 60076-2	Part 2: Temperature Rise
IEC 60076-3	Part 3: Insulation Levels and Dielectric Tests
IEC 60076-4	Part 4: Guide to the lightning impulse and switching impulse testing –Power transformers and Reactors
IEC 60076-3-1	Part 3-1: Insulation Levels and Dielectric Tests – External Clearances in Air
IEC 60076-5	Part 5: Ability to Withstand Short-circuits
IEC 60044 BS 3938	Current transformers
IEC 60050	International Electrotechnical Vocabulary
IEC 60050(421)	International Electrotechnical vocabulary-Chapter 421 : Power Transformers and Reactors
IEC 60060	High Voltage test techniques
IEC 60060-1	General definitions and test requirements
IEC 60060-2	Measuring systems
IEC 60071	Insulation co-ordination
IEC 60071-1	Part 1: Definitions, principles and rules
IEC 60071-2	Part 2 : Application guide
IEC 60076-8	Application Guide for Power Transformers
IEC 60076-10	Determination of Transformer and Transformer sound Levels
IEC 60137	Bushing for alternating voltage above 1000V

IEC 60214	On-Load Tap changers
IEC 255-21-3	Relays vibration
IEC 60270	Partial discharge measurements
IEC 60289	Reactors
IEC 60296	Specification for Unused Mineral Oil for Transformers and Switchgear
IEC 60076-7	Loading Guide for Oil-Immersed Transformers
IEC 60422	Supervision and Maintenance guide for Mineral Insulating Oil in Electrical Equipment
IEC 60475	Method of Sampling Liquid dielectrics
IEC 60529	Classification of Degrees of Protection provided by Enclosures
IEC 60542	Application Guide for On-Load Tap-Changers
IEC 60567	Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment for the Analysis of Free and Dissolved Gases
IEC 60651	Sound Level Meters
IEC 61083	Digital Recorders and Software for High Voltage Impulse testing
IEC 61083-1	Part 1: Requirements for digital recorders in high voltage impulse tests
IEC 61083-2	Part 2: Evaluation of software used for the determination of the parameters of impulse waveforms
CISPR 16	Specification for radio disturbance and immunity measuring apparatus
CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR-18	Radio Interference Characteristics of Power Lines and High Voltage Equipment
ISO 9001	Quality system-Model for Quality Assurance in Design /development
Cigre Publication 202	Guidelines for conducting design reviews for transformers 100 MVA and 123 kV and above. August 2002-Cigre Working Group 12.22
WG 12-15	Guide for Customers Specifications for Transformers 100 MVA and 123 kV and above
WG 12 19	Short Circuit Performance of Transformers.
BS-4360	Specification for weldable structural steel
BS-5135	Specification for arc welding of carbon and carbon manganese steels

BS-5500	Specification for unfired fusion welded pressure vessels
IS-3618	Specification for phosphate treatment of iron & steel for protection against corrosion
IS-6005	Code of practice for phosphating of Iron and Steel
ISO-8501	Preparation of steel surface before application of Paints and related product
IEC-60599	Mineral oil impregnated electrical equipment in service – guide to the interpretation of dissolved and free gases analysis
IS-10593	Method of evaluating the analysis of gases in oil filled electrical equipment in service
IS-2099	Bushings for alternating voltages above 1000 volts
IS-3347 Part I to 8	Dimension for porcelain transformer bushing DIN-42530 Bushing up to 1000kV from 250A-5000A for liquid filled Transformer
IS-2026 Part 1 to 5	Power transformer
IS-4691	Degrees of protection provided by enclosure for rotating electrical machinery
IEC-60034-5	Degrees of protection provided by integral design of rotating electrical machines(IP Code) classification
IS:325 / IEC -60034	Performance of cooling fan / oil pump motor
IS-13947 part 1 to 5	Specification for low voltage switchgear and control gear
IS:3400	Methods of test for vulcanised rubber
IS:7016 part 1 to 14	Methods of test for coated and treated fabrics
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS:3637	Gas operated Relays
IS:335	New Insulating oils – Specification
IEC-62271-203	Gas insulated metal enclosed switchgear for rated voltage above 52kV
IEC-61639	Direct connection between power transformers and gas-insulated metal enclosed switchgear for rated voltages of 52.5 kV and above.
IS:3400 / BS 903 / IS:7016	Air cell (Flexible Air Separator)
IEC 60529 / IP : 55	Degree of protection for cooler control cabinet , MOLG ,Cooling fan , oil pump, Buchholz Relay
IEC 60529 / IP : 56	Degree of protection for Pressure Relief Device
IEC 60529 / IP : 43	Degree of protection for Remote tap Changer cubicle (RTCC)

4.0 Performance

4.1 The autotransformers shall be used for bi-directional flow of rated power.

4.2 Transformers shall be capable of operating under natural cooled condition upto the specified load. The forced cooling equipment shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate as a forced cooling unit initially as ONAF1 up to specified load and then as OFAF/ODAF/ONAF2. 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 140 deg C. Transformer shall be fitted with 4x33.3 % independent cooler banks, out of which 3x33.3 % shall be capable of dissipating total losses at continuous maximum rating and 1x33.3% radiator bank shall be used as stand by. Each bank (1x33.3%) shall be capable of dissipating 33.3 per cent of the loss at continuous maximum rating independently and shall be capable of operating for 20 minutes in the event of failure of the oil circulating pump or blowers associated with two cooler banks without the calculated winding hot spot temperature exceeding 140 deg C at continuous maximum rating.

4.3 The transformers shall be capable of being operated, without danger, on any tapping at the rated MVA with voltage variation of $\pm 10\%$ corresponding to the voltage of the tapping.

4.4 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 per cent continuous overvoltage condition it does not exceed 1.9 Tesla at the minimum tap position. That is, , the transformer operating at 1.1 times of $765/\sqrt{3}$ kV voltage and at minimum tap the maximum flux density shall be within 1.9 tesla. (REFER AMENDMENTS SECTION - 2A)

4.5 Dissolved Gas Analysis (DGA) of oil shall be periodically monitored by the Purchaser during the service of the transformer and the interpretation of DGA results will be as per IEC -60599. The contractor may take separate samples for DGA during warranty period as it is the responsibility of the contractor to make their own assessment regarding the overall health of the transformer during this period.

4.6 Radio Interference and Noise Level

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

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

4.8 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.

4.9 The transformer and all its accessories including bushing/ built in CTs etc. shall be designed to withstand without injury, 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 subject transformers will be connected is 50 kA for 1 sec (sym, rms, 3 phase fault on 765 kV) & 63 kA for 1 sec (sym, rms, 3 phase fault on 400 kV). For transformer design purpose, the through fault current shall be considered limited only by the transformer self impedance.

4.10 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 bolted 3-phase and single phase through fault for transformer rated voltage applied to HV and / or IV transformer terminals. The short circuit shall alternatively be considered to be applied to each of the IV, HV and tertiary (LV) transformer terminals. The tertiary terminals shall be considered not connected to system source. For bolted 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 short circuit duration shall be 2 seconds.

4.11 Transformers shall withstand, without injurious heating, combined voltage and frequency fluctuations which produce the following overfluxing conditions:

1.05 U_m for 10 minutes

1.25 U_m for 1 minute

1.50 Um for 5 seconds

Where maximum operating voltage (U_m) = $800/\sqrt{3}$ KV,

Nominal voltage U_n = $765/\sqrt{3}$ kV

4.12 The air core reactance of HV winding of transformer shall not be less than 20%. The knee point voltage shall not be less than 1.1 pu.

4.13 Tertiary Windings

4.13.1 The Tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals.

4.13.2 The tertiary winding shall be designed for an equivalent 3- phase rating of 500 MVA. However, the cooling for continuous thermal rating of the tertiary winding shall be of at least 5 MVA capacity.

4.13.3 The transformer shall be free from any electrostatic charging tendency (ECT) under all operating conditions when all oil circulation systems are in operation. The manufacturer shall submit the evidence that there is no electrostatic charging tendency in the design. In general, oil flow speed shall not exceed 1.0 m/sec at any location in the oil flow system of the transformers.

4.13.4 Tertiary windings shall be brought out through weather-proof bushings of 36KV class.

4.13.5 The contractor shall connect 33kV of single-phase auto-transformers in DELTA configuration by overhead connection to operate in 3-Ph Bank. The Delta shall be formed by approximate size of 3" IPS Al tube, which shall be insulated with heat shrinkage insulating sleeve (Raychem/3M make kit or other make) of at least 52kV class of adequate thickness and shall be supported by structure mounted bus post insulators at suitable intervals. The minimum phase to phase horizontal spacing for delta formation shall be 1.5 meter. All associated materials like bus post insulators, Aluminium tube, conductor, clamps & connectors, support structures, hardware etc. required for tertiary delta formation shall be provided by the contractor.

The tertiary winding insulation shall be adequate to withstand transferred surge voltage appearing across them due to an impulse on HV or IV windings. Therefore 33KV windings shall be designed to withstand impulse and power frequency voltage corresponding to 36KV highest system voltage. The tertiary winding will be kept idle and no lightning arrestors or capacitors are contemplated to be connected

at present. If however any additional protective device, if required for withstanding the transferred surge shall be supplied by the bidder.

4.13.6. Tertiary windings rating is indicated for normal voltage. If required, the supplier shall increase this value for additional reactive power absorbed at maximum voltage and for suppression of harmonic currents.

5.0 Design review

The transformers shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin w.r.to thermal, mechanical, dielectric and electrical stress etc. shall be maintained during design, selection of raw material, manufacturing process etc so that the transformer provided long life with least maintenance.

Design reviews shall be conducted by Purchaser or an appointed consultant during the procurement process for transformers; however the entire responsibility of design shall be with the manufacturer. Purchaser may also visit to the manufacturer's works to inspect design, manufacturing and test facilities.

5.1 Design review during detail engineering

The design review will commence after placement of award with the successful bidder and shall be finalised before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the transformer under the scope of this specification.

The design review shall be conducted generally following the "Guidelines for conducting design reviews for transformers 100 MVA and 123 kV and above" prepared by Cigre SC 12 Working Group 12.22.

The manufacturer shall provide all necessary information and calculations in the bid to demonstrate that the transformer meets the requirements for short circuit strength and durability. The latest recommendations of IEC and Cigre SC 12 shall be applied for short circuit withstand evaluation.

The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric and vibration etc in design to take into account the uncertainties of his design and manufacturing processes.

The scope of such a design review shall at least include the following:

1. Core and magnetic design

2. Winding and tapping design
3. Short-circuit withstand capability
4. Thermal design including review of localised potentially hot area.
5. Cooling design
6. Overload capability
7. Eddy current losses
8. Seismic design, as applicable
9. Insulation co-ordination
10. Tank and accessories
 - 10.1 Bushings
 - 10.2 Tap changers
 - 10.3 Protective devices
 - 10.4 Fans, pumps and radiators
 - 10.5 Sensors and protective devices– its location, fitment, securing and level of redundancy
 - 10.6 Oil and oil preservation system
11. Corrosion protection
12. Electrical and physical Interfaces with substation
13. Earthing
14. Processing and assembly
15. Testing capabilities
16. Inspection and test plan
17. Transport and storage
18. Sensitivity of design to specified parameters
19. Acoustic Noise
20. Spares, inter changeability and standardization
21. Maintainability
- 3.3 Construction Details

The features and construction details of each power transformer shall be in accordance with the requirement stated hereunder.

6.0. LOSSES

6.1. The maximum no load, load & auxiliary losses at rated voltage ratio & frequency and rated output at 75°C for the Auto Transformer, shall not exceed the limits as follows.

500 MVA,Single Phase
unit 765/400/kV

- 1) No load loss : **80 KW (max)**
- 2) Load loss : **575 KW (max)**
- 3) Auxiliary loss : **14 KW (max)**

In case the losses are found to be more than the quoted losses during testing at factory / site the transformer shall be **summarily rejected**.

7.0 Tank and Tank Accessories

7.1 Tank

7.2 Tank shall be of welded construction and fabricated from tested quality low carbon steel of adequate thickness. Unless otherwise approved, metal plate, bar and sections for fabrication shall comply with BS-4360. The components and fitting associated with transformers are subject to Purchaser's approval and design review. Samples, technical literature, drawings, test reports and list of the names of the principal users with experience gained shall be supplied on request.

7.3 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. After completion of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. The requirement of post weld heat treatment of tank/stress relieving shall be based on recommendation of BS-5500 .

7.4 Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.

7.5 The tank shall be of proven design either bell type with bolted /welded joint or conventional type with welded top cover. Bell type tank with the joint at about 500 mm above the bottom of the tank. 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 of the joint.

7.6 Each tank shall be provided with:

- (a) 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.

The lifting lugs shall be so arranged and located so as to be accessible for use when the transformer is loaded on the transport vehicle.

(b) A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks.

(c) 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 for maximum possible misalignment of the jacking force to the centre of the working surface.

(d) Suitable haulage holes shall be provided.

7.7 The tank shall be designed in such a way that it can be mounted on the plinth directly.

7.8 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. Unless otherwise approved, transformer base shall have a thickness not less than as specified below. (Also refer Annexure-I)

Length of tank (m)	Minimum plate thickness (mm)
Fabricated bases, - Exceeding 2.5	12
Flat bases - over 2.5m but less than 5m - over 5m but less than 7.5m - exceed 7.5m	20 26 32

7.9 The lid inside the tank shall be shaped to ensure efficient collection and direction of free gas to the buchholz relay.

7.10 Tank hotspot

The maximum temperature on any metal part shall not exceed 130 deg Celcius.

7.11 Paint system and procedures

Manufacturer's standard paint systems shall be furnished along with the bid. High quality, modern environment friendly paint system shall be proposed. A typical paint system is indicated below and the proposed paint system shall generally be similar or better than this.

The painting details for transformer main tank, pipes, conservator tank, radiator, control cabinet/ marshalling box / oil storage tank etc. shall be as given

below. The detailed painting procedure shall also be submitted along with the bid which shall be finalized before award of the contract. The quality of paint should be such that its colour does not fade during drying process and shall be able to withstand temperature up to 120 deg C.

	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	Total dry film thickness (DFT)	Colour shade
Main tank, pipes, conservator tank, oil storage tank etc. (external surfaces)	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40mm)	Epoxy high build Micaceous iron oxide (HB MIO) (75mm)	Aliphatic polyurethane (PU) (Minimum 50mm)	Minimum 155mm	RAL 7035
Main tank, pipes (above 80 NB), conservator tank, oil storage tank etc. (Internal Surfaces)	Shot Blast cleaning Sa 2 ½*	Hot oil resistant, noncorrosive varnish or paint or epoxy	--	--	Minimum 30mm	Glossy white for paint
Radiator (external surfaces)	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40mm)	Epoxy base Zinc primer (30-40mm)	PU paint (Minimum 50mm)	Minimum 100mm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish	--	--	--	--
Control cabinet / marshalling box	Seven tank process as per IS:3618	Zinc chromate primer (two coats)	--	EPOXY paint with PU top coat	Minimum 80mm	RAL 7035 shade for exterior and interior

	& IS:6005					
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Note: * indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1.

7.12 Tank Cover

7.13 The tank cover shall be designed to prevent retention of water and shall not distort when lifted. The internal surface of the top cover shall be shaped to ensure efficient collection and direction of free gas to the buchholz relay

7.14 At least two adequately sized inspection openings one at each end of the tank, shall be provided for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. Handles shall be provided on the inspection cover to facilitate lifting.

7.15 The tank covers shall be fitted with pockets at the position of maximum oil temperature at maximum continuous rating for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.

7.16 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.

7.17 All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over-compression.

All gasketed joints shall be designed, manufactured and assembled to ensure long term leak and maintenance free operation. Non O - ring gaskets shall be retightened in the second 6 months of service by the contractor at no extra cost to Purchaser. Gaskets and O-rings shall be replaced each time they are disturbed by opening.

All gasketed joints unless otherwise approved shall be of the O-ring and groove type. The O-rings shall be of Nitrile rubber or better.

Details of all gasketed joints shall be submitted for approval.

7.18 Currents flowing in tank cover and bushing turrets

To allow for the effect of possible induced and capacitive surge current, 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.

7.19 The transformer shall be provided with a 150 mm nominal diameter pipe flange with bolted blanking plate, gasket and shall be fitted at the highest point of the transformer for maintaining vacuum in the tank.

7.20 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 and manhole covers shall be filled with suitable material to avoid inadvertent gas pockets.

Covers shall be vented at least at both longitudinal ends.

The design for gas venting shall take into account the possible slopes of the plinth on which the transformer will be mounted.

- Wherever possible the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets can not be avoided, pipes shall be provided to vent the gas into the main expansion pipes.
- Adequate space shall be provided at the bottom of the tank for collection of sediments. Suitable guides shall be provided for positioning the core & coil assembly and other various parts during assembly or dismantling.
- Suitable shielding arrangement with a magnetic material of low permeability shall be provided inside the tank to shield off the leakage/stray magnetic fields, entering the tank and causing local heating/temperature rise at the joints. 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. The Tenderer may confirm use of tank shields in the schedule of additional information.
- All seam and joints, other than those which may have to be opened, shall be welded and wherever possible, double welded. After completion of construction of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members.

8.0 Axles and Wheels

8.1 The transformer shall be mounted either on rollers or on concrete plinth foundation directly, as per manufacturer's standard practice.

8.2 The roller mounted transformers are to be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the undercarriage 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.

8.3 The rail track gauge shall be 1676 mm.

8.4 Bidder can supply one set of trolleys in place of wheel assembly rollers for movement of transformer per sub-station for plinth mounted transformer.

8.5 The wheels shall be arranged so that they can be turned through an angle of 90 deg. (on both directions) when the tank is jacked up, clear of the rails or floor. Necessary jacking steps shall be provided. Bi directional wheels without locking and swivel movements shall be provided.

9.0 Foundation and Anti Earthquake Clamping Device

To prevent transformer movement during earthquake, suitable clamping devices 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 transformers to the foundations shall be designed to withstand seismic events to the extent that a static co-efficient of 0.3g, 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.

10.0 Conservator & Oil Preservation System

10.1 Main conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture, and shall be fitted with magnetic oil level gauge/ prismatic oil level gauge with low oil level potential free contacts.

10.2 OLTC shall have conventional type conservator with magnetic oil level gauge/prismatic oil level gauge unless otherwise approved.

10.3 Conservator tank and pipe work

10.3.1 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 115 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.

10.3.2 The conservator shall be fitted with integral 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.

10.3.3 Conservator shall be positioned so as not to obstruct any electrical connection to transformer.

10.3.4 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.

10.3.5 High and low oil level alarm contacts shall be provided together with the oil level indication.

10.3.6 To prevent oil filling into the air cell, the oil filling aperture shall be clearly marked.

10.3.7 The transformer rating and diagram plate shall bear a warning statement that the conservator is fitted with an air cell.

10.3.8 The conservator tank shall be stencilled 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.

10.3.9 The transformer manual shall give full and clear instructions on the operation, maintenance, testing and replacement of the air cell. It shall also indicate shelf life, life expectancy in operation, the recommended replacement intervals and the supplier.

10.3.10 Pipe work connections shall be of adequate size for their duty and as short and direct as possible. Only radiused elbows shall be used.

10.3.11 The feed pipe to the transformer tank shall enter the transformer 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.

10.3.12 This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than 5 degrees.

10.3.13 The feed pipe diameter for the main conservator shall be not less than 75 mm. The feed pipe shall extend inside the conservator for at least 25mm so as to form a sump inside the conservator.

10.3.14 Gas-venting pipes shall be connected to the final rising pipe to the Buchholz relay as nearly as possible in an axial direction and preferably not less than five pipe diameters from the Buchholz relay, on the transformer side of the relay.

10.3.15 Pipe work shall neither obstruct the removal of tap changers for maintenance or the opening of inspection or manhole covers.

Magnetic oil level gauge:

The conservator shall be fitted with one magnetic oil level gauge having,

- i) Dial with minimum, maximum and normal (at 30° C) oil level markings and a pointer.
- ii) Low oil level alarm contacts of 0.5 Amp. 220V DC rating

10.4.0 Oil Preservation Equipment

The requirements of air cell type oil sealing system are given below.

10.4.1 Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth.

10.4.2 The temperature of oil in the conservator is likely to raise upto 100 degree C during operation. As such air cell used shall be suitable for operating continuously at least at 100 degree C.

10.4.3 The conservator tank and piping shall be designed for complete vacuum filling of the main tank and conservator tank. Provision must be made for equalising the pressure in the conservator tank and the air cell during vacuum filling operations to prevent rupturing of the air cell.

10.4.4 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator.

10.4.5 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 that the oil will not become saturated with oxygen in less than 10 years. Air cells with well proven long life characteristics shall be installed.

10.5.0 Dehydrating Filter Breather

Conservator shall be fitted with a dehydrating filter breather. Connection shall be made to a point in the oil conservator not less than 50 mm above the maximum working oil level by means of a pipe with a minimum diameter of 25 mm.

Breathers having a mass less than 10 kg may be supported by the connecting pipe, whereas units of 10 kg and above shall be supported independent of the connecting pipe.

Connecting pipes shall be securely cleated to the transformer, or other structures supplied by the contractor, in such a manner so as to eliminate undesirable vibration and noise. In the case where a breather of less than 10 kg is supported by the pipe, there shall be a cleat directly above the breather flange. It shall be so designed that:

- a) Passage of air is through silicagel.
- b) Silicagel is isolated from atmosphere by an oil seal.
- c) Moisture absorption indicated by a change in blue (cobalt type) colour of the tinted crystals can be easily observed from a distance.
- d) Breather is mounted not more than 1200 mm above rail top level.
- e) To minimise the ingress of moisture following shall be provided.
- f) Two breathers (of identical size) shall be connected in parallel by three way valve for main tank conservator.

10.6 Pressure Relief Device

Adequate number of pressure relief devices but at least 2 numbers shall be provided at suitable locations preferably close to bushing turret/ cover. These shall have opening diameter of at least 100 mm for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment. The device shall maintain its oil tightness under static oil pressure equal to the static operating head of oil plus 20 kPa.

The device shall operate and attain its full opening in not more than 2.5 ms when subject to an internal pressure impulse equal to static operating head of oil plus 50 kPa. It shall be capable of withstanding full internal vacuum at sea level. It shall be mounted directly on the tank. One set of electrically insulated contacts per device shall be provided for alarm/tripping. Following routine tests shall be conducted on PRD.

- a. Air pressure test
- b. Liquid pressure test
- c. Leakage test
- d. Contact test

e. Dielectric test.

10.7 Buchholz Relay

Two numbers double float/reed type Buchholz relay shall be provided in series in the connecting pipe between the oil conservator and the transformer tank with at least a distance of five pipe diameters between them. Any gas evolved in the transformer shall collect 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 with the transformer in service. Each device shall be provided with two electrically independent ungrounded contacts, one for alarm 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 pumps under any oil temperature conditions. The use of pipe or relay aperture baffles shall not be used to decrease the sensitivity of the relay. The relay shall not malfunction for through fault conditions or be influenced by the magnetic fields around the transformer during the external fault conditions.

10.8 Temperature Indicators

10.8.1 Oil Temperature Indicator (OTI)

All transformers shall be provided with a dial type thermometer of around 150 mm diameter for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device shall be provided in the OTI. 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. Temperature indicator dials shall have linear graduations to clearly read at least every 2 deg C. Accuracy of OTI shall be ± 3.0 deg C or better.

The setting of alarm and tripping contacts shall be adjustable at site and typical values are as given below.

Alarm – 95 deg C

Trip - 105 deg C

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

a) Signal transmitter

Signal transmitter shall have additional facility to transmit signal for recording oil temperature at Employer's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied. The RTD shall be three wire ungrounded system. The calibration shall be as per SAMA (USA) standard or equivalent.

The RTD may be placed in the pocket containing temperature sensing element and image coil for OTI system which will be used for both remote OTI and DAS. Necessary equipment for sending the signal to remote OTI and DAS shall be provided. In lieu, separate RTD for each of the functions shall be provided.

b) Remote oil temperature indicator

It shall be suitable for flush mounting on Employer's/RTCC panel. This shall not be a repeater dial of local OTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connection between cooler control cabinet and remote OTI control circuit, shall be in the scope of Contractor.

10.8.2 Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of each winding shall be provided (HV, IV and LV). It shall comprise the following:

i) Temperature sensing element.

ii) Image coil.

iii) Auxiliary CTs, if required to match the image coil, shall be furnished and mounted in the cooler control cabinet.

iv) 150 mm dia (approximate) local indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts; besides that required for control of cooling equipment if any, one for high winding temperature alarm and one for trip. Temperature indicator dials shall have linear graduations to clearly read at least every 2 deg C.

v) Calibration device.

vi) Accuracy of WTI shall be ± 3.0 deg C or better.

The setting of alarm and tripping contacts shall be adjustable at site and typical values are as given below.

Alarm – 110 deg C

Trip - 120 deg C

vii) In addition to the above, the following equipment shall be provided for remote indication of winding temperature for each of the winding:

a) Signal transmitter for each winding

Signal transmitter shall have additional facility to transmit signal for recording winding temperature at Purchaser's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied. The RTD shall be three wire ungrounded system. The calibration shall be as per SAMA (USA) standard or equivalent. The RTD may be placed in the pocket containing temperature sensing element and image coil for WTI system which will be used for both remote WTI and DAS. Necessary equipment for sending the signal to remote WTI and DAS shall be provided. In lieu, separate RTD for each of the functions shall be provided.

b) Remote winding temperature indicator

It shall be suitable for flush mounting on Purchaser's panel. This shall not be a repeater dial of local WTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connection between cooler control cabinet and remote WTI control circuit, shall be in the scope of Contractor. Only one RWTI with a four point selector switch shall be provided for all the three windings (HV, IV and LV). Drawing showing the mounting details of RWTI shall be submitted to the purchaser within two months from the date of award of the contract.

10.8.3 Optical sensors:

Adequate no of optical temperature sensors of at least 16 numbers with the unit which is to be type tested and at least 8 numbers with each other units shall be fitted. This optical sensors measuring system shall be of direct measurement non calibrating type.

All the sensors shall be brought out to individual cooler control cabinet to facilitate measurement of temperature during service life.

A temperature measuring system having at least 16 channels shall be mounted on one cooler control cabinet (preferably type tested unit) for each substation to measure the temperature from the optical sensors. In all cooler control cabinet of other units provision shall be kept to connect the same measuring unit in future.

The measuring unit shall be capable to retain temperature data for at least 30 days and shall have facility to download these data.

Location of optical temperature sensors inside the transformer shall be decided during design review.

10.9 Earthing Terminals

10.9.1 Two (2) earthing pads (each complete with two (2) nos. holes, M 10 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.

10.9.2 Two earthing terminals suitable for connection to 75 x 12 mm galvanised steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately.

Size of earthing connection

All earthing connections with the exception of those from the individual coil clamping rings shall have a cross sectional area of not less than 0.8 sq.cm. Connections inserted between laminations of different sections of core and shall have a cross sectional area of not less than 0.2 sq.cm.

Two earthing pads, at diagonally opposite external ends of the main tank, at its bottom, capable of carrying the short circuit current for 4 seconds without injurious heating, shall be provided with clamp type terminal for external connection.

11.0 Core

11.1 The core shall be constructed from high grade, non-ageing, cold rolled, super grain oriented, silicon steel laminations.

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 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 most extreme operating condition.

Adequate temperature margin shall be provided to maintain the long life expectancy for this material.

11.3 The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 KV (rms) for 1 minute.

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.

11.5 All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling and welding.

11.6 Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

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.

11.8 Adequate lifting lugs will be provided to enable the core and windings to be lifted.

11.9 The core shall be earthed to the core clamping structure at one point only, through a removable external link of minimum size of 80 sq mm copper suitably located and protected to facilitate testing after installation of the transformer. The removable links shall have adequate section to carry ground fault current. Separate identification name plate/labels shall be provided for the 'Core' and 'Core clamp' on the tank cover.

In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination or by insulating material above 0.25 mm thick, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

A drawing furnishing the details of the earthing design shall be included in the manual.

12.0 Windings

12.1 The Contractor shall ensure that windings of all transformers are made in dust proof and conditioned atmosphere.

12.2 The conductors shall be of electrolytic grade copper free from scales and burrs.

12.3 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.

12.4 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.

12.5 The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.

12.6 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.

12.7 The windings shall be designed to withstand the dielectric tests specified. The type of winding used shall be of time tested and in successful operation for at least 5 year in the similar voltage application at the time of design review. 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 the fact that the system will not always be in the new factory condition.

12.8 The barrier insulation including spacers shall be made from high- density pre compressed pressboard (1.1 gm/cc minimum for load bearing and 1 to 1.3 gm/cc minimum for non load bearing) to minimize dimensional changes.

12.9 All spacers shall have rounded edges and radially stepped spacers between winding disks will not be accepted.

12.10 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.

12.11 An electrostatic shield made from material that will withstand the mechanical forces will be used to shield the high voltage windings from the magnetic circuit unless otherwise approved.

12.11.1 The windings shall be of interleaved continuous disc type designed to reduce the out-of-balance forces in the transformer to a minimum, at all voltage ratios. They shall withstand the impulse and power frequency test voltages as specified in this specification.

* The star connected winding shall have graded insulation. The neutral point of the star connected winding shall be insulated for the voltages specified in IS:2026.

* The completed core and coil assembly shall be dried in vacuum, at not more than 0.5 mm of mercury absolute pressure and shall be immediately impregnated with oil after processing to ensure the elimination of air and moisture within the insulation.

* The strip conductor wound on edge shall not have a width exceeding six times its thickness.

12.12 Bracing of windings

12.12.1 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.

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

12.12.3 The bracing of the windings and connections shall be such that these parts shall safely withstand the cumulative effects of stresses which may occur during handling, transportation, installation and service including line-to-line and line-to-ground faults.

12.12.4 Full details of the winding clamping arrangements, and their adjustment in or out of the tank together with relevant drawings and values, shall be verified during design and shall form part of the instruction manual.

12.13 Current carrying connections

12.13.1 The design of all connections shall be subjected to Design Review.

12.13.2 The mating faces of bolted connections shall be appropriately finished and prepared for achieving good long lasting, electrically stable and effective contacts.

12.13.3 All lugs for crimping shall be of the correct size for the conductors.

12.13.4 Connections shall be carefully designed to limit hot spots due to circulating eddy currents.

12.14 Winding terminations into bushings

12.14.1 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.

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

12.14.3 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.

12.14.4 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.

12.14.5 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.

13.0 Unused inhibited Insulating Oil (REFER AMENDMENT SECTION 2A)

13.1 The insulating oil shall be virgin high grade inhibited, conforming to IEC-60296 & all parameters specified below, while tested at supplier's premises. The contractor shall furnish test certificates from the supplier against the acceptance norms as mentioned below, prior to despatch of oil from refinery to site. Under no circumstances, poor quality oil shall be filled into the transformer and only thereafter be brought up to the specified parameter by circulation within the transformer

Sl. No.	Property	Test Method	Limits
A1.	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	The oil shall be clear and bright, transparent and free from suspended matter or

		thick layer, at ambient temperature	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 or ASTM D1298	(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 90deg C	IEC 60247 or IEC 61620 Or ASTM D924	(Max) 0.0025
8.	Resistivity at 90 deg C	IEC 60247	150 X 10 ¹² Ohm – cm, (Min.)
9	Negative impulse testing KVp @ 25 degC	ASTM D-3300	145 (Min.)
10.	Carbon type composition (% of Aromatic, Paraffins and Naphthenic compounds)	IEC 60590 or ASTM D 2140	Max.Aromatic : 4 to12 % Paraffins : <50% & balance shall be Naphthenic compounds.
B1.	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 D129	0.15 % (Max.)
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.)
C1.	Performance		
1.	Oxidation stability -Total acidity -Sludge - Dielectric dissipation factor (tan delta) at 90deg C	IEC 61125 (method c) Test duration 500 hour IEC 60247	Max 0.3 mg KOH/g Max 0.05 % Max 0.05
2.	Gassing	IEC 60628A or ASTM D2300	No general requirement
3.	Oxidation stability (Rotating Bomb test)	IEC : 61125(Method B) / ASTM D2112 (e)	220 Minutes (Min.)
D1.	Health, safety and environment (HSE)		
1.	Flash point	ISO 2719	(Min.)135degC
2.	PCA content	BS 2000 Part 346	Max 3%
3.	PCB content	IEC 61619 or ASTM D4059	Not detectable (Less than 2mg/kg)

13.2 i) Prior to filling in main tank at site and shall be tested for

1. Break Down voltage (BDV) : 70kV (min.)

2. Moisture content : 30 ppm (max.)

3. Tan-delta at 90 °C : Less than 0.01

4. Interfacial tension : More than 0.035 N/m

ii) Prior to energisation at site oil shall be tested for following properties & acceptance norms as per below generally in line with IS :1866 / IEC 60422 :

1. Break Down voltage (BDV) : 70 kV (min.)

2. Moisture content : 10 ppm (max.)

3. Tan-delta at 90 °C : 0.01 (max.)

4. Resistivity at 90 °C : 6×10^{12} ohm-cm (min.)

5. Interfacial tension : 0.035 N/m (min.)

6. *Oxidation Stability (Test method as per IEC 61125 method C, Test duration: 500 hour 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.)

7. * Total PCB content : Not detectable (2 mg/kg total)

* For Sr. No. 6 & 7 separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of TANTRANSCO.

13.3 At manufacturer's works the quality of oil used for first filling, testing and impregnation of active parts shall meet at least parameter as mentioned in serial

no. 1 to 5 of clause 13.2 ii) above. The oil test results shall form part of equipment test report. 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.

13.4 Sufficient quantity of oil necessary for maintaining required oil level in tank, radiators, conservator etc till the completion of warranty period shall be supplied.

13.5 Particles in the oil

The particle analysis shall be carried out in an oil sample taken after completion of the oil purification at site. The procedure and interpretation shall be in accordance with the recommendation of CIGRE report WG-12.17 - "Effect of particles on transformer dielectric strength".

13.6 Moisture content in the solid insulation

Bidder may follow either method-1 or method-2 below to ensure dryness of solid insulation

Method-1: An Oil/paper moisture equilibrium chart shall be applied for the analysis of the moisture-in-oil results obtained from an oil sample taken after complete winding drying and oil filling in the tank at site. In order to ensure that equilibrium conditions are properly assessed, the sample shall be taken not earlier than 7 days after completing the oil and impregnation treatment. Recording the temperature of transformer oil during sampling is essential.

With this sample it shall be demonstrated that the moisture content in the paper insulation body of the Transformer is less than at least 0.5%.

Method-2: Dummy insulation test block shall be inserted in the active part of Transformer at factory and same shall be used to detect the volume moisture content.

Before application of vacuum and oil filling in the Transformer, it will be ensured that moisture content in the dummy insulation test block is less than 0.5%.

* The insulating oil, supplied with the transformer, shall be of EHV grade conforming to IS:335 of latest issue. No inhibitors shall be used in the oil. All the tests, specified in the standard, shall be carried out for confirmation of the quality on the oil samples, drawn at the following stages.

- i) Prior to filling of the transformer
- ii) Before carrying out the Heat-Run test
- iii) After carrying out the Heat-Run test
- iv) Before energizing the transformer at site

* Oil shall be filtered and tested for breakdown voltage (BDV) and moisture content before filling. The design and all materials and processes used in the manufacture of the transformer shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

* The insulating oil shall be subjected to testing at the manufacture's works/reputed laboratory before supply, in the presence of Inspecting personnel.

* Sufficient quantity of oil necessary for first filling of all tanks, coolers and radiators shall be supplied in sealed non returnable containers, suitable for outdoor storage.

* The tenderer shall furnish the following information in his offer to enable the purchaser, to procure, if decided to go for separate procurement.

- i) Recommended Technical parameters of the oil.
- ii) List of manufacturers of oil, who are preferred by the tenderer for the transformers offered by them.

* Where the supplier prefers to despatch the transformer without oil, due to limitations in the handling and transport facility, the transformer tank shall be filled with dry Nitrogen or equivalent inert gas. A gas cylinder, with suitable reducer connection and pressure gauge, shall be supplied to monitor the pressure of the gas in the tank during transit and storage at site, till completion of oil filling. These accessories shall become the property of the Purchaser.

* 5 Nos. of oil sampling bottles shall be provided.

14.0 Oil filling

14.1 Procedures for site drying, oil purification, oil filling etc shall be submitted for approval and complete instructions shall form part of the manual.

14.2 The duration of the vacuum treatment shall be demonstrated as adequate by means of water measurement with a cold trap or other suitable method but shall generally not be less than 72 hours. The vacuum shall be measured on the top of the Transformer tank and should be less than 1mbar.

14.3 Oil filling under vacuum at site shall be done with transformer oil at a temperature not exceeding 65°C. Vacuum shall not be broken until the Transformer is oil filled up to the Buchholz relay. Whenever the active insulation or any paper insulated HV connections, especially those from the windings to the bushings are exposed, these shall be re-impregnated under vacuum along with the complete Transformer. For this purpose the Transformer shall first be drained to expose all insulation material.

14.4 The minimum safe level of oil filling (if different from the Buchholz level) to which the Transformer shall be oil filled under vacuum, shall be indicated in the manual.

14.5 The Ultra High Vacuum type oil treatment plant of suitable capacity (preferably 4500 to 6000 litres per hour) suitable for treatment of oil in EHV class Transformer shall be used in order to achieve properties of treated oil. The plant shall be capable of treatment of new oil (as per IEC 60296 and reconditioning of used oil (as per IS: 1866/IEC: 60422 for oil in service) at rated capacity on single pass basis as follow:

- (i) Removal of moisture from 100 ppm to 3 ppm (max.)
- (ii) Removal of dissolved gas content from 10% by Vol. To 0.1% by vol.
- (iii) Improvement of dielectric strength break down voltage from 20 to 70 KV
- (iv) Vacuum level of degassing chamber not more than 0.15 torr/0.2 mbar at rated flow and at final stage. Machine shall have minimum of two degassing chambers and these should have sufficient surface areas to achieve the final parameters.
- (v) Filter shall be capable of removing particle size more than 0.5 micron in the filtered oil.
- (vi) Processing temperature shall be automatically controlled and have an adjustable range from 40°C to 80°C.

15.0 Terminal Arrangements

15.1 Bushings

15.1.1 The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137/DIN 42530.

15.1.2 Bushing for voltage of 800 kV shall be of porcelain type and hermetically sealed Oil filled condenser type.

Bushing for voltage of 52 kV and above shall be of the hermetically sealed Oil filled condenser type/ RIP bushing with porcelain or composite insulator. 36 kV bushings shall be solid porcelain or oil communicating type.

15.1.3 Oil filled condenser type bushing shall be provided with at least the following fittings.:

(a) Oil level gauge.

(b) Tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable.

15.1.4 Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.

15.1.5 Bushings of identical rating shall be interchangeable. Further, 800 kV class bushings for autotransformers and shunt reactors and 400 kV class bushing for autotransformer shall be interchangeable to optimise the requirement of spares.

15.1.6 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.

15.1.7 Clamps and fittings shall be of hot dip galvanised steel.

15.1.8 Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.

15.1.9 No arcing horns shall be provided on the bushings.

15.1.10 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.

15.1.11 All details of the bushing shall be submitted for approval and design review along with the original pamphlet.

15.1.12 Spare Bushing shall be specially packed suitable for long storage.

15.2 Terminal Marking

The terminal marking and their physical position shall be as per IEC: 60076.

15.3 Neutral Earthing Arrangement

15.3.1 The neutral terminals of star connected windings shall be brought to the ground level by a brass/tinned copper grounding bar, supported from the tank by using porcelain insulators.

15.3.2 The neutral terminals of winding of the three (3) single phase transformers shall be connected to an overhead common brass/tinned copper grounding bus, supported from the tank and fire walls by using porcelain insulators. The neutral formation shall be such that neutral winding of single phase spare transformer can be disconnected or connected to either of the three phase banks unless approved otherwise.

15.3.3 The end of the brass/tinned copper bar overhead common ground bus shall be brought to the ground level, at a convenient point, for connection to Purchaser's ground network through two (2) 75 x 12 mm galvanised steel flats at a single point to avoid any loop formation in the earthing circuit. . The connection shall be made by using two (2) bolted neutral grounding terminals with necessary accessories.

(Specific requirements of bushings and their ratings given in Annexure I)

16.0 Cooling Equipment and its Control

16.1 Cooling Equipment

16.1.1 The cooler shall be designed using 4 x 33.3% independent detachable radiator banks out of which 1x33.3% shall be used as standby. Design of cooling system shall satisfy the performance requirements. The wall thickness of radiator shall be not less than 1.2 mm. Each radiator shall be designed to withstand the pressure test. When assembled, they shall be accessible for cleaning and painting. Each radiator unit shall be provided with the following:

- (a) An 100 mm shut-off valve at each point of connection to the header/ transformer tank
- (b) Removable blanking plates to permit blanking-off the oil connection
- (c) A drain valve of size 25mm at the lowest point
- (d) Air release plug of 15 mm dia. at the highest point
- (e) Lifting lugs

16.1.2 Each radiator bank shall have its own cooling fans, oil pumps, oil flow indicator, shut off valves at the top and bottom of at least 80 mm size, lifting lugs, top and bottom oil filling valves, air release plug at the top, a drain and sampling valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.

16.1.3 Required number of standby fans of approximately 20% capacity shall also be provided with each radiator bank.

16.1.4 Cooling fans shall not be directly mounted on radiator bank which may cause undue vibration. These 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.

16.1.5 One low speed propeller type oil pumps shall be provided with each radiator bank. Measures shall be taken to prevent mal operation of Buchholz relay when all oil pumps are simultaneously put into service. 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. Original pamphlets for the oil pumps shall be submitted and oil pump shall be subject to approval & design review.

16.1.6 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.

16.1.7 Cooling fans and oil pump motors shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall conform to IS: 325/IEC60034. Each cooling fan and oil pump motors 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: 4691/IEC: 60034-5

16.1.8 The cooler and its accessories shall preferably be hot dip galvanised or corrosion resistant paint should be applied to it.

16.1.9 Expansion joint shall be provided on top and bottom cooler pipe connections as per requirement.

16.1.10 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. The drilling of all pipe flanges shall comply with IS:3639.

16.2 Cooling Equipment Control ONAN/ONAF1/(OFAF or ODAF or ONAF2) Cooling

16.2.1 Automatic operation control of fans/pumps shall be provided (with temperature change) from contacts of winding temperature indicator. The Contractor shall recommend the setting of WTI for automatic change over of cooler control from ONAN to ONAF and then to OFAF /ODAF or ONAN to ONAF to ONAF1 and then ONAF2. The setting shall be such that hunting i.e. frequent start-up operations for small temperature differential do not occur.

16.2.2 Suitable manual control facility for cooler fans and oil pumps shall be provided.

16.2.3 The changeover to standby radiator bank oil pump in case of failure of any service oil pump shall be automatic.

16.2.4 Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans and pump manually.

16.2.5 In addition to the traditional starting of fan and pump by oil temperature, the starting of forced cooling shall be done if the load exceeds an current setting of 0.6 p.u. for 5 seconds.

16.2.6 Once started the cooling shall remain in operation for a minimum duration of 30 minutes .This timer shall be at least adjustable from 15 to 60 minutes. Starting the pumps on load shall provide the cooling system a lead on the temperature that is about to follow during high loading conditions. Spurious operation should however be avoided by appropriate settings.

16.2.7 Further more, a one-week timer is required to check the healthiness of the cooling system on a routine basis for one hour at a time.

16.2.8 Adequate warning/ safety labels are required to indicate that the fans may start at any time.

16.2.9 All settings shall be adjustable.

16.2.10 If any one group(s) is out of service and isolated, this shall not affect the automatic starting of the other radiator banks.

16.3 Indicating Devices

Following lamp indications shall be provided in cooler control cabinet :

- a) Control Supply failure.
- b) Cooling fan failure for each bank.
- c) Cooling pump failure for each pump.
- d) No oil flow/reverse oil flow for pumps.
- e) Common thermal overload trip.

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet.

Local cooler control cubicle:

25.6.1. Each transformer shall be supplied with outdoor type, vermin and weather proof local cooler control cubicle for accommodating the control gears of the cooling fans and pumps, besides cable termination from remote tap changer control panel and other transformer accessories.

25.6.2. The cooler control cubicle shall be provided with three pole, electrically operated, contactor and with control gears of suitable design, both for starting and stopping the individual oil pumps and groups of cooling fans, manually and also automatically, from the contacts of the Winding Temperature Indicating device. These shall be accommodated in the local cooler control cubicle.

25.6.3. The local control panel shall have all necessary devices meant for cooler control viz.

- (a) MCBs of adequate capacity for main supply.
- (b) Protection against over load
- (c) Protection against single phasing
- (d) Selector switch for Manual/Automatic operation of individual pump & groups of cooling fans.
- (e) Selector switch for Local/Remote operation of individual pumps and groups of cooling fans.
- (f) Pump control ON/OFF/Test for each pump. (for applicable capacity)
- (g) Fan control ON/OFF/Test for each fan.

25.6.4. The following additional terminals shall be provided in the cooler control cubicle for remote indication.

- a) Oil flow fail alarm.
- b) Cooling fan trip (for each group of fans & standby)
- c) Cooler pump trip (for each pumps in service & standby)
- d) Cooler supply failure.
- e) Low oil level alarm.

25.6.5. The following initiating contacts for lamp indicators shall be provided for local as well as remote indication

- (a) Cooling system is on 'Manual' control
- (b) Cooling system is on 'Automatic control'.
- (c) Selector switch is in 'Auto' or 'Manual' or 'Local'
- (d) Pump 'ON', pump 'OFF' for each pump
- (e) Fan 'ON' / 'OFF' for each group each group of fan and each pump.
- (f) Oil flow failure.

MARSHALLING BOX

Tank mounted, vermin and weather proof marshalling box, shall be provided with a controlled metal-clad heater to accommodate the following :

- (a) Temperature indicators/controllers.

(b) Terminal blocks, made up of molded, non inflammable plastic material with adequate size terminals, washers, binding screws/nuts for external wire connections, a white marking strip for circuit identification and a molded plastic cover.

(c) Suitable glands with gland plates for incoming and outgoing cables, meant for oil level alarm, Temperature alarm/Trip, Buchholtz alarm/trip, annunciation and indication provisions for RTCC panel etc.

16.4 Valves

16.4.1 All valves upto and including 100 mm shall be of gun metal or of cast steel/cast iron.

Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.

16.4.2 Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.

16.4.3 Each valve shall be provided with the indicator to show clearly the position of the valve.

16.4.4 All valves flanges shall have machined faces.

16.4.5 All valves in oil line shall be suitable for continuous operation with transformer oil at 115 deg C.

16.4.6 The oil sampling point for main tank shall have two identical valves to be put in series. Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.

16.4.7 Valves or other suitable means shall be provided to fix the on line condition monitoring system to facilitate continuous monitoring.

* Each tank shall be fitted with the following valves.

i) Oil valves between each cooler and main tank.

ii) One 100 mm drain valve with padlocking arrangement, located on the low voltage side of the transformer at the bottom most point of the tank , enabling complete draining of oil.

iii) Two 50 mm filter valves, one on the top of the tank and at a diagonally opposite end to that of drain valve and another at the bottom. The bottom valve shall be with padlocking arrangement. These shall have adaptor suitable for 32 mm hose.

- iv) Two sampling valves (size 25 mm) at top and bottom of the main tank, with provision for fixing PVC pipe.
 - v) One 15 mm air release plug on the top cover.
 - vi) Two plugged pipe outlets for applying vacuum.
- All valves with opening to atmosphere, shall be fitted with blank flanges.
 - All valves shall be of gun metal or cast steel or may have cast iron bodies with gun metal fittings.
 - Valves shall be provided with flanges, having machined faces/ screw connection for external piping.

16.4.8 Valves or other suitable means shall be provided to fix the on line oil drying system to facilitate continuous on line oil drying. The location & size of the same shall be finalised during detail engineering stage.

16.4.9 Suitable small bore (8 mm copper) piping with an appropriate valve shall be provided to take sample of oil from the OLTC chamber by the user while at ground.

16.4.10 All valve shall be painted with a shade (preferably red or yellow distinct and different from of main tank surface and as per the painting system and procedure specified in clause no 7.11

16.4.11 All hardware used shall be cadmium plated/electro galvanised.

17.0 Tap Changing Equipment

The design, manufacture and performance of the OLTC shall comply with the CBIP regulations, other statutes and safety codes and IS 8468 of latest issue. The transformer supplier shall ensure the above.

a) 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.

b) The on-load tap changer shall include the following:

- a) An oil immersed diverter switch of transition resistor type.
- b) Motor driven mechanism for local as well as remote operation.
- c) Control and protective devices.
- d) Remote Tap Changer control panel.
- e) Annunciation schemes.
- f) Local - manual operating device.

OLTC manufacturer shall conduct the following routine tests fully in compliance with IEC 60214 on every unit, as given below, before despatch to assure the quality of the products.

<u>S. No.</u>	<u>IEC Reference</u>		<u>Test Description</u>
1.	Cl.5.3.1	-	Mechanical Test
2.	Cl.5.3.2	-	Sequence Test
3.	Cl.5.3.3	-	Auxiliary circuits Insulation Tests
4.	Cl.5.3.4	-	Pressure Test
5.	Cl.5.3.4	-	Vacuum Test

All the relevant test reports shall be submitted along with the test report of transformer for approval.

17.1 Tap Change Switch General Requirement

OLTC shall be motor operated for local as well as remote operation. An external handle shall be provided for local manual operation. This handle shall be suitable for operation by a man standing at ground level.

17.2 On Load Tap Changing Gear (OLTC)

17.2.1 Each single/ three phase transformer shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load and without producing phase displacement.

17.2.2 The requirements of on load tap changing equipment are given here below:

- a) The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer.
- b) The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.
- c) 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. Necessary tools and tackles shall be furnished for maintenance of OLTC gear.
- d) The OLTC oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with a oil surge relay the outlet of which shall be connected to a separate conservator tank.
- e) 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 safeguard the transformer and its ancillary equipment.
- f) Tap changer shall be so mounted that bell cover of transformer can be lifted without removing connections between windings and tap changer.
- g) Local OLTC control cabinet shall be mounted on the tank in accessible position.

It should be adequately ventilated and provided with anti-condensation metalclad heaters. All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.

h) Operating mechanism for on load tap changer shall be designed to go through one step of tap change per command. Subsequent tap changes shall be initiated only by a new or repeat command.

i) On load tap changer 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.

j) The selsyn units or approved equivalents shall be installed in the local OLTC control cabinet to provide tap position indication for the transformer. The Bidders shall also provide a set of instruments for tap position indication in the control room. Complete mounting details shall be included in the approved diagram.

k) Transformer on load tap shall be equipped with a fixed resistor network capable of providing discrete voltage steps for input to the supervisory system.

l) Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition.

m) Limit switches may be connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated.

n) Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, fuses etc. shall be mounted in the local OLTC control cabinet and shall be clearly marked for the purpose of identification.

o) A permanently legible lubrication chart if required, shall be fitted within the local OLTC control cabinet.

p) Any 'DROP DOWN' tanks associated with the tap changing apparatus shall be fitted with guide rod to control the movements during lifting or lowering.

q) A counter of at least five digit shall be fitted to the tap changing equipment to indicate the number of operations completed and shall have no provision

forresetting . These high quality counters shall be suitable for at least 1 millionoperation and shall be supported by a type test certificate.

r) All relays and operating devices shall operate correctly at any voltage between the limits specified.

s) It shall not be possible to operate the electric drive when the manual operatinggear is in use.

t) It shall not be possible for any two controls to be in operation at the same time.

u) The equipment shall be suitable for supervisory control and indication with makebefore 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 indication.

v) Operation from the local or remote control switch shall cause one tap movement only until the control switch is returned to the off position between successive operation.

w) All electrical control switches and the local operating gear shall be clearly labelled in a suitable manner to indicate the direction of tap changing.

x) Transfer of source in the event of failure of one AC supply shall not affect the tap changer.

17.3 OLTC Control of single phase Transformer

For three single phase units operating as three phase bank the OLTC gear shall be suitable for local and remote control. The control features shall provide the following:

i) Local Electrical Control

a) 'Local-remote' selector switch mounted in the local OLTC control cabinet shall switch control of all on load tap changers as under:

When the selector switch is in 'local' position, it shall be possible to operate any of the 'raise-lower' control switches.

Control of the raise-lower function from the control panel shall be prevented.

When the selector switch is in 'remote' position, the raise-lower functions formswitches in local OLTC control cabinets as well as common marshalling box shall be inoperative. Remote control of the raise-lower function of the three phase transformer banks shall be possible from the control panel.

The remote-local selector switch shall be have at least two spare contacts per

position.

b) 'Independent-combined selector switch shall be provided for single phase transformer only and shall be mounted in the common marshalling box. This switch shall control the on load tap changers as follows.

When the selector switch in combined position, it shall be possible to raise lowertaps by operating the combined 'raise-lower' switch in commonmarshalling box or the remote raise-lower switch. Independent operation ofeach single phase transformer will be prevented.

When the selector switch is in independent position it shall be possible toraise-lower taps by operating individually each single phase transformerthrough their individual 'raise-lower' control switch mounted in Local OLTCControl Cabinet. Combined operation of all the three (3) single phasetransformers will be prevented.

c) A combined raise-lower control switch shall be provided in the commonmarshalling box for a bank of three single phase transformers only. This switch shall be functional only when 'local-remote' selector switch is in localposition and 'Independent combined' selector switch is in combined position.

d) An individual 'raise-lower' control switch in local OLTC control cabinet foreach single phase transformer. This switch shall be functional only when'local-remote' selector switch is in local position and 'Independent -combined'selector switch is in 'Independent position.

ii) Local Manual control

The cranking device for manual operation for OLTC gear shall be removable andsuitable for operation by a man standing at ground level. The mechanism shall becomeplete with the following.

a) Mechanical tap position indicator which shall be clearly visible from near thetransformer.

b) A mechanical operation counter.

c) Mechanical stops to prevent over-cranking of the mechanism beyond theextreme tap positions.

d) The manual control considered as back up to the motor operated on load tapcharger control shall be interlocked with the motor to block motor start-upduring manual operation. The manual operating mechanism shall be labelledto show the direction of operation for raising the voltage and vice-versa.

17.4 .DIGITAL REMOTE TAP-CHANGER CONTROL PANEL (RECOMMENDMENTS SECTION 2A)

1. It shall be possible to remotely control and monitor OLTC from Digital RTCC panel. The Panel should be erected along with the respective transformer protection relay panels in switchyard panel room(kiosk).The digital RTCC panel shall have Automatic Tap Changer control and monitoring relay with Automatic Voltage Regulating features (referred as **Digital RTCC relay**).The relay shall be of reputed make and shall be in successful operation for at-least 2years for transformer OLTC application .

2. Digital RTCC relay should be microprocessor based adopting the latest state of the art design & technology with in-built large 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 site conditions without sending back to works. The programming shall be menu driven and can be easily configurable. If it is supplied as a draw out type module, 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.

3. The digital RTCC Panel shall be provided with digital RTCC relay, Raise/Lower push buttons, Manual/ Automatic mode selector switch and Master / Follower/ Independent/Off mode selector switch for control of OLTC. The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select these set points from SCADA, with a facility to have the possibility of additional set points command from SCADA.

4.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.

5. 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.

6. Master / Follower/ Independent/ Off mode

Master Position: If the selector switch is in master position, it shall be possible to control the OLTC units of other transformer banks/three phase transformer in the follower made by operation the master unit.

Follower Position: If the selector switch 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.

7.Raise/Lower: The remote OLTC scheme offered shall have provision to raise or lower taps only for the complete bank of three 1-phase transformers. Individual single phase OLTC operation shall not be possible from the remote control panel.

8. The Digital RTCC relay shall incorporate all the control facilities specified in this specification. The Digital RTCC relay shall be provided for controlling all three phases of a transformer bank. The system shall be self-sufficient and shall not require any additional devices like parallel balancing module etc.

9. Communication between the Digital RTCC relays in order to execute the commands for parallel operation shall be implemented using hardware and communication protocol, suitable up to a maximum length of 1km.

10. Digital RTCC relays shall communicate with SCADA using IEC 61850 protocols to monitor, parameterise & control OLTC. Any software required for this purpose shall be supplied. The software supplied will not have restriction in loading of multiple The software supplied will not have restriction in loading of multiple computers for downloading and analyzing the data. The vendor shall provide necessary provision for SCADA integration with the existing/ future SCADA system. Software shall indicate the current overview of all measured parameters of the connected transformer on-line in real time.

11. It shall be possible to communicate/integrate with all digital RTCC relays of different make located at different locations in the substation by making hardwire and using IEC 61850 communication link. The integration of existing conventional RTCC panel with Digital RTCC panel of different make shall also be possible.

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

13. Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated to the next (higher or lower) tap.

14. "Step-by-Step" operation ensuring only one tap change from each tap changing impulse and a lock-out of the mechanism if the control switch (or push button) remains in the "operate" position.

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

- a. INCOMPLETE STEP alarm
- b. OLTC motor overload protection alarm
- c. Supply to DM Motor fail alarm
- d. OLTC IN PROGRESS alarm
- e. OLTC upper/lower limits reached alarm
- f. 415V Main AC supply Fail alarm
- g. 415V Standby AC supply Fail alarm
- h. Local / Remote Selector switch positions in DM Box
- i. OLTC Tap position indications for all three 1-Ph transformer units separately
- j. 'Independent-combined-remote selector switch positions of CMB

17.5 Local OLTC Control Cabinet, Cooler Control Cabinet and Remote Tap Changer Control Panel

17.5.1 Each single transformer unit shall be provided with local OLTC control cabinet, cooler control cabinet /marshalling box for each single phase unit and RTCC panel and common marshalling (for a bank of three single phase unit) .

17.5.2 The sheet steel used for cooler control cabinet and local OLTC control cabinet shall be at least 2.0 mm thick for cold rolled and 2.5 mm for hot rolled. The degree of protection shall be IP: 55 in accordance with IS: 13947/IEC: 60947. All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM /Neoprene gaskets. The gaskets shall be tested in accordance with approved quality plan, IS: 1149 and IS; 3400. The quality of gasket shall be such that that it does not get damaged / cracked during the ten years of the operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh of brass. All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof. All the control cabinets shall be provided with suitable lifting arrangement.

17.5.3 A space heater, and cubicle lighting with ON-OFF switch shall be provided in each panel.

17.5.4 Necessary shorting of terminals shall be done at the cooler control cabinet, local OLTC cabinet and remote OLTC panel. All the CT secondary terminals in the cooler control cabinet shall have provision for short circuiting to avoid CT open circuit while it is not in use.

17.6 Cooler Control Cabinet

17.6.1 The cooler control cabinet shall have all necessary devices meant for cooler control and local temp. 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. All the necessary terminals for remote connection to Purchaser's panel shall be wired up to the cooler control cabinet.

17.6.2 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, aux. CTs and the terminal boards meant for termination of various alarm and trip contacts as well as various bushing CT secondary. Alternatively the two sections may be provided as two separate panels depending on the standard practice of the Bidder.

17.6.3 The temperature indicators 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.

17.7 Local OLTC 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:

- I) A circuit breaker/contactors with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor.
- ii) Cubicle light with door switch.
- iii) Space heaters to prevent condensation of moisture.
- iv) Padlocking arrangement for hinged door of cabinet.
- v) Cable terminal glands for power and control cables to the OLTC gear.

17.8 Remote Tap Changer Control Panel.

17.8.1 The Contractor shall supply a Digital Remote Tap Changer Control (RTCC) panel suitable for remote operation of On load tap changing gear.

17.8.2 The RTCC panel shall house actuating switch for electrical raise/lower control, tap position indicator, signal lamps for "Tap change in progress" and "Tap changer out of step", and all other auxiliary devices for remote electrical control of the OLTC. For tap position indicator, the dual output type OLTC transducer shall be provided in the RTCC panel. The one of the output of this transducer shall be used for local indication of tap position in RTCC panel and other output (0-10 mA or 4-20 mA) shall be used for RTUs / automation system.

17.8.3 The RTCC panel shall be located in Purchaser's local kiosk. The size & colour of the RTCC panel shall match with Purchaser's control panel. The matching details shall be furnished at the time of award.

17.9 Auxiliary Power Supply of OLTC, Cooler Control and Power Circuit

17.9.1 Two auxiliary power supplies, 415 volt, three phase four (4) wire shall be provided by the Purchaser at common marshalling box for OLTC and cooler control and power circuit. Further the supplying and laying of cable from common marshalling box to individual units (including spare unit) is in the scope of this package.

17.9.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the common marshalling box for on load tap changer control and cooler circuits.

Design features of the transfer switch 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 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.

17.9.3 Power Supply for OLTC Circuits

a) AC feeder shall be brought to the local OLTC control cabinet by the Contractor after suitable selection at common marshalling box, for control power circuit of OLTC.

b) The Contractor shall derive AC power for OLTC control circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformers. If the control circuit is operated by DC supply, then suitable main and standby converters shall be provided by the Contractor to be operated from AC power source.

17.09.4 Power Supply for Cooler Circuits

17.09.4.1 Control and power supplies are to be given for Cooler circuits after the selection as mentioned in 17.09.1 above.

17.09.4.2 The Contractor shall derive AC power for Cooler Control Circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformer. If the control circuit is operated by DC supply then suitable main and standby convertors shall be provided by the Contractor, to be operated from AC power source.

17.09.4.3 Necessary isolating switches and protective devices shall be provided at suitable points as per Purchaser's approved scheme.

18.0 Tertiary Bus Arrangement: (FOR INFO)

18.1 The arrangement for the external delta formation of the tertiary winding for a three phase bank shall be made by overhead connection using aluminium pipe of size 3" IPS.

18.2 The overhead conductors shall be insulated by heat shrinkable sleeves (Raychem/3M make) of adequate thickness of at least 52 kV and shall be supported by structure mounted on bus post insulators.

18.3 All the materials like structures, bus post insulators, pipe conductors, terminal connectors etc. required for the tertiary bus arrangement shall be included in the scope of the supply of the bidder.

19.0. Fittings

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

19.1 Conservator for main tank with oil filling hole and cap, isolating valves, drain valve ,magnetic oil level gauge with low level alarm contacts and dehydrating breather.

19.2 Conservator for OLTC with drain valve, oil surge Relay, filling hole with cap,prismatic oil level gauge and silica gel breather.

19.3 Oil preservation equipment.

19.4 Pressure relief devices with alarm/trip contacts.

19.5 Buchholz relay double float/reed type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.

19.6 Air release plug.

19.7 Inspection openings and covers.

19.8 Bushing with metal parts and gaskets to suit the termination arrangement.

19.9 Winding & Oil temperature indicators for local and remote mounting.

19.10 Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.

19.11 Protected type mercury or alcohol in glass thermometer or magnetic type dial type temperature indicator.

19.12 Bottom and top filter valves with threaded male adaptors, bottom sampling valve and drain valve.

19.13 Rating and diagram plates on transformers and auxiliary apparatus.

19.14 Flanged bi-directional wheels/Trolley for movement

19.15 Cooler control cabinet.

19.16 On load tap changing gear.

19.17 Cooling equipment.

19.18 Bushing current transformers.

19.19 Oil flow indicator.

19.20 Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.

19.21 Terminal marking plates.

19.22 Valves schedule plates.

19.23 Common marshalling box for a bank of three single phase unit:

All the circuit connections from individual marshalling box and local OLTC box of three single phase unit (spare unit, if applicable) of a bank to Purchasers

Controlpanels shall be routed through common marshalling box. Common marshalling boxshall have following arrangement in addition to schematic arrangement for auxiliarypower supply mentioned in clause no 3.3.11.

a) In case of connection arrangement for spare unit is in such a way that spare unit oftransformer can be connected in place of faulty unit without physically shifting, then,all the control, protection, indication signals of spare unit shall also be brought incommon marshalling box of all the banks. Necessary arrangement in schematic ofCommon marshalling box is required to facilitate changeover of all the signals from banked Auto Transformer, to ensure flow of control, protectionand indication signals between RTCC panel / Purchasers Control panels andindividual units under operation .

b) In case of connection of spare unit in place of faulty unit require physical displacement of faulty unit and spare unit then all the control, protection and indication circuit connections from individual marshalling box of three single phaseunit of a bank to RTCC panel and Purchasers Control panels shall be routed throughcommon marshalling box. In such case, control, protection and indication signals ofspare unit are not required in common marshalling box, however auxiliary powersupply shall be extended to the spare unit from nearby common marshalling box.

19.24 Ladder to climb up to the Transformer tank cover with suitable locking arrangement to prevent climbing during charged condition.

19.25 Flow sensitive conservator Isolation valve for Fire Control in 765 kV classTransformers

19.25.1 In order to restrict the supply of oil in case of a fire in transformer, following shall be provided to isolate the conservator oil from the main tank.

19.25.2 A valve which shall be flow sensitive and shut off when the flow in the pipe is more than the flow expected in the permissible normal operating conditions. This valveshall be located in the piping between the conservator and the buchholz relay andshall not affect the flow of oil from and to the conservator in normal conditions.

19.25.3 When the flow from conservator to main tank is more than the normal operating conditions, the valve shall shut off by itself and will have to be reset manually. It shall be provided with valve open/close position indicator along with alarm indication in control room during closing operation of valve. This valve shall

be provided with locking arrangement for normal position and oil filling / filtration position.

19.26 The fittings listed above are only indicative and other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

20.0 Inspection and Testing

The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment. An indication of inspection envisaged by the Purchaser is given under Clause 20.1. This is however not intended to form a comprehensive programme as it is Contractor's responsibility to draw up and carry out such a programme in the form of detailed quality plan duly approved by

Purchaser for necessary implementation.

20.1 Inspection

20.1.1 Tank and Conservator

20.1.1.1 Certification of chemical analysis and material tests of plates.

20.1.1.2 Check for flatness.

20.1.1.3 Electrical interconnection of top and bottom by braided tinned copper flexible.

20.1.1.4 Welder's qualification and weld procedure.

20.1.1.5 Testing of electrodes for quality of base materials and coatings.

20.1.1.6 Inspection of major weld preparation.

20.1.1.7 Crack detection of major strength weld seams by dye penetration test.

20.1.1.8 Measurement of film thickness of:

i) Oil insoluble varnish.

ii) Zinc chromate paint.

iii) Finished coat.

20.1.1.9 Check correct dimensions between wheels, demonstrate turning of wheels through 90° and further dimensional check.

20.1.1.10 Check for physical properties of materials for lifting lugs, jacking pads, etc. All load bearing welds including lifting lug welds shall be subjected to Non Destructive

Testing.

20.1.1.11 Leakage test of the conservator.

20.1.1.12 Certification of all test results.

21.0 Core Testing

21.1 Sample testing of core materials for checking specific loss, bend properties, magnetisation characteristics and thickness.

21.2 Check on the quality of varnish if used on the stampings:

- i) Measurement of thickness and hardness of varnish on stampings.
- 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 spots, no over burnt varnish layer and no bubbles on varnished surface.

21.3 Check on the amount of burrs.

21.4 Bow check on stampings.

21.5 Check for the overlapping of stampings. Corners of the sheet are to be part.

21.6 Visual and dimensional check during assembly stage.

21.7 Check for interlaminar insulation between core sectors before and after pressing.

21.8 Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

21.9 High voltage test (2 kV for one minute) between core and clamps.

21.10 Certification of all test results.

21.11 Insulation Material

21.12 Sample check for physical properties of materials.

21.13 Check for dielectric strength.

21.14 Visual and dimensional checks.

21.15 Check for the reaction of hot oil on insulating materials.

21.16 Dimension stability test at high temperature for insulating material.

21.17 Tracking resistance test on insulating material

21.18 Certification of all test results.

22.0 Winding Testing

22.1 Sample check on winding conductor for mechanical properties and electrical conductivity.

22.2 Visual and dimensional checks on conductor for scratches, dent marks etc.

22.3 Sample check on insulating paper for pH value, bursting strength and electric strength.

22.4 Check for the reaction of hot oil on insulating paper.

22.5 Check for the bonding of the insulating paper with conductor.

22.6 Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.

22.7 Check for absence of short circuit between parallel strands.

22.8 Check for brazed joints wherever applicable.

22.9 Measurement of voltage ratio to be carried out when core/yoke is completely restacked and all connections are ready.

22.10 Conductor enamel test for checking of cracks, leakage and pin holes.

22.11 Conductor flexibility test

22.12 Heat shrink test for enamelled wire.

22.13 Certification of all test results.

23.0 Checks Before Drying Process

23.1 Check condition of insulation on the conductor and between the windings.

23.2 Check insulation distance between high voltage connections, cables and earth and other live parts.

23.3 Check insulating distances between low voltage connections and earth and other parts.

23.4 Insulation of core shall be tested at 2 kV/minute between core to bolts and core to clamp plates.

23.5 Check for proper cleanliness and absence of dust etc.

23.6 Certification of all test results.

24.0 Checks During Drying Process

24.1 Measurement and recording of temperature, vacuum and drying time during drying process.

24.2 Check for completeness of drying by periodic monitoring of dryness.

24.3 Certification of all test results.

25.0 Assembled Transformer

25.1 Check completed transformer against approved outline drawings, provision for all fittings, finish level etc.

25.2 Test to check effective shielding of the tank.

25.3 Jacking test with oil on all the assembled transformers.

25.4 Dye penetration test shall be carried out after the jacking test.

26.0 Bought Out Items

26.1 The makes of all major bought out items shall be subject to Purchaser's approval.

26.2 The Contractor shall also prepare a 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/ Individual Marshalling box and common marshalling box for a bank of three 1-Phase units
- h) Cooling equipment.
- i) Oil pumps.
- j) Fans/Air Blowers
- k) Tap change gear.
- l) Pressure relief device.

The above list is not exhaustive and the Contractor shall also include other bought out items in his programme.

27.0 Factory Tests (RECOMMENDATION SECTION 27.0 TEST PROCEDURE)

The manufacturer shall be fully equipped to perform all the required tests as specified.

Bidder shall confirm the capabilities of the proposed manufacturing plant in this regard when submitting the bid. Any limitations shall be clearly stated in.

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

The contractor shall submit a Inspection and test plan (ITP) for approval. A typical test plan is indicated below.

All tests shall be done in line with IEC: 60076 . Complete test report shall be submitted to purchaser after proper scrutiny and signing on each page by the test engineer of the contractor.

No.	Item	Test Category
1.	Measurement of winding resistance	Routine
2.	Voltage ratio measurement	Routine
3.	Polarity test	Routine
4.	No-load loss and current measurement	Routine
5.	Impedance voltage and load loss measurement	Routine
6.	Measurement of insulation resistance & Polarization Index	Routine
7.	Measurement of insulation power factor and capacitance between winding and earth	Routine
8.	Lightning impulse test	Routine
9.	Measurement of transferred surge on LV (tertiary) due to HV lightning impulse and IV lighting impulse.	Routine
10.	Switching impulse test Routine	Routine
11.	Measurement of transferred surge on LV (tertiary) due to HV switching impulse and IV switching impulse	Routine
12.	Separate source voltage withstand test	Routine
13.	Induced over voltage test with Partial Discharge measurement	Routine
14.	On-load tap changer test(Ten complete cycle before LV test)	Routine
15.	Gas-in-oil analysis	Routine
16.	Core assembly dielectric and earthing continuity test	Routine
17.	Oil leakage test on transformer tank	Routine
18.	Appearance, construction and dimension check	Routine
19.	Short duration heat run test (Not Applicable for unit on which temperature rise test is performed)	Routine
20.	Magnetic balance test (For three phase Transformer only)	Routine
21.	Measurement of no load current & Short circuit Impedance with 415 V, 50 Hz AC.	Routine
22.	Frequency Response analysis (Soft copy of test report to be submitted to site along with test reports)	Routine

23.	High voltage with stand test on auxiliary equipment and wiring after Assembly	Routine
24.	Over excitation test	Routine
25.	Tank vacuum test	Routine
26.	Tank pressure test	Routine
27.	Lightning Impulse Test on Neutral	*Type
28.	Temperature rise test	*Type
29.	Overload testing in short-circuit method	*Type
30.	Measurement of harmonic level in no load current	*Type
31.	Measurement of acoustic noise level	*Type
32.	Measurement of power taken by fans and oil pumps (3 x 33.3 % cooler bank)	*Type
33.	Measurement of Zero seq. reactance (for three phase Transformer only)	*Type

*Type test shall be carried out at first unit manufactured against the LOA at each manufacturing plant.

DYNAMIC SHORT CIRCUIT TEST:

Calculation for dynamic short circuit test on single phase 500MVA 765/400KV ICT may be furnished.

28.0 Type Tests on fittings:

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings. The list of fittings and the type test requirement is:

1. Bushing (Type Test as per IEC:60137 including Snap back/Seismic test for 400 kV and above voltage class bushing)
2. Buchholz relay
3. OLTC (Test as per IEC:60214 and IP-55 test on driving mechanism box)
4. Cooler Control cabinet & common marshalling box (IP-55 test)
5. Pressure Relief device Test
6. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.
7. Air Cell (Flexible air separator)
8. OTI & WTI
9. Oil pump
10. Cooling fan and motor assembly –
11. Terminal connectors

- 12. Bus post insulators
- 13. Disc insulator and hardware
- 14. Conductor(s)

29.0 Pre-Shipment Checks at Manufacturer's Works

- 29.1 Check for inter changeability of components of similar transformers for mounting dimensions.
- 29.2 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.
- 29.3 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.
- 29.4 Gas tightness test to confirm tightness and record of dew point of gas inside the tank.
- 29.5 Derivation of leakage rate and ensure the adequate reserve gas capacity.

30.0 Inspection and Testing at Site

The Contractor shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage up to commissioning stage. An indicative programme of inspection as envisaged by the Purchaser is given below. However, it is contractor's responsibility to draw up and carry out such a programme duly approved by the Purchaser. Testing of oil sample at site shall be carried out as per Cl.13.0 above.

30.1 Receipt and Storage Checks

- 30.1.1 Check and record condition of each package, visible parts of the transformer etc. for any damage.
- 30.1.2 Check and record the gas pressure in the transformer tank as well as in the gas cylinder.
- 30.1.3 Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.
- 30.1.4 Check and record reading of impact recorder at receipt and verify the allowable limits as per manufacturer's recommendations.

30.2 Installation Checks

- 30.2.1 Inspection and performance testing of accessories like tap changers, cooling fans, oil pumps etc.

30.2.2 i) Check the direction of rotation of fans and pumps.

ii) Check the bearing lubrication.

30.2.3 Check whole assembly for tightness, general appearance etc.

30.2.4 Oil leakage test

30.2.5 Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.

30.2.6 Leakage check on bushing before erection.

30.2.7 Measure and record the dew point of gas in the main tank before assembly.

30.3 Commissioning Checks

30.3.1 Check the colour of silicagel in silicagel breather.

30.3.2 Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.

30.3.3 Check the bushing for conformity of connection to the lines etc,

30.3.4 Check for correct operation of all protection devices and alarms :

(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.

30.3.5 Check for the adequate protection on the electric circuit supplying the accessories.

30.3.6 Check resistance of all windings on all steps of the tap changer.

Insulation resistance measurement for the following:

(i) Control wiring.

(ii) Cooling system motor and control.

(iii) Main windings.

(iv) Tap changer motor and control.

30.3.7 Check for cleanliness of the transformer and the surroundings.

30.3.8 Phase out and vector group test.

30.3.9 Ratio test on all taps.

30.3.10 Magnetising current test.

30.3.11 Capacitance and Tan delta measurement of winding and bushing.

30.3.12 Frequency response analysis (FRA). FRA equipment shall be arranged by purchaser.

30.3.13 DGA of oil just before commissioning and after 24 hours energisation at site.

30.3.14 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.

30.3.15 Continuously observe the transformer operation at no load for at least 72 hours.

30.3.16 Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to Purchaser for future record.

31 Technical Parameters

Technical Parameters: 500 MVA Single Phase Auto Transformer

31.1 Rating- H.V. / I.V : 500 MVA / 500 MVA

LV (Tertiary) : 167 MVA, however continuous thermal rating shall be at least of 5 MVA active loading

31.2 Cooling : i) ONAN/ONAF/ (OFAF or ODAF)
OR
ii) ONAN/ONAF1/ONAF2

31.3 Rating at different cooling : 60%/80%/100%

31.4 Type of Transformer : Auto transformer

31.5 Voltage ratio : $\frac{765}{\sqrt{3}}$ / $\frac{400}{\sqrt{3}}$ 33 kV

31.6 Frequency : 50 Hz

31.7 Phases : Single

31.8 Impedance

At principal tap, rated MVA of HV & IV & at 75deg C between

- HV-IV : 14.0% (IEC tolerance applicable)

- HV/LV : 195.0 %

- IV/LV : 180.0 %

31.9 Air core reactance of HV : 20% (minimum)

31.10 Service : Outdoor

31.11 Duty : Continuous

31.12 Overload capacity : As per IEC-60076-7

31.13 Temperature rise over

50 deg C Ambient Temp.

- Of top oil measured by thermometer : 40⁰ C

- Of average winding measured
by resistance method : 45⁰ C

- Of winding hot spot : 59⁰ C

31.14 Cooling medium : Mineral oil (The insulating oil shall be virgin high grade inhibited , conforming to IS 335/IEC 60296)

31.15 Max. design Ambient temp. : 50⁰ C

31.16 Windings	H.V.	I.V.	L.V.
i) Lightning : Impulse withstand voltage kVp(1.2/50 μ-sec)	1950	1300	250
ii) Switching impulse : withstand voltage kVp(250/2500 μ-sec)	1550	1050	--
iii) One minute power : frequency withstand voltage KV (rms)	--	--	95
iv) Winding connection :	Star	Star	delta
v) Neutral :	Solid ground	Solid ground	Ungrounded
vi) Insulation :	Graded	Graded	Uniform
vii) Tertiary :	Ungrounded delta		
viii) Tan delta of windings :	----- Less than 0.005 ----- corrected at 20 ⁰ C		

31.17 Vector Group (3 –ph) : ----- YN aO d11 -----

31.18 Tap Changer

i) Tap range : Tap changer shall be located on the neutral side of the winding and shall be designed for tapping range of ± 5.5% on HV variation in 22 steps.

ii) Tap control : Full capacity - on load tap changer
suitable for group / independent,
remote /local electrical and local
manual operation and bi-directional
power flow.

iii) Operation per year : Less than 10,000

iv) Tie Resistor : Calculation for requirement of tie
resistor Shall be verified during design
review.

31.19 Bushing :	HV	IV	Neutral	LV
i) Rated voltage (kV) :	800	420	36	52
ii) Rated current : (Amp) (Min.)	2500	2500	2500	3150
iii) Lightning : impulse withstand voltage (kVp)	2100	1425	170	250
iv) Switching impulse : withstand voltage (kVp).	1550	1050	--	--
v) One minute power : frequency withstand voltage kV (rms)	970	695	77	105
vi) Minimum total : creepage distances (mm)	20000	10500	900	1300
vii) Tan delta of bushings :	----- Less than 0.004 ----- corrected at 20 ⁰ C			

31.20 Max Partial discharge level : 100 pico-columb
at 1.5 P.U./ $\sqrt{3}$

31.21 Noise level at rated voltage : i) The ONAN noise shall not exceed 75
and at principal tap dBA.
ii) At full load and all cooling active, the
noise level shall not exceed 80 dBA.

Note 1: In case of parallel operation with existing transformer, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.

32.0 Current Transformer

32.1 Bushing Current Transformer

32.1.1 Current transformers shall comply with IEC-60044-1.

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

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

32.1.4 Bushing Current transformer parameters indicated in this specification are tentative and liable to change within reasonable limits. The Contractor shall obtain Purchaser's approval before proceeding with the design of bushing current transformers.

32.2 Technical Parameters

32.2.2 Current Transformer Parameters for

1-ph, 500 MVA $\frac{765}{\sqrt{3}}$ / $\frac{400}{\sqrt{3}}$ / 33 kV Auto Transformers

	On each phase connection		
	HV	IV	Neutral
	Side	side	side
(a) Ratio			
Core - 1	3000/1A	3000/1A	3000/1A
Core - 2	1500/1A	3000/1A	
(b) Minimum knee point voltage and accuracy class:			
Core – 1	3000V	3000V	3000V
	Class PS	Class PS	Class PS
Core – 2		0.2 class	0.2 class
	30 VA ISF<5	30 VA ISF<5	
(c) Maximum CT Resistance			
Core - 1	12 ohms	12 ohms	12 ohms

Core - 2	-	-	
(d) Application			
Core - 1	Restricted	Restricted	Restricted
(Near the wdg)	earth fault	earth fault	earth fault
Core-2	Metering	Metering	
(e) Maximum magnetization			
	Core-1 20 mA	20 mA	20 mA
current (at knee	Core-2	-	-
point voltage)			

32.3 Neutral Current Transformer

32.3.1 Current transformers shall comply with IEC-60044-1.

32.3.2. One number single phase current transformer for earth fault protection shall be provided for each bank of transformer and shall be located in the neutral conductor connecting common neutral point with earth.

32.3.3 Technical Parameters

Common Neutral Side (for each three phase bank) (*Outdoor type*) *In sublim*
SCOPE

(a) Ratio	:	400/1 A
(b) Minimum knee point voltage	:	400 V
(c) Accuracy class	:	PS
(d) Maximum CT Resistance	:	1.6 Ohms
(e) Application	:	Earth fault protection
(f) Maximum magnetization	:	60 mA
current (at knee		
point voltage)		

33.0 OIL SAMPLING BOTTLE

33.1 Oil sampling bottles shall be suitable for collecting oil samples from transformers and shunt Transformers, for Dissolved Gas Analysis. Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

33.2 Oil sampling bottles shall be made of stainless steel having a capacity of 1 litre.

33.3 Oil Sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.

33.4 The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.

33.5 An impermeable oil-proof, transparent plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

33.6 The scope of oil sampling bottles shall be included in the bid price as per the quantity indicated in the bid price schedule.

34.0 On-line tan delta monitor for HV Bushing : *Refer admendment section 2A*

Online tandelta monitoring system for HV bushing with proper communication facility to be provided.

To continuously monitor the HV (765KV, 3 Nos.) and IV (400KV, 3 Nos.) Bushings of the Auto Transformer with expert system capable of detecting abnormalities in the Bushing insulation and issuing alerts locally and remotely.

- The system shall monitor two sets of Bushings with 3 Bushings in each set associated with the same apparatus. Devices are to be fitted physically at the Bushings for display for the Capacitance and Tan Delta values at the device and at control room.
- The following minimum parameters pertaining to individual Bushing should be accessed through the P.C.
 - (i) Power Factor/ Dissipation Factor
 - (ii) Capacitance.
 - (iii) Rate of change of the above values.
 - (iv) Leakage current through the test tap.
- The calculation and display should be automatic and integral part of the instrument and should be able to indicate measuring status (LED/Buzzer/Display).
- The instrument should be able to identify the problems and issue alerts/warnings on the following conditions.

Absolute change in Power/Dissipation factor.

Rate of change in Power/ Dissipation factor

Absolute change in capacitance.

Rate of change in capacitance.

35.0 FIRE PREVENTION SYSTEM BY INJECTING NITROGEN GAS (NIFPS)

(NOT IN SCOPE. FOR INFORMATION)

35.1. All the transformers shall be provided with fire prevention system by injecting Nitrogen gas.

35.2 Technical specification

35.2.1. The fire prevention system shall protect the oil filled power/auto transformer against explosion fire that may emanate internally (during internal fault etc) and /or externally (such as failure of condenser bushing of the transformer under subject, other source of equipment etc).

35.2.2. The system may be an integral part of the transformer and of leak proof.

35.2.3. The system shall be of automatic operation in sensing and taking Prevention measures in protecting the transformer whenever internal/external fire risk arises.

35.2.4. The fire fighting equipment/ system shall operate normally on automatic mode. Additional facilities for remote/local control and manual operation shall also be provided with separate annunciation and indication in control room.

35.2.5. The tenderer shall indicate the maintenance and testing schedules required. Practically maintenance free system is preferred.

35.2.6. Inter locks shall be provided to prevent mal-operation.

35.2.7. The scope of this specification is for complete design, engineering, shop testing, supply and installation and commissioning of system for prevention of fire & explosion of Auto Transformers as indicated by TANTRANSCO.

35.2.8. The materials shall be manufactured as per Indian/ International Standards as applicable.

35.2.9. The tenderer may furnish the detailed working of the system offered meeting the requirement of national/ international requirement for fire prevention. Necessary literatures, pamphlets, brochures etc required may also be enclosed along with tender offer.

35.2.10. Any modifications required in the transformer must be minimal and other related civil works may be indicated and this shall also be under the scope of installation.

35.2.11. The design, material, construction, manufacture, inspection, testing, commissioning and performance of equipment supplied shall comply with all currently applicable statues, regulations and safety codes. Deviations, if any, from the specification/ standards shall clearly be explained.

35.2.12. The scope of supply shall include all apparatus such as control boxes, piping, cabling, detectors, valves, control, necessary cabinets etc., to make it fully operational.

35.2.13 Control box to be fixed in control room, with monitoring and mechanical releasing devices for automatic control/local operation with alarms, indication lights, switches, push buttons, audio signals suitable for tripping and signalling shall operate on 230 V AC supply. The control box must be installed in the control room of the substation as indicated by TRANTRANSCO based on control room lay out and feasibility. Necessary cables, cable laying, marshalling cabinets in control room, cabinets for fixation of control boxes etc are under the scope of tenderer.

35.2.14. The tenderer must demonstrate the system commissioned is totally leak proof (Nitrogen and oil). Necessary visual indications must be provided.

35.3.0. BRAND NAMES:

The specific reference in these specifications and documents to any material by trade name, make or catalogue number shall be construed as establishing standard of quality and performance and not as limiting competition. However, bidders may offer similar equipment provided it meets specified design standards and performance requirements and the purchaser's approval.

35.4.0. Schematic of the System.

The Transformer Explosive and Fire Prevention System shall be a stand alone dedicated system for oil filled transformer. It shall have a fire extinguishing Cabinet placed on a plinth near the transformer. The Cabinet shall be connected to the transformer oil tank (near its top) and to the oil pit (of capacity approx. equal to 10% for transformer oil tank) from its bottom through oil pipes with gate valves and properly routed considering safety aspect.

The Cabinet shall house a pressurized nitrogen cylinder connected to the transformer oil tank (near its bottom). Cable connections are to be provided from the signal box placed on the transformer to the control box in the control room and from the control box to the Cabinet.

Heat detecting/Fire detecting system placed in transformer is to be connected in parallel to the signal box. The signal box shall be connected to a Shutter valve fitted between the conservator tank and Buchholz relay. Control box is also to be connected to the relay panel in the control room for system activation signals.

35.5.0. Operation

On receipt of all activating signals, the drain of a pre-determined quantity of oil commences thus removing high temperature top oil layer. After a time gap depending on the scenario, the nitrogen is injected inside the tank at a pre-fixed rate from the storage cylinder, stirring the oil thus bringing the temperature of oil down. Nitrogen occupies the top space created by oil drained out and acts as an insulating layer between the tank oil & fire, if any on top cover. Shutter valve blocks oil flow from conservator tank thus fully isolating transformer and preventing aggravation of fire.

35.6.0 Performance Requirement of the System

The system for prevention of fire and explosion of Auto Transformers shall act as fire preventer by preventing transformer oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fires, OLTC fires fire from surrounding equipment etc., it shall act as a fast & effective fire fighter. The Drain and Stir system shall accomplish its role as fire preventer using nitrogen and extinguisher without employing water and / or carbon dioxide.

35.7.0. Activation

Mal-functioning of fire prevention / extinguishing system is their major shortcoming which leads to interruption in power supply. The supplier shall ensure that the chances of malfunctioning and leak of the Drain and Stir system is practically nil. To achieve this objective, the supplier shall work out his scheme of activating signals which will preventing mal-operation, should not be too rigorous to make the operation of the Drain and Stir system impracticable in case of actual need. Following electrical signals shall be provided in series for activating the system.

35.7.1 Auto Mode:

The system should activate upon reception of the following signals.

- a) For prevention of Fire :
Pressure Release Relay)
- 1) Differential Relay Operation
 - 2) Pressure Relief valve or RPRR (Rapid
 - 3) Tripping of all connected breakers
(As a Pre-requisite for initiation of system activation).

- b) For Extinguishing of Fire:
- 1) Linear Heat / Fire Detector
 - 2) Buchholz Relay paralleled with Pressure Relief valve or RPRR (Rapid Pressure Release Relay)
 - 3) Tripping of all connected breakers
(As a Pre-requisite for initiation of system activation).

35.7.2. Manual Mode

Tripping of all connected breakers is a Pre-requisite for initiation of system activation.

In this mode, the Drain & Stir system should work in manual mode. The activation must be operated from the Control Box by switching the key from "automatic mode" to "manual mode", selecting a dedicated button to the manual activation. This leads to the opening of the Quick Depressurization Valve and injection of nitrogen 20 seconds later.

35.8.0. Cabinet:

It shall be made of 3 mm thick steel frame, painted dark red from inside and outside with hinged split doors fitted with high quality tamper proof lock. The protection of the cabinet should be IP55. The cabinet shall be complete with the base frame and the following:

- multiplication of connections
- Oil drain pipe with mechanical quick drain valve
- Electro mechanical 220VDC control equipment for oil drain with (protection IP20)
- Pre-determined regulated nitrogen flow reducer to release the Nitrogen
- Limit switches and monitoring for the system
- Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer
- Panel lighting (CFL Type)
- Oil Drain pipe extension of suitable sizes for connecting pipes of oil pit
- Anti seismic mechanical protection
- All electrical cables inside panel must be routed and channelled with cover.

38.9.0. Cylinder:

The Nitrogen gas cylinder should be of 50 / 60 Liters capacity and should be filled at a pressure of 200 / 150 Bars with falling pressure electrical contact manometer. Such cylinder with such capacity should have been already handled and delivered successfully by the supplier.

Additionally:

- The Nitrogen Cylinder valve shall be of IP 67 protection
- The Nitrogen shall be contained within the cylinder and released from the Cylinder Valve only upon activation of the Drain and Stir system (to avoid any possible leakage due to a multiplication of non IP 67 connections)
- Nitrogen purity shall be equal or above 99,99%
- Proper approvals and certificates should be available with the cylinder

35.10. Draining valve:

The Depressurization / Draining operation should be conducted (release of constrained oil through the butterfly valve) in no more than 0.2 seconds (time to have the Depressurization valve released totally) so as to allow an efficient depressurization process at the required moment.

35.11. Control Box

Control Box to be fixed in control room of substation as indicated by TRANTRANSCO based on control room lay out and feasibility, for monitoring system operation, automatic control and remote operation, with following alarms indication, light switches, push buttons, audio signal, suitable for tripping and signalling on 220 DC supply

- System on
- Conservator shutter valve open
- Oil drain valve closed
- Gas inlet valve closed
- Shutter valve closed
- Fire Detector / Linear heat detector Trip
- Fire Detector/heat detector faulty
- Oil drain valve open
- Extinction Mode activated
- Cylinder pressure low
- Differential relay trip
- PRV/RPRR trip
- Transformer trip
- System Out of service
- Auto/Manual/ Off
- lamp test
- Visual / Audio Alarm

35.12. Shutter Valve

Shutter valve is to be fitted in the conservator pipe line between conservator & Buchholz relay. It shall have the proximity switch for remote alarm, indication and with visual position indicator.

35.13. Fire Detectors / Linear Heat Detectors

The System shall be provided with (Water Proof/Weather Proof) Heat Detector /Fire detector across the transformer oil tank & OLTC. The heat/fire detectors shall be rated for 138°C/141°C for sensing. The Heat/Fire Detector should have been tested by the supplier and the performance should have been certified by a proper Agency accredited in India. A proper certificate and report should have been issued.

35.14. Signal Box

It shall be fitted on the transformer with cable connections from Shutter & fire detectors and for further connection to the control box.

35.15. Cables

All the cables are under the scope of tenderer. Fire survival cables, able to withstand 750°C, 4core x 1.5 Sq.mm for connection of fire detectors in parallel shall be used.

Fire retardant low smoke (FRLS) cable 10 core x 1.5 mm Sq. for connection between transformer signal box/marshalling box to control box and control box to fire extinguishing cubicle shall be used. Fire retardant low smoke (FRLS) cable 4 core x 1.5 Sq.mm for connection between the Control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box/ marshalling box to pre-stressed Shutter valve connection on transformer shall be used.

35.16. Pipes

Pipes, complete with connections, flanges, bend tees etc., shall be supplied by tenderer along with the system.

35.17. Other items

- a) Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.
- b) Heat/ fire detectors brackets on transformer top cover.
- c) Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.
- d) Cabling on transformer top cover for fire/heat detectors to be connected in parallel and inter cabling between signal box to control box and control box to fire extinguishing cubicle.

- e) Gate valves on oil drain pipe & nitrogen injection pipe should be able to withstand full vacuum. A non-return valve shall also be fitted on nitrogen injection pipe between transformers & gate valve.
- f) The cabinet shall be painted with post office red colour (Shade 538 of IS-5). All the exposed parts i.e., pipes, supports, signal box etc. shall be painted with enamelled paint.

35.18. Mandatory Spares

The following mandatory spares may be supplied along with recommended mandatory spares if any, for the entire system at free cost:

- a) 1 No. filled nitrogen cylinder
- b) 1 set of hose pipes with fittings.
- c) 25 meters. Of linear heat detector/ 6nos. fire detectors

35.19. Interlocks.

It shall be ensured that once the system gets activated, all the connected breakers shall not close until the system is actually put in OFF mode.

35.20. Technical Particulars

Fire Extinction Period

On commencement of Nitrogen Injection : Maximum 30 seconds

From the moment of system activation to : Maximum 30 minutes
Complete cooling.

Fire Detector heat sensing temp : 138°C / 141°C

Shutter valve setting for operation : Minimum 60ltr. Per minute

Shutter valve setting for normal condition: 40 litre per minute
(Valve should not close)

Capacity of Nitrogen Cylinder : 10 m³ gas at pressure of 150 kg/cm² up to 60000 litres oil capacity of transformer tank and 20 m³ gas at pressure of 150 kg/cm² up to 60000 litres oil capacity of transformer tank.

Control Box : 220V DC

Fire extinguishing cubicle for lighting : 230 V AC

CONDITIONS FOR NIFPS GIVEN ANNEXURE-A.

36.0. TERMINAL CONNECTORS (NOT IN SCOPE)

- i) Bushing terminals on HV and IV sides, shall be out door type provided with clamping arrangement and suitable bi-metallic sleeves to receive Quad AAC Bull with adequate spacing.
- ii) Bushing terminals on LV side shall be provided with clamping arrangement and suitable bimetallic sleeves to receive Quad Besimis conductor with adequate spacing. The clamp shall be such that the conductor takes off from the bushings vertically.
- iii) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the conductor and the temperature rise under any condition shall not be more than 50% of that in the main conductor.
- iv) All the terminal connectors shall conform to IS:5561 of latest issue.
- v) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- vi) All ferrous parts shall be hot dip galvanised conforming to IS:2633. For bimetallic clamps copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminium body.
- vii) Size of the terminal/conductor for which the clamp/connector is suitable shall be embossed/punched on each clamp/connector.
- viii) Neutral bushing terminal shall be suitable to receive 3" Aluminium Bus with insulators up to ground level. Necessary outdoor type porcelain insulators, GI flats and bi-metallic sleeves shall also be supplied.

37.0 Oil Syringe

The glass syringe and three way stop cock valve shall meet the following specification The tentative dimensions are given below

Volume 50 ml } 1.5 %

Piston outside diameter 27.45 } 0.20 mm

Barrel Diameter (OD) 32.35 } 0.55 mm

Barrel Diameter (OD) 44.00 } 0.75 mm

Barrel Diameter (OD) 34.05 } 0.65 mm

Length (L) 178.00 mm } 0.50 mm

Dimensions

Increment 2.0 ml

The syringe shall be made from Heat resistant borosilicate Glass

The material and construction should be resistant to breakage from shock and sudden temperature changes.

Reinforced at luer lock tip Centre and barrel base.

The cylinder-Plunger fit is leak proof and shall meet the requirement of IEC-60567.

Plunger shall be individually ground and fitted to barrel for smooth movement with no back flow.

General

Barrel rim should be flat on both sides to prevent rolling and should be wide enough for convenient finger tip grip.

The syringe shall be custom fit and uniquely numbered for matching.

The syringe shall be clearly marked with graduations of 2.0 ml and 10.0ml and shall be permanently fused for life time legibility.

Shall be made of 100% Nylon.

Two female ports and one male port.

Three way Valve

Two female ports shall be designed to accept luer lock fitting.

38.0.QUALITY PLAN AND INSPECTION

38.1. The tenderer shall furnish the programme of manufacturing works well in advance.

38.2. The purchaser or the accredited representative of the purchaser shall have access to the contractor or sub-contractor's works at any time during working hours for the purpose of inspection of manufacture and selection of samples of the materials going into the equipment and testing. The contractor shall provide necessary facilities for such inspection or test.

38.3. Documents like invoice or receipted challans, detailing the source of supply of raw materials and their specification, shall be shown by the supplier on demand either during the manufacturing process or at the time of inspection of the transformer.

38.4. The core and coil assembly, shall be offered for inspection and to verify the guaranteed technical parameters prior to connections and tanking. The readiness for such inspection shall be intimated at least 15 days in advance. Further process of manufacture of core and coil assembly, shall be taken up only after our approval in this regard.

38.5. The transformers shall be completely assembled and arranged for conducting all the TYPE/SPECIAL/ROUTINE tests as per IS 2026 of latest issue at manufacturers work or at the accredited laboratories, in the presence of purchaser or the accredited representative of the purchaser. The readiness of the transformer with all its accessories for testing/inspection shall be intimated at least 15 days in

advance. The transformer shall be despatched only after the approval of the test certificates by the purchaser.

39.0.TESTING

39.1. All the TYPE, ROUTINE & SPECIAL TESTS on the first unit of each rating and all the Routine tests on the other unit, as per IS 2026 of latest issue / IEC 60076 shall be carried out at suppliers COST in the presence of purchaser or purchaser's representative.

39.2. The supplier shall ensure that the testing instruments and equipments used for testing/measurements have calibration certificates issued by a recognised/standard laboratory not earlier than one year from the date of testing.

39.3. The correction for the errors of measuring instruments / testing transformers and resistance of test connections shall be applied, as specified in IEC before coming to the conclusion on the test results.

39.4. The first unit of each rating shall be tested for measuring No-load and load losses concurrently at CPRI or any other Government Recognised High Voltage testing laboratory. The arrangements connected towards testing shall be made by the supplier.

If the losses are found to be higher than the guaranteed values, transformer will be rejected.

39.5 The Purchaser at its discretion may re-test the same Transformer or any other Transformer (s) at a Govt. / or Govt. Recognized laboratory of his choice for reconfirmation of the test results, particularly no load losses, load losses and percentage impedance, which will be taken as the final and binding as per the clause 25.4 mentioned above.

40.0. Type/Special/Routine Tests :

40.1. i)The following Type /special tests as per IS 2026 of latest issue shall be carried out on the first unit at Supplier's cost in the presence of Board's representative.

(a) Vacuum test on the transformer tank: The transformer tank shall be tested at an internal pressure of 3.33 KN/sq.m. (25 torr) for one hour. The permanent deflection of flat plates, after the vacuum has been released, shall not exceed the values below and the performance of the transformer shall not be affected in any way.

<u>Horizontal length of Flat Plate</u> <u>(mm).</u>		<u>Permanent deflection (</u> <u>mm).</u>
Upto and including 750	-	5
751- 1250	-	6.5

1251 to 1750	-	8.0
1751 to 2000	-	9.0
2001 to 2250	-	11.0
2251 to 2500	-	12.5
2501 to 3000	-	16.0
Above 3000	-	19.0

(b) Pressure test: The transformer tank shall be subjected to a pressure corresponding to twice the normal head of oil or to normal pressure plus 35 KN/sq.m. whichever is lower. The applied pressure shall be measured at the base of the tank and maintained for One hour. The equivalent air pressure corresponding to oil pressure calculated at the base of the tank to be considered for Air Pressure test. The permanent deflection of flat plates, after the excess pressure has been released, shall not exceed the values specified under the caption 'Vacuum test'.

(c) Temperature rise test at the lowest tap.

(d) Full wave lightning Impulse voltage withstand test on all three phases including chopped impulses on principle tap and extreme taps.

(This test shall precede power frequency high voltage tests).

(e) Capacitance and Tan-delta measurement

(f) Zero sequence impedance test.

(g) Noise Level Test.

(h) Measurement of harmonic voltages

(i) Measurement of transformer oil required for first filling for entire transformer including radiators, coolers, conservator etc.

40.2 STAGE & FINAL INSPECTION

The supplier shall offer the core, windings and tank of each transformer for inspection by the purchaser's representative(s). During stage Inspection, all the measurements like diameter, window height, leg centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can

offer for final inspection of the transformers subject to clearance of the stage Inspection report by the purchaser.

The proforma for Stage & Final inspection is furnished in Annex. II & III.

40.3ROUTINE TESTS

The following Routine tests as per IS 2026 of latest issue and special tests shall also be carried out on all the transformers, at supplier's cost.

- (a) Measurement of winding resistance on all taps.
- (b) Measurement of voltage ratio on all taps and check of voltage vector relationship.
- (c) Measurement of impedance voltage/short circuit impedance, load-loss & spill current at principal and extreme taps. The test shall be repeated at 415 volts for comparison during pre-commissioning tests at site.
- (d) Measurement of No-load loss and current corresponding to normal & extreme taps at 100%,90% and 110% of rated voltage.
- (e) Measurement of insulation resistance.
- (f) Dielectric Tests (Short duration Power frequency withstand voltage test and Induced over voltage withstand test with line/leakage current measured)
- (g) Oil leakage test on transformer tank: The tank and oil filled compartments shall be tested for oil tightness by completely filling with air/oil of viscosity not greater than that of insulating oil, conforming to IS:335 1983/'87 at the ambient temperature and applying a pressure, equal to the normal pressure plus 35 KN/sq.m. 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 time no leakage shall occur.
- (h) Magnetic balance test.
- (i) Measurement of No-load current with 415 Volts supply.
- (j) Check of polarity and ratio, tests for knee point voltage, and magnetizing current for Bushing current transformer.
- (k) Tests on On- load tap changer (fully assembled on transformer) as per Clause 10.8 of IEC: 60076-1 as referred in Clause 5.3 of IEC:60214/2003.
- (l) Measurement of neutral unbalance current.

The test sequence shall be:- Tests on transformer tank, Heat run test, Oil leakage test on the assembled transformer, Impulse test, Routine tests and Special tests.

40.4. FURTHER TESTS

i) The purchaser reserves the right of having other reasonable tests carried out at his own expense either before transport or at site, to ensure that the transformer complies with the requirements of our specification.

ii) It may also be noted that the purchaser reserves the right to conduct **impulse voltage withstand test** in accordance with the IS, afresh on each ordered rating at Purchaser's cost even if the transformers of the same rating and similar design are already tested. This test shall be carried out on a transformer either offered for inspection or randomly from supply already made at site and under erection. The finding and conclusion of these tests shall be binding on the supplier.

40.5. TEST CERTIFICATES

40.5.1. Six copies of the test certificates on the above type tests/ special tests/ routine tests with the endorsement of the inspecting officer shall be furnished to the Superintending Engineer/TR.IV/ 6th Floor, NPKRR Maaligai, 800, Anna salai, Chennai -2.

40.5.2. The test report shall contain the following information.

i) Complete identification data, including serial No. of the transformer.

ii) Method of application where applied, duration, and interpretation of results in each test.

iii) Details of Temperature rise corrected to 75 ° C .

40.5.3. The equipment will be rejected if test results are not in conformity with the Guaranteed Technical particulars.

40.5.4. Besides the above test certificates, manufacturer's test certificates in respect of the following accessories shall also be furnished in six sets

- a) Bushings (HV, IV, LV & Neutral).
- b) Buchholz relay and surge relay.
- c) Magnetic oil level gauge.
- d) Winding Temperature Indicator.
- e) Oil Temperature Indicator.
- f) Radiators.
- g) Transformer oil(including Dissolved Gas Analysis tests)
- h) OLTC

40.5.5. TYPE TEST FOR BOUGHT OUT COMPONENTS :

Tenderers are requested to furnish along with tender copy of type test certificates for the bought out components in full shape as conforming to relevant IS/IEC standards of latest issue obtained from a Government ./ Government Recognized Laboratory. The above test certificates should accompany the drawings of the material/equipments, duly signed under seal by the institution who have issued the type test certificate.

Otherwise the above type test certificates shall be furnished before the offer of inspection for the first lot of materials/ equipments at no extra cost to Corporation and no relaxation to Corporation's Delivery clause will be given on this accounts.

The above type test should have been conducted not earlier than five years (5 Years) as on the date of tender opening. Non submission of above type test certificates within the stipulated time will entail cancellation of Purchase Order without any further reference to supplier.

The original type test certificate shall be furnished for verification on request. The details of type test if already conducted should be furnished in the Section.-G.

40.5.6. The supplier shall also furnish test certificates to the effect that the withstand capability of the insulation between the core and all core bolts , side plates & structural frame has been tested with 2000 Volts AC for one minute after assembling the core and prior to the despatch of the transformer .

40.6. TESTS AT SITE (NOT IN BIDDER SCOPE)

After erection at site and prior to commissioning, the transformer shall be subjected to the following tests by the Supplier in the presence of the purchaser.

- (a) Insulation resistance test.
- (b) Ratio and polarity test on all taps.
- (c) All relevant tests on oil.
- (d) Open circuit and short circuit test.
- (e) Tests on the operation of OLTC.
- (f) Tests on the protective devices and interlocks.
- (g) Measurement of winding resistance at all taps.
- (h) Vector group verification
- (i) Capacitance and Tan-delta measurement on windings and bushings
- (j) Dissolved gas analysis on transformer.(The test figures will form the base values for comparison in future.).

41.0. DRAWING, TECHNICAL LITERATURE AND GUARANTEED TECHNICAL PARTICULARS

- 41.1. (a) General out line drawing, showing front side elevations and plan views of the transformer and all accessories and external features with detailed dimensions, weights, crane lift for untanking and for erection/removal of bushings, size of lifting lugs and pulling eyes, HV and LV terminal clearances, live terminal to ground clearance, quantity of insulating oil, dimensional details for foundation etc with list of fittings and accessories.
(b) Assembly drawings of HV, LV /cable box and Neutral bushings
(c) Mounting arrangement for cooling pipes, radiators, fans etc.
(d) Schematic control and wiring drawing and drawings showing temperature indicator/recorder circuits, and control system for cooling equipment.
(e) Drawing, showing construction and mounting details of marshalling Boxe
(f) Drawing, giving details of name plate, terminal marking and connection diagram.
(g) Drawing on OLTC gear assembly.
(h) Remote Tap Changer control panel.
(i) Remote Tap Changer control circuit.
(j) Drawing on Terminal Clamps.

The responsibility rests with the supplier in case of any corrections or modification on scrutiny of the drawings.

41.2 Six complete sets of final drawings shall be supplied for the transformer, sufficiently before the actual despatch of the equipment.

41.3 Six copies of all bulletins, complete instruction manuals for the erection, operation and maintenance of the transformer are to be supplied, before they are despatched.

41.4 Any approval given to the detailed drawings by the purchaser shall not relieve the contractor of the responsibility for correctness of the design, completeness of the equipment supplied and in the execution of the works in accordance with the terms of specification.

42.0 CENTRE OF GRAVITY

The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as possible. The transformer shall be stable with or without oil. If the centre of Gravity is eccentric, relative to track either with or without oil, its location shall be shown in the "Outline" drawing.

43.0.CONTROL WIRING, TERMINAL BOARDS, FUSES ETC.

43.1. All wiring connections, terminal Boards, fuses and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the Board ends of stranded wire shall be sweated together to prevent creepage of oil along the wire.

43.2. There shall be no possibility of oil entering into the connection boxes, used for cables or wiring.

43.3. 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.

43.4. 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 conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

43.5. When 415 Volt connections are taken through junction boxes or marshalling boxes they shall be adequately screened and "415 volts Danger" notices must be affixed to the outside of the junction boxes or marshalling boxes.

43.6. All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded copper of 1100 grade and size not less than 4.00 sq.mm. for CT leads and not less than 2.5 sq.mm. for other connections.

43.7. All wires on panels and all multicore cables shall have ferrules which bear the same number at both ends.

43.8. At those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided, double ferrule shall be shown on the appropriate diagram of the equipment.

43.9. The same ferrule numbers shall not be used on wires in different circuits on the same panels.

43.10. Ferrule shall be of yellow insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by damp or oil.

43.11. Stranded wires shall be terminated with tinned Ross country terminals, claw washers or crimped tubular lugs. Separate washers shall be used for each wire. The size of the washers shall be suitable to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting stems of relays and other apparatus is not impeded.

43.12. Wires shall not be jointed or tied between terminal points.

43.13. Wherever practicable, all circuits in which the voltage exceeds 125 Volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal Boards.

43.14. Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of copper wire or strip having a cross section of not less than 2.0 sq.mm. where strip is used, the joint shall be sweated.

43.15. All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal Boards arranged as in service. All diagrams shall show, which view is employed.

43.16. Multicore cable tails shall be so bound that each wire may be traced without difficulty to its cable.

43.17. The screens or screen pairs of multicore cable shall be earthed at one end of the cable only. The position of earthing connections shall be shown clearly on the diagrams.

43.18. All terminal Boards shall be mounted obliquely towards the rear doors to give easy access to terminations and to enable ferrule numbers to be read without difficulty.

43.19. Terminal Board rows should be spaced adequately, not less than 100 mm apart, to permit convenient access to wires and terminations.

43.20. Terminal Boards shall be so placed with respect to the cable gland (at a minimum distance of 200 mm), as to permit satisfactory arrangement of multicore cable tails.

43.21. Terminal Boards shall have pairs of terminals of incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust-proof covers.

43.22. No live metal shall be exposed at the back of the terminal Boards.

43.23. All fuses shall be of the cartridge type.

43.24. Fuses and links shall be labeled.

44.0. REJECTION

28.1. The transformer may be rejected if any of the following conditions arise during the tests or while in service.

- (a) No load loss exceeds the guaranteed value.
- (b) Load loss exceeds the guaranteed value.
- (c) Percentage impedance values exceed by the guaranteed figure.
- (d) Temperature rise of oil and or windings exceed the specified values.
- (e) Transformer fails during impulse test.
- (f) Transformer fails during power frequency voltage withstand test.
- (g) If either of the test results conducted at factory and site (during pre-commissioning test) are not satisfactory.
- (h) Transformer has not been manufactured in accordance with the specification and approved drawings.

Annexure-A (Nitrogen Injection Fire Protection System - Conditions)

1. Testing, demonstration and installation and commissioning of all the units of Transformer Fire prevention system (By injecting nitrogen gas devices) shall be carried out at the site in presence of TANTRANSCO representatives and necessary training shall also be arranged for TANTRANSCO staffs.
2. The breaker status required for the NIFPS system shall be wired from direct CB aux contacts.
3. Two DC sources shall be provided with DC changeover scheme for NIFPS system operation.
4. Direct contacts of respective protection signals shall be wired for NIFPS system operation.
5. System shall protect Transformer along with OLTC and the system shall operate in automatic, remote and manual mode in the event of power failure.
6. System shall have interlock to ensure operation of system only after transformer electrical isolation to avoid Nitrogen injection in energised transformer.
7. System shall have mechanical interlocking arrangement for nitrogen injection as well as oil drain to avoid unnecessary operation during maintenance or testing of the transformer or testing of NIFPS system.
8. Pressure monitoring switch for back up protection for nitrogen release as redundancy to first signal of oil draining commencement of nitrogen release shall be provided.
9. System shall have individual mechanical release devices and provision for oil drain and Nitrogen release to operate manually in case of DC supply failure.
10. The panel construction shall be meet NIFPS specification requirement.
11. The LED lamp shall be provided for cubicle illumination.

~~SECTION 2~~

AUTO TRANSFORMER ERECTION

1.0 GENERAL:

- 1.1. Unless otherwise stated the work shall be carried out as per Section-K of CBIP guidelines.
- 1.2. The following shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work on this Contract to be performed at site.
- 1.3 The Contractor, shall nominate a responsible person as its representative at site suitably designated for the purpose of overall responsibility and co-ordination of the works to be performed at site.

2.0. SCOPE OF WORK

- 2.1. The scope of work shall be to make the transformer ready for testing and commissioning and include the following
 - a) Placing of the transformer on the plinth and fixing of wheels and carrying- out stop block welding including moving the transformer to the plinth, where the transformer is supplied and unloaded near the plinth.
 - b) The Contractor has to supply, lay, erect and weld M.S.Channel, Flat of the 50x8 mm. sizes, including green painting and providing with adequate bolts and nuts as applicable.

50x8 mm. Flat with suitable M.S.Channel for earthing with neutral bushing at two different earth points of existing earth pit, Transformer tank, Cooler fan and pumps. D.M.box RTCC panel & other accessories body earthing with required standards.
 - c) Erection of the following, wherever applicable:
 - (i) HV bushing with turrets
 - (ii) LV and neutral bushing with turrets.
 - (iii) Cable boxes
 - (iv) Bushing current transformers

- (v) Conservators
- (vi) Valves
- (vii) Radiators
- (viii) Fans/pumps
- (ix) Buchholz relay
- (x) Surge relay
- (xi) Gaskets
- (xii) Temperature indicators
- (Xiii) Erection of separate Neutral CT for each bank of Auto Transformer.
- (xiv) Others wherever stated
- d) Erection of the Drive Mechanism Box, Marshalling at site with equipment and RTCC Panel in the control room after removing the existing panel, if any.
- e) Filling of transformer oil in the transformer and OLTC under hot oil circulation, vacuum drying wherever applicable/necessary to the required level and circulation of oil till satisfactory results are obtained before commissioning.
- f) i) The Contractor scope of work shall include all the control cables required for the successful commissioning of Auto/Power Transformers including supply, laying, providing suitable glands ferrules, lugs, termination etc., but not limited to the above mentioned for successful commissioning of the transformer as per standard requirement.
 - 1) Protection schemes of Auto/Power Transformer including differential protection cable.
 - 2) Indication/Annunciation scheme for cooler fan and pumps.
 - 3) OLTC Remote operation
 - 4) OLTC fan, pump D.M. power supply cable
 - 5) DC cable from control room to Transformer
 - 6) Scada scheme for Remote/Automation operation
 - 7) CTs cable from CT secondaries to Marshalling Box and Marshalling box to LV panel/RTCC panels
 - 8) Any other control cable with required site for successful commissioning of the transformer
 - 9) Interconnection of cables for AC/DC panels to RTCC/LV panels
- ii) All CT cables shall be 4 sq.mm. (minimum) and shall be copper, armoured cables. The other cables that are to be provided shall be 2.5 sq.mm

(minimum), copper multi-strand and armoured cables, separate cables for AC and DC are to be used. The AC supply cables shall be sufficient to cater the load of pumps, fans and the load of pumps, fans and the loads of transformer for the AC panel around in the transformer end.

Additional adequate quantity of cable length shall be provided at the Transformer end and at the RTCC/LV panels ends in case of shifting of panels/ Transformers. All the cables shall be laid end to end without any joints and it should be ensured that the cables so provided shall comply with TANTRANSCO control cable specification and should be strictly adhered all the control cables shall be neatly laid /buried in control cable duct/trench by suitable dressing.

However any additional work and in the schedule of cables shall be discussed with the site Engineers/ TANTRANSCO Engineers before laying of cables and necessary approval shall be obtained before connection to the panels/ Transformer ends.

g) Painting as required will be carried out so as to maintain the finish of the surface of the transformer and accessories prior to the erection of the same at site.

h) Required assistance for testing and commissioning

Any other works not covered in items(a) to (h) but required for satisfactory commissioning of the power transformer shall also to be carried out by the contractor free of cost.

2.2. The supplier shall prepare a schedule of the works to be carried out with specific periods for each item of work involved. All assembly and erection drawing shall be made available at site.

2.3. If the commissioning of the transformer is delayed due to incompleteness of erection works, the Corporation has the right to recover an estimated amount for such pending erection works from the contractor besides Levy of L.D. clause.

3.0. REGULATION OF LOCAL AUTHORITIES AND STATUTES

The Contractor shall comply with all the rules and regulations of local authorities during the performance of its field activities. The Contractor shall also comply with the Minimum Wages Act, 1948 and the payment of Wages Act (both of the Government of India) and the rules made there under in respect of any employee or workman employed or engaged by it or its Sub-Contractor.

4.0. OWNER'S LIEN ON EQUIPMENT

The Owner shall have lien on all equipment including those of the Contractor, brought to the Site for the purpose of erection, testing and commissioning of the plant. The Owner shall continue to hold the lien on all such equipment throughout the period of Contract. No material brought to the site shall be removed from the site by the Contractor and/or its Sub-contractors without prior written approval of the Site Engineer.

5.0. INSPECTION, TESTING AND INSPECTION CERTIFICATES

The provisions of the clause entitled inspection, Testing and Inspection Certificates under Technical Specification applicable to the erection portion of the Works. The Site Engineer shall have the right to re-inspect any equipment, even though the same may have been previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Site Engineer rejects any equipment, the Contractor shall make good such rejected equipment etc., either by replacement or modification/repairs as may be necessary to the satisfaction of the Site Engineer. Such re-placements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.

6.0. ACCESS TO SITES AND WORKS ON SITE

6.1 The works so far as it is carried out on the Owner's premises, shall be carried out at such time as the Owner may approve and the Owner shall give the Contractor reasonable facilities for carrying-out the works.

6.2 In the execution of the works, no person other than the Contractor or its duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the site except by the special permission, in writing of the Site Engineer or his representative.

7.0. CO-OPERATION WITH OTHER CONTRACTORS

7.1 The Contractor shall co-operate with all other Contractors or tradesmen/ representative(s) of the Owner, who may be performing other works on behalf of the Owner and the workmen who may be employed by the Owner and doing work in the vicinity of the works under the Contract. The Contractor shall also so arrange to perform its work as to minimise, to the maximum extent possible, interference with the work of other Contractors and their work-men. Any injury or damage that may be sustained by the employee(s) of the other Contractors and the Owner, due to the Contractor's work shall promptly be made good by the Contractor at its own expense. The site Engineer shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the Owner in regard to their work. If the work of the Contractor is delayed because of any acts of omission of another Contractor, the Contractor shall have no claim against the Owner on that account other than an extension of time for completing its works.

7.2. The Site Engineer shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's works. The Site Engineer shall determine the corrective measures, if any, required to rectify this situation after inspection of the works and such decisions by the Site Engineer shall be binding on the Contractor.

8.0. DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the Site Engineer in respect of its/its Sub-Contractor's employees and workmen at site. The Site Engineer shall be at liberty to object to the presence of any representative or employee of the Contractor/its Sub-Contractor at the site, if in the opinion of the Site Engineer such representative/ employee has misconduct himself or is incompetent or negligent or other-wise undesirable. The Contractor shall remove such person(s) objected to, and provide competent replacement in his place.

9.0. PROTECTION OF WORK

The Contractor shall have total responsibility for protecting its works till it is finally taken over by the Site Engineer. No claim will be entertained by the Owner or by the Site Engineer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions, to comply with the specification(s) and drawings. Should any such damage to the Contractor's works occur because of any other party not being under its supervision or control, the Contractor shall make its claim directly to the party concerned without involving the Owner. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's works the same shall be resolved as per the provisions of Clause 6.0 above titled co-operation with other Contractors. The Contractor shall not cause any delay in the repair of such damaged works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the work immediately and no cause thereof will be assigned pending resolution of such disputes.

10.0. EMPLOYMENT OF LABOUR

10.1 The Contractor will be expected to employ on the work only its regular skilled employees with experience in the particular type of work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.

10.2 All traveling expenses including provisions of all necessary transport to and from site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.

10.3 The hours of work on the site shall be decided by the Owner and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day-Monday through Saturday.

10.4 Contractor's employees shall wear identification badges while on work at Site.

10.5 In case the Owner becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contract Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Owner may make such payments and shall recover the same from the Contractor's bills.

10.1 The Contractor shall be provided with free supply of electricity for the purposes of the Contract only, at one point in the project Site. The Contractor, at its own cost shall make its own further distribution arrangement. All temporary wiring shall comply with local regulations and will be subject to Site Engineer's inspection and approval before connection to supply.

11.0. FACILITIES TO BE PROVIDED BY THE CONTRACTOR

11.1 Tools, scaffolding and tackle

11.1.1. The Contractor shall bring to site all the construction/erection equipment tools, tackle, scaffolding etc required for pre-assembly, erection of the equipment covered under the contract. He shall submit a list of all such materials to the Site Engineer before the commencement of pre- assembly at Site.

11.1.2. The following items are generally required

(1) Lifting equipment:

(a) Derrick or mobile crane of adequate capacity.

(b) wire ropes

(c) pulley blocks

(d) chain blocks

(e) Manila ropes,

(f) shackles

(g) sleepers.

(2) Oil purifier with heating and vacuum facilities and hot oil resistant hose pipes.

(3) Vacuum pump

(4) Oil storage tank.

11.1.3. The Owner shall have a lien on such goods for any sum or sums which may at any time be due or owing to it by the Contractor.

11.1.4. After the completion of the Works, the Contractor shall not remove from the Site, the materials such as construction equipment, erection tools and tackle, scaffolding etc. without permission of the Site Engineer.

11.2. First - Aid

The Contractor shall provide necessary first-aid facilities for all its employees, representatives and workmen working at the site. Adequate number of Contractor's personnel shall be trained in administering first-aid.

11.3. Cleanliness

11.3.1. The Contractor shall be responsible for keeping the entire allotted area clean and free from rubbish, debris etc. during the period of Contract.

11.3.2. Waste oil shall be disposed off in a manner acceptable to the Owner. Under no circumstances shall waste oil be dumped into uncontrolled drains.

12.0. FIRE PROTECTION

12.1. All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel shall be available at the Site during the entire period of the Contract.

12.2. The Contractor shall provide enough fire protection equipment of the types and number for the ware-house, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all times.

13.0. SECURITY

The Contractor shall have total responsibility for all equipment and materials in its custody, stored, loose, semi-assembled and/or erected by it at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the work site only with the written permission of the Site Engineer in the prescribed manner.

14.0. MATERIALS HANDLING AND STORAGE

14.1. All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage by the Contractor.

14.2. The Contractor shall be responsible for examining all the consignment and shall notify the Site Engineer immediately of any damage, shortage, discrepancy etc. for the purpose of Site Engineer's information only. However, the Contractor shall be solely responsible for any shortages or damage in transit, handling and/or in storage and erection of the equipment at site as

well as for preferring all claims with the underwriter(s). Any demurrage, wharfage and other such charges claimed by the transporters, railways etc., shall be to the account of the Contractor.

14.3. The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by it for the purpose of erection and keep all such record open for the inspection of the Site Engineer.

14.4. All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the equipment without the specific written permission of the Site Engineer. The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored.

14.5. The Contractor shall ensure that all the packing materials and protection devices used for the various equipment during transit and storage are removed before the equipment are installed.

14.6. All the materials stored in the open or dusty location(s) shall be covered with suitable weather-proof and flameproof covering material, wherever applicable.

14.7. The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which require indoor storage. Normally, all the electrical equipment such as motors, control gears and consumables shall be stored in the closed storage space.

15.0. CONSTRUCTION MANAGEMENT

15.1. The field activities of the Contractor's working at site, will be co-ordinated by the Site Engineer and the Site Engineer's decision shall be final in resolving any dispute or conflict between the Contractor and other Contractors and tradesmen of the Owner regarding scheduling and co-ordination of work. Such decision by the Site Engineer shall not be a cause for extra compensation or extension of time for the Contractor.

15.2. Time is the essence of the Contract and the Contractor shall be responsible for performance of its works in accordance with the specified construction schedule.

16.0. PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

The Contractor shall be responsible for any damage resulting from its operations. It shall also be responsible for protection of all persons including members of public and employees of the owner and the employees of other Contractors and Sub-Contractors and all public and private property including structures, building, other plants and equipment and utilities either above or below the ground.

17.0. INSURANCE

17.1. In addition to the conditions covered under the Clause, titled Insurance the following provisions will also apply to the portion of works to be done beyond the Contractor's own or its Sub-Contractor's manufacturing Works.

17.2. Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of its or its Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than

Workmen's Compensation : As per statutory Provisions

Employee's liability : As per statutory Provision

17.3. Comprehensive Automobile Insurance

This insurance shall be in such form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Owner's men and damage to the property of other arising from

the use of motor vehicles during on or off the Site operations, irrespective of the owner-ship of such vehicles. The minimum liability covered shall be as herein indicated :

Fatal Injury : Rs. 100,000 each person

: Rs. 200,000 each occurrence

Property Damage : Rs. 100,000 each occurrence

17.4. Comprehensive General Liability Insurance

17.4.1. The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, its agents, its employees, its representatives and Sub Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause titled Defence of Suits under General Conditions of Contract of this Volume-1A.

17.4.2. The hazards to be covered will pertain to all the works and areas where the Contractor, its Sub-Contractors, its agents and employees have to perform work pursuant to the Contract.

17.5. The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.

18.0. WORK & SAFETY REGULATIONS

18.1. The Contractor shall ensure proper safety of all the workmen, materials plant and equipment belonging to it or to the others, working at the site. The

Contractor shall also be responsible for provision of all safety notices and safety equipment required by the relevant legislations and deemed necessary by the Site Engineer.

- 18.2. All equipment used in construction and erection by Contractor shall meet Indian/International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipment shall be strictly operated and maintained by the Contractor in accordance with manufacturer's operation manual and safety instructions and as per Guidelines/Rules in this regard.
- 18.3. Periodical examinations and all tests for all lifting/hoisting equipment & tackle shall be carried-out in accordance with the relevant provisions of Factories Act 1948, Indian Electricity Act and associated Laws/Rules in force from time to time. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by Site Engineer or by the persons authorised by him.
- 18.4. No electric cable in use by the Contractor/Owner will be disturbed without prior permission.
- 18.5. No repair work shall be carried out on any live equipment. The equipment must be declared safe by the Site Engineer and a permit to work shall be issued by the Site Engineer before any repair work is carried out by the Contractor. While working on electric lines/equipment whether live or dead, suitable type and sufficient quantity of tools will have to be provided by Contractor to electricians/workmen/officers.
- 18.6. The Contractor shall employ necessary number of qualified, full time electricians/electrical supervisors to maintain its temporary electrical installations.
- 18.7. In case any accident occurs during the construction/ erection or other associated activities undertaken by the Contractor, thereby causing any minor or major or fatal injury to its employees due to any reason whatsoever, it shall

be the responsibility of the Contractor to promptly inform the same to the Site Engineer in prescribed form and also to all the authorities envisaged under the applicable laws.

18.8. The Site Engineer shall have the right at its sole discretion to stop the work, if in its opinion the work is being carried out in such a way as may cause accidents and endanger the safety of the persons and/or property, and/or equipment. In such cases, the Contractor shall be informed in writing about the nature of hazards and possible injury/accident and he shall comply to remove short-comings promptly. The Contractor, after stopping the specific work, can, if felt necessary, appeal against the order of stoppage of work to the Site Engineer within 3 days of such stoppage of work and the decision of the Site Engineer in this respect shall be conclusive and binding on the Contractor.

18.9. The Contractor shall not be entitled for any damages/compensation for stoppage of work due to safety reasons as provided above and the period of such stoppage of work will not be taken as an extension of time for completion of work and will not be the ground for waiver of levy of liquidated damages.

18.10. The Contractor shall follow and comply with all Safety Rules, relevant provisions of applicable laws pertaining to the safety of workmen, employees plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation. In case of any unconformity between statutory requirement and Safety Rules referred above, the latter shall be binding on the Contractor unless the statutory provisions are more stringent.

18.11. If the Contractor does not take all safety precautions and/or fails to comply with the Safety Rules as prescribed by the Owner or as prescribed under the applicable law for the safety of the equipment, plant and personnel and the Contractor does not prevent hazardous conditions which may cause injury to its own employees or employees of other Contractors, or Owner or any

other person at Site or adjacent thereto, the Contractor shall be responsible for payment of compensation to the Owner as per the following schedule :-

a) Fatal injury or accident } Rs. 1,00,000/-) These are
causing death } (per person) applicable
for death
injury to
any person
whosoever.

b) Major injuries or accident } Rs. 20,000/-
accident causing 25% or } (per person)
or more permanent disability }
to work men or employees }

Permanent disability shall have the same meaning as indicated in Workmen's Compensation Act. The compensation mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the Workmen's Compensation Act and rules framed there under or any other applicable law as applicable from time to time. In case the Owner is made to pay such compensation, the Contractor will be liable to reimburse the Owner such amount(s) in addition to the compensation indicated above.

19.0. CODE REQUIREMENTS

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant ASME codes, accepted good engineering practice, the Engineer's Drawings and other applicable Indian codes and laws and regulations of the Government of India.

20.0. CHECK OUT OF CONTROL SYSTEMS

After completion of wiring and cabling the Contractor shall check out the operation of all control systems for the equipment furnished and installed under these specifications and documents.

21.0. CABLING

- 21.1. All cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends for fittings. When cables are run on cable trays, they shall be clamped at a minimum intervals of 2000 mm or otherwise as directed by the Site Engineer.
- 21.2. Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both ends of the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.
- 21.3. Sharp bending and kinking of cables shall be avoided. The minimum radii for PVC insulated cables 1100 V grade shall be $15 D$ where D is the overall diameter of the cable. Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gaslines, special care should be taken for the protection of the cables in designing the cable channels.

- 21.4. In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop fault at a later date.
- 21.5. Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to Site Engineer's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable as far as possible to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilising plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly out.
- 21.6. The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.

FITTING AND ACCESSORIES TO BE SUPPLIED ALONG WITH EACH UNIT

Conservator with partition for main transformer and OLTC:

1.For main transformer:

50 mm oil filling valve.

25 mm drain cum sampling valve with dummy plug.

50 mm filter valve with dummy plug.

Lifting hooks.

2.For OLTC conservator.

50 mm oil filling valve.

25 mm drain cum sampling valve with dummy plug.

25 mm shut-off valve.

Prismatic oil level gauge.

Surge relay.

Magnetic type oil gauge with low oil level alarm contacts.

3.Two Nos. Silica gel breather associated with oil seal in parallel each one with a valve for main conservator and 1 No. Silica gel breather associated with oil seal for OLTC conservator.

4.Buchholz relay double float with alarm and trip contacts with shut off valves on either side of the relay of size 80 mm.

5. Pressure relief device (safety valve type) with alarm contacts.

6. Pockets for thermometer on tank cover.

7. Oil temperature controller with maximum pointer and two sets of contacts, with mercury switches.

8. Winding temperature controllers with maximum pointer and four sets of contacts with mercury switches.

9.Valves.

1.0. between cooler and tank.

2.0. One 100 mm drain valve with padlocking arrangement, located on the low voltage side.

3.0. Two 50 mm filter valves at diagonally opposite corners with padlocking arrangement for the bottom valve.

4.0. Two sampling valves of 25 mm with provision for fixing PVC pipe.

5.0. One 15 mm air release plug.

10.Two Nos. earthing terminals.

11.Rating, diagram, terminal marking, schematic wiring and valve position plates, (stainless steel) of not less than 300 x 300 mm.

12.Inspection cover.

13.Bi-directional rollers with greasing duct and nipple.

14.Wiring upto marshalling box with PVC stranded copper cables of 1100 V grade from various points.

15. Lifting and hauling facilities.

Lifting lugs.

Pulling eyes.

Jacking pads at a height of 500 mm.

Latching lugs.

Lifting eyes for the tank cover.

Fixed ladder with anti clamping device.

16. Weather-proof marshalling boxes for housing control equipment and terminal connections.

17. OLTC gear with remote control panel comprising, among other things,

- a. Necessary valves for filling drain and sampling of oil.
- b. Conservator for OLTC.
- c. Equaliser pipe with valve between divertor and main tank.
- d. Drive mechanism box.

18. Local control panel with necessary wiring and with the following:

- 1 Remote/Local selector switch.
- 2 Push button switch; Raise/off/lower.
- 3 Limit switch to prevent motor over-travel in either direction.
- 4 Counter.
- 5 Electrically interlocked reversing contractors.
- 6 Heaters with switch and HRC fuse.
- 7 Master/follower selector switch.
- 8 Interior lighting
- 9 Auxiliary relays.
- 10 Manual operating device.

19. Remote control panel.

1. Control push button switch: Raise/off/lower.
2. Independent/Off/Master/follower selector switch.
3. Lamp indications and initiating contacts as specified.
4. Remote top position indicator. (digital type)
5. Alarm annunciation scheme for trip and non-trip alarm as specified.
6. Local/remote selector switch for OLTC.
7. Provision with dummy plate for fixing differential relay in the panel.

20.Cooling accessories:

- i) Requisite number of radiators with shut-off valves at top and bottom , air release plug, drain plug and lifting eyes.

(a) Fans and pumps.

- (b) Cooler control cubicle with necessary wiring and with the following:

1. Lamp indications as specified.
2. Initiating contacts.
3. Selector switch for Local/Auto/Remote control
4. Fan control switch for ON/OFF/Test.
5. Pump control switch for ON/OFF/Test.

- (c) Transformer oil required for first filling at site including wastage in pre-commissioning process.

21.Bushings.

22 . Bushing current transformers as specified on HV, IV, & LV.

1. Terminal clamps for HV, IV, LV and Neutral.
2. One set of spare gaskets for assembling at site.

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ANNEXURE - I

TYPE, RATING AND TECHNICAL REQUIREMENTS 765/√3/400/√3/33KV SINGLE PHASE AUTO TRANSFORMER

Sl. No	DESCRIPTION	REQUIREMENT
1.	Maximum continuous rating (MVA)	
	(a) HV	500
	(b) IV	500
	(c) LV	167 (continuous active power of 5 MVA)
2.	Maximum continuous rating and cooling	
	(a) ONAN	60%
	(b) ONAF	80%
	(c) ODAF	100%
3.	Type of cooling	(a) ONAN/ONAF/ODAF
		(b) 4 x 33.3% cooler bank
		(c) 4 X 100% cooling pumps out of which one is connected stand-by in each
		(d) Adequate fans with 20% capacity as stand-by fans for each cooler bank.
4.	Max. Temperature rise over ambient temperature of 50 deg. C	
	(a) Top oil measured by thermometer	40 °C
	(b) Average winding measured by resistance method	45 °C
	(c) Winding hot spot	59 deg C
5.	Maximum flux density at normal voltage and frequency	1.9 Tesla
6.	Rated voltage (KV)	Rated Min Max
	(a) H.V. winding	765 745 785
	(b) I.V. winding	
	(c) L.V. winding	400 412 388

7.	Number of phases	Single phase			
8.	Rated frequency	50 Hz ± 5%			
9.	Voltage Ratio (KV)	765/√3 / 400/√3/ 33 KV			
10.	(i) Type of connection				
	(a) H.V.	Star in 3 phase bank			
	(b) I.V.	Star in 3 phase bank			
	(c) L.V.	Delta in 3 phase bank			
	(ii) Vector group	YnaOd11			
	(iii) Neutral	Effectively earthed			
12.	Max. current density of winding	300 A/cm			
13.	Insulation levels	HV	IV	LV	Neutral
	(1) Winding voltage KV (rms)	765	400	33	--
	(2) Highest system voltage KV (rms)	800	420	52	36
	(3) Lightning impulse withstand	1950	1300	250	170
	(4) Switching impulse withstand voltage	1550	1050	--	--
14.	Duration of short circuit withstand capacity	2 seconds			
15.	(a) Tap changer	OLTC with remote control panel			
	(b) Tapping range	Tap changer shall be located on the neutral side of the winding and shall be designed for tapping range of ± 5.5% on HV variation in 22 steps			
16.	D.C. voltage for relays etc.	220 Volts			
17.	Percentage impedance (Tolerance ±10%) (With IEC tolerance)	Principal Tap	Highest Tap	Lowest Tap	
	HV – IV	14.0			
	HV – LV	195.0			
	IV – LV	180.0			
18.	Cooling medium/insulating oil	Virgin EHV grade transformer oil conforming to IS:335.			
19.	Maximum Losses .				
	(a) No-load loss	85 KW (Max)			
	(b) Load loss	575 KW (Max)			

	(c) Auxiliary loss	14 KW (Max)					
20.	Termination arrangement	Bushing type suitable for outdoor operation.					
21.	Terminal bushings	HV	IV	LV	Neutral		
	System voltage	765	400	33	--		
	(a) Voltage rating (KV rms)	800	420	52	36		
	(b) Current rating (Amps)	2500	2500	3150	2500		
	(c) Impulse withstand voltage (KV Peak)	2100	1425	250	170		
22.	Bushing Current transformers:						
	a) C.T. Ratio	HV		IV		LV	Neutral
		Core-I	Core-II	Core-I	Core-II	Core-I	Core-I
		1500/1	3000/1	3000/1	3000/1	1837/1	3000/1
	b) Accuracy class	0.2	PS	0.2	PS		PS
c) VA Burden	30		30				
23.	Tank:						
	(i) Type		BELL/Conventional				
	(ii) Thickness (mm)						
	(a) Bottom		16				
	(b) Sides		10				
	(c) Top		12				
	(iii) Pressure release device						
Type		Safety valve type spring operated					
Number		2					
(iv) (a) Suitable opening at top cover for Oil drain & In the bottom of the tank for Nitrogen injection fire prevention system.							
24.	Clearances (mm)	765 KV		400 KV	33KV		
	(a) Phase to Phase	7600		4000	690		
	(b) Phase to Earth	4900		3500	630		
25.	Noise level	Less than 81 db					
26.	Oil preservation	Air cell type with 2 Nos. Silicagel breathers associated with oil seal in parallel, each one with a valve					
	Main Conservator						

	OLTC Conservator	1 no. silicagel breather with oil seal.
27.	Expected life period of the transformer	25 Years

Technical Parameters of Neutral Current Transformer (Outdoor type):

Common Neutral Side (for each three phase bank)

- (a) Ratio : 400/1 A
- (b) Minimum knee point voltage : 400 V
- (c) Accuracy class : PS
- (d) Maximum CT Resistance : 1.6 Ohms
- (e) Application : Earth fault Protection
- (f) Maximum magnetization : 60 mA

Current (at knee-point voltage)

Note:

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.

ANNEXURE – II

PROFORMA FOR STAGE INSPECTION OF AUTO TRANSFORMERS

(A) GENERAL INFORMATION:

1. Name of firm :
2. Order No. and date :
3. Voltage rating available :
4. Details of offer
 - a) Capacity :
 - b) Quantity :
 - c) Serial Nos. :
5. Details of last stage inspected lot :
 - a) Total quantity inspected :
 - b) Serial Nos. :
 - c) Date of stage inspection :
 - d) Quantity offered for final :
Inspection of (a) above with :
Date

(B) Availability of material for offered quantity:

Details to be filled in :

(C) Position of manufacturing stage of the offered quantity

- a) Complete tanked assembly :
- b) Core and coil assembly ready :
- c) Core assembled :
- d) Coils ready for assembly :

- (i) HV coils :
- (ii) LV coils :
- (iii) IV coils :

SECTION – 3

GENERAL TECHNICAL REQUIREMENTS

3.0 FOREWORD

The provisions under this section are intended to supplement general requirements for the materials, equipment's and services covered under other sections.

3.1 PROJECT INFORMATION AND SYSTEM PARAMETERS

- a) Customer : M/s Tamil Nadu Transmission Corporation Limited
b) Project Title : 765/400KV AIS SUB STATION AT ARIYALUR
c) Transport facilities : Road/Rail

Physical and other parameters:

3.1.1 Location of the substation

- 3.1.2 Nearest Railway station : Tindivanam
Railway : Southern Railway

3.1.3 Meteorological data

- | | |
|---|---------------|
| (i) Atmosphere | : Polluted |
| (ii) Maximum ambient temperature | : 50°C |
| (iii) Minimum ambient temperature | : 20°C |
| (iv) Maximum daily average ambient air temperature | : 45° C |
| (v) Maximum yearly average ambient air temperature | : 32° C |
| (vi) Maximum Humidity (%) | : 100% |
| (vii) Average thunder storm days per annum | : 50 |
| (viii) Average rainy days per annum | : 65 |
| (ix) Average annual rainfall (mm) | : 750 mm |
| (x) No. of months during which tropical monsoon condition prevail | : 3 |
| (xi) Maximum wind pressure | : 150 Kg/Sqmm |
| (xii) Altitude above MSL | : <1000M |

(xii) Basic Wind Speed

: 47 m/s(Zone -4)

However for design purpose, ambient temperature should be considered as 50° C and relative humidity as 100%.

3.1.4 System Parameter

SL No	Description of parameters	765kV System	400 kV System
1.	System operating Voltage	765kV	400k V
2.	Maximum operating voltage of the system(rms)	800kV	420k V
3.	Rated Frequency	50HZ	50H
4.	Number of Phases	3	3
5.	Rated Insulation Levels (i)Full wave impulse withstand voltage.(1.2 to 50 micro sec) (ii)Switching impulse withstand voltage(250/2500 micro sec) dry and wet. (iii) One minute power frequency dry withstand voltage (rms)frequency dry withstand voltage (rms)	2100kVp 1550kVp 830kV	1550kVp 1050kVp 630kV
6.	Corona extinction voltage	508kV	320kV
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 508 kV rms for 765kV,and 266kV rms for 400kV system	2500 microvolts	1000 microvolts
8.	Minimum creepage distance (25mm/kV)	20000 mm	10500 mm
9.	Rated short circuit current for 1 sec. Duration	50kA	63kA
10.	System neutral earthing	Effectively earthed	Effectively earthed
11.	Seismic acceleration	0.3g horizontal	0.3g horizontal
12.	Plinth level of switchyard	500mm above FGL	500mm above FGL

3.1.5 AUXILIARY POWER SUPPLY:

Auxiliary electrical equipment's maintenance equipment's etc., shall be suitable for operation on the following supply system.

3 phase AC Supply	415V, 3 phase 4 wire 50 Hz, neutral grounded AC supply -10% to +10%, frequency +/- 5%
1 phase AC supply	240V, single phase, 50 Hz neutral grounded AC supply
DC supply	220, 2 wire DC supply + 10% to -15%, Ungrounded 48V, 2 wire DC supply , Positively earthed

3.2 GENERAL REQUIREMENT

3.2.0 ALL THE EQUIPMENTS / MATERIALS TO BE SUPPLIED SHOULD BE IN ACCORDANCE WITH RELEVANT LATEST / AMENDED IS/IEC, WHETHER IT HAS BEEN SPECIFICALLY MENTIONED IN THE SPECIFICATION OR NOT.

3.2.1 The bidder shall also furnish drawings for the following:

All EQUIPMENTS and type of clamps, fittings hardware's, insulators, bus bar . These designs / drawing shall be got approved by the purchaser before commencing the manufacture / construction / erection and are to be as per latest IS /IEC.

3.2.2 GENERAL:

The bidder shall be fully responsible for providing all equipment, materials system and services specified or otherwise which are required to complete the construction and successful commissioning of the substation in all respects.

Any other items not specifically mentioned in the specification but which are required for erection of materials/equipment under the scope of work, testing and commissioning are deemed to be included in the scope of the specification unless specifically excluded.

All items shall be supplied as per schedule and as specified in the relevant Indian standard of latest revision. The Technical specification of the main materials/equipment is furnished. The Technical specification contained herein for the materials are for the guidance of the tenderer.

The bidders are requested to procure the equipment's/materials/component only from reputed /qualified manufacturer as per Technical requirement stipulated in Section - I of Technical specifications. Approval of make of item shall be taken up by vendor from TANTRANSCO himself.

3.3 SPECIFIC REQUIREMENT

The bidder shall furnish make/manufacturer, catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification and get approval from competent authority before commencement of any work.

All steel materials, other than materials for earthing should be of galvanized if not specified.

3.4 STANDARD:

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standards specified in each section.

The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

The Bidder shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.5 TYPE TEST:

The Type Test for all the equipments/materials used for this project should have been conducted in any approved Government/Govt. recognized laboratories conforming to latest IS/IEC. The above type test certificates should accompany the drawings of the materials equipments, duly signed under seal by the Institution, who have issued the type test certificate. The above type test should have been conducted not earlier than Ten years , subject to no change in design as on the originally scheduled date of technical bid opening i.e. **30.09.2016**

In case the type tests were conducted earlier than 10 (ten) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test (s) at no extra cost to the purchaser.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally scheduled date of bid opening.

- i) Lightning Impulse Test
- ii) Switching Impulse Test
- iii) Multiple Chopped Impulse Test (For CT)
- iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the BHEL. The original type test certificates shall be furnished for verification on request.

TANTRANSCO/BHEL reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative at no extra cost.

Non furnishing of type test certificates by the tenderers, will be liable for rejection.

3.6 MATERIALS AND WORKMANSHIP:

All the materials shall be of the best class and capable of satisfactory operation in the tropics with humid atmosphere conditions. Unless otherwise specified, they shall conform to the requirements of the appropriate ISS/IEC. The workmanship shall be of the best grade and the entire construction in accordance with the best modern practice.

The equipment shall be designed to facilitate inspection and repairs and to ensure satisfactory operation under atmosphere condition prevailing at site and under such sudden variation of load and voltage as may be met with under working conditions in the system including those due to faulty synchronizing and short circuit within the rating of the apparatus.

The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the equipment.

All the equipment's should operate without undue vibration and with the least practicable amount of noise.

3.7 INSPECTION:

The inspection may be carried out by the TANTRANSCO/BHEL at any stage of manufacture. The supplier shall grant free access to TANTRANSCO's/BHEL representative at a reasonable time when the work is in progress. The TANTRANSCO/BHEL shall have access at all times to the works and all other places of manufacture/fabrication, where the equipments are being manufactured/fabricated and the bidder shall provide TANTRANSCO's/BHEL representative all facilities for unrestricted inspection of the works, raw materials, manufacture of all the accessories and for conducting necessary tests.

Inspection and acceptance of any equipment under this specification by the TANTRANSCO/BHEL shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the TANTRANSCO/BHEL informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The TANTRANSCO/BHEL , reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

The correct grade and quality of steel shall be used by the supplier. To ascertain quality of steel, the TANTRANSCO/BHEL may at his discretion get the material tested at an approved laboratory.

The bidder shall take an account the fabrication wastage while quoting the rates. The Employer will not accept any liability in connection with the wastage of steel during fabrication or otherwise. Steel shall be procured exclusively from the main producers. However, sections not rolled by main produces can be procured from reroller , provided rerolling of structural steel section is done from billets/ingots of tested quality. Rerolled sections are duly tested as per relevant standards. Supplier should obtain approval of list of primary producers of Steel

and Zinc before Proto assembly .

The BHEL/TANTRANSCO or his representative shall have the right to inspect and/or test the goods /works to confirm their conformity to the supplier. BHEL/TANTRANSCO shall notify the supplier in writing of the identity of any representatives authorized for these purposes.

The inspections and tests may be conducted on the premises of the supplier or his Sub vendor at the point of delivery and /or at the goods' final destination. Where tests are conducted in the premises of Supplier, all reasonable facility and assistance including access to drawings and production data shall be furnished at no charge to the BHEL.

Should any inspected or tested goods fail to conform to specifications, the BHEL/TANTRANSCO may reject them and the supplier shall either replace the rejected goods or make all alterations necessary to meet specification requirements free of cost to the BHEL/TANTRANSCO within one week of intimation.

The BHEL/TANTRANSCO's right to inspect, test and where necessary reject the goods after the goods; arrival at the site, shall in no way be limited or waived by reason of the goods having been previously inspected. Tested and passed by the BHEL/TANTRANSCO or his representative prior to the goods dispatch.

Not less than 15 (Fifteen) days advance intimation shall be given about the quantity of materials that will be ready for inspection by the officers of TANTRANSCO/ BHEL/Third agency authorized by the Corporation. The materials should not be dispatched without instruction from the Corporation.

3.8 GUARANTEE:

The supplier shall guarantee that the goods under the Contract are new, unused of the most recent or current models and incorporated all recent improvements in design and materials unless provided otherwise in the Contract. The supplier shall further guarantee that the goods supplied under this Contract shall have no defects arising from design, materials or workmanship, installation and erection, if that may develop under normal use of the supplied goods. The supplier shall also guarantee the performance of the works executed by him including the performance of all the materials/goods supplied by him.

BHEL shall promptly notify supplier in writing of any claims arising under guarantee in respect of goods. Upon receipt of such notice, the supplier shall, with all reasonable speed, repair or replace the defective works or parts thereof, free of cost at site. All the expenses towards transportation of defective parts to supplier's works and of repaired/replaced parts to site shall be borne by the Supplier.

If the Supplier, having been notified, fails to remedy the defects within 14 days, the BHEL will proceed to take such remedial action as may be necessary, at the supplier's risk and expenses. All expenses in this regard will be recovered from Supplier.

3.9 PRE COMMISSIONING TESTING (if applicable) :-

On completion of erection of equipment's and before charging each item of equipment's shall be thoroughly cleaned and inspected jointly by the TANTRANSCO and the BHEL for correctness and completeness of installation and acceptability for charging leading to initial pre commissioning test. The pre commissioning testing to be carried all equipment's in the presence of BHEL/ TANTRANSCO. Necessary tools, testing kits to be arranged by the Supplier.

3.10 DOCUMENTATION : All drawings shall conform to relevant international standards Organization (ISO) specification. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. units.

3.11 PAINING, GALVANISING:

All interiors and exteriors of all metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter and the surfaces treated by phosphating (e.g. seven tank phosphating sequences).

All metal surfaces exposed to atmosphere shall be given, in addition to the treatment, two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external paintings shall be as per shade No.697/631 of IS-5.

Paint inside the metallic housing shall be of anti condensation type and the paint on outside surfaces shall be suitable for outdoor installation.

All components shall be given adequate treatment of climate proofing as per IS: 3202 so as to withstand corrosive and several service conditions.

All ferrous parts including all sizes of nuts, bolts, support channel structures, etc. as also the mechanism housing shall be hot dip galvanized conforming to latest version of IS : 2629 or epoxy painted. Spring washers shall be electro-galvanised.

All members of the structure members shall be hot dipped galvanised with a zinc coating of **610 gms. per square metre** . Galvanising shall be done after a work is completed, except that the nuts may be tapped or rerun after galvanization. The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanising itself shall not adversely affect the mechanical properties of the coated materials. The employer shall be at liberty to have the samples of zinc used, test checked in any laboratory at his own cost and reject the particular supply if it is below standard.

All galvanised material shall withstand test as per IS 2633-1972 or any other equivalent

standard. The zinc used for galvanising fabricated material shall be of high grade Electrolytic zinc of 99.99% purity.

All nuts and pins shall be adequately locked. Nuts, bolts and pins used inside the transformer and tap-changer compartment where gaskets are not used shall be provided with spring washers or locknuts. Where galvanizing is specified, it shall be applied by the hot dipped process or by electro-galvanizing process and for all parts, other than steel wires, shall consist of a thickness of zinc coating equivalent to not less than 610gm of zinc per square meter of surface. The zinc coating shall be smooth, of uniform thickness and free from defects.

3.12 SURFACE FINISH

All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulating oil as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paints.

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limit specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

3.13 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves, pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner. Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

3.14 FUNGI-STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on the parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interface with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application to the varnish.

3.15 DEGREE OF PROTECTION

The supplier shall propose following Degree of protection for those equipment/Items for which the degree of protection has not been specified in the specification for the approval of BHEL/TANTRANSCO. The decision of BHEL/TANTRANSCO shall be final. The enclosures of the Control Cabinets, Junction boxes and Marshalling boxes panels etc to be installed shall be provided with degree of protection as detailed here under:

- a) Installed outdoor: IP-55
 - b) Installed indoor in air conditioned area: IP-42
 - c) Installed in covered area IP:52
 - d) For LT switchgear (AC & DC distribution Boards): IP-54
- The degree of protection shall be in accordance with IS:13947, (Part-1)/IEC-947(Part-1). Type test report/or degree of protection test on each type of the box shall be submitted for approval.

3.16 RATING PLATES, NAME PLATES AND LABELS :-

The equipment's shall be provided with a rating plate or plates marked with but not limited to following data whatever needs to that particular equipment's.

- (a) Manufacturer's name or trade mark.
- (b) Serial number and type design making it possible to get all relevant information from the manufacturer.
- (c) Year of manufacture.
- (d) Rated voltage
- (e) Rated insulation level.
- (f) Rated frequency
- (g) Rated Normal current.
- (h) Rated short circuit breaking current
- (i) First pole to clear factor
- (j) Rated duration of short circuit
- (k) Rated auxiliary D.C. supply voltage of closing and opening devices.
- (l) Rated pressure of SF6 gas for operation and interruption.
- (m) Rated out of phase breaking current.
- (n) Rated supply voltage of auxiliary circuit.
- (o) Rated supply frequency of auxiliary circuits.
- (p) Purchase Order Number and Date.

The rating plate shall be visible in position of normal service and installation.
The rating plate shall be weather proof and corrosion proof.

Type or serial number together with details of the loading conditions under which the item of the substation in question has designed to operate and such diagram plates as may be required by the BHEL/TANTRANSCO. The rating plate for each equipment shall be according to IEC requirements.

Alternately two separate plates one with Hindi and other with English inscriptions may be provided. During approvals drawings of Rating/name plates/labels shall also be submitted.

3.17 EARTHING :

The operating mechanism housing, control cabinets, support structure etc. shall be provided with two separate earthing terminals suitable for bolted connection to 50x8mm mild steel flat to be provided for connection to station earth mat.

Circuit breakers, LA, Isolator, CVT, CT, BPI shall be provided with two grounding pads suitable for connection to galvanized steel flat of Size 75X12 mm. Control panels, Relay panel, outdoor marshalling boxes, Junction boxes, Lighting panels and distribution board shall be provided with two grounding pads, for connection to galvanized steel flat. The two pads shall be provided, one each at the middle of the two opposite sides of the bottom frame of the equipment. Earthing of hinged door shall be done by using a separate earth wire.

3.18 TERMINAL BLOCKS AND WIRING

Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All Inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

Terminal blocks shall be 1100 V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wedge or equivalent. The Insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, fluorocarbons etc.

Terminal block for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on

each side.

All circuits except CT circuits :	Minimum of 2 nos. of 2.5 sq.mm.copper flexible.
All CT circuits :	Minimum of 4 nos. of 2.5 sq.mm, copper flexible.

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be a minimum clearance of 250mm between the first bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm. The Supplier shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connection (where applicable) as well as between phases and common terminal boxes or control cabinets.

All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The supplier shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

TB sizes for incoming power supply shall be informed/confirmed during drawing approval stage.

3.19 CONTROL CABINETS, JUNCTION BOXES, TERMINALS BOXES AND MARSHALLING BOXES FOR OUTDOOR EQUIPMENTS

All types of boxes, cabinets etc. shall generally conform to and be tested in accordance with IS-5039, IS-8623 or IEC-439, as applicable and the clause given below.

Control cabinet, Junction boxes, Marshalling boxes & Terminal boxes shall be made of sheet steel. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.

Cabinet /boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of gaskets shall be such that it does not get damaged/cracked during the operation of the equipment.

All door, removable covers and plates shall be gasketed all around with suitably profiled Neoprene /EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged /cracked during the years of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth, straight and reinforced if necessary

to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above from the base of the Marshalling Kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required.

3.20 SPACE HEATERS

The heater shall be suitable for continuous operation at 240 V AC supply voltage and shall be provided with on – off switch and fuse shall be provided for heater.

One or more adequately rated, thermostatically connected heaters shall be supplied to prevent condensation in any compartment.

3.21 DELIVERY OF GOODS AND DOCUMENTS RELATED THERETO:

Delivery of goods shall be made by the supplier in accordance with the terms specified by the BHEL in its schedule of requirements.

3.22 INCIDENTAL SERVICES:

The Supplier is required to provide any or all the services broadly outlined in the Technical specification. Any other minor incidental service related to the scope of work like providing necessary assistance whether specifically mentioned or not must be carried out by the Supplier at his own cost. All tools, Tackles Plant etc., required for completion of above works shall be brought by the Supplier.

3.23 DISCREPANCIES BETWEEN DRAWING AND SPECIFICATION:

Should there be any discrepancy between the specifications and/or schedule of prices and/or drawings or any inconsistency, error or omission in either of them, reference must be made to the BHEL/TANTRANSCO for an explanation and the Supplier will be held responsible for any errors that may occur in the work through neglect of this precaution. The explanation of the BHEL/TANTRANSCO shall be final and binding on the Supplier.

3.24 LIST OF DRAWINGS AND DOCUMENTS :

The drawings for the equipments provided by the TANTRANSCO shall be followed strictly by the bidder while designing. For the rest of the equipments, the design is in the scope of the bidder and the

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same got approved by the TANTRANSCO.

The bidder shall furnish One sets of relevant descriptive and illustrative published literature pamphlets and the following drawings/documents for preliminary study along with the offer.

- (i) General outline drawings showing dimensions and shipping weights, quantity of insulating media , etc.
- (ii) Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.
- (iii) Schematic diagrams of breaker offered for control supervision and re- closing.
- (iv) Structural drawing, design calculations and loading data for support structures.
- (v) Foundation drilling plan and loading data for foundation design.
- (vi) The Type Test Reports
- (vii) Bill of materials shall be furnished along with drawings.

The supplier shall, within 1 weeks of placement of order submit Six sets of final version of all the above drawings for BHEL/TANTRANSCO's approval. The TANTRANSCO shall communicate its comments/approval on the drawings to the supplier within reasonable period. The Supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for TANTRANSCO's approval within two weeks from the date of comments.. However the drawing approval does not absolve the supplier from complying with the terms of the specification.

The following should be supplied to each consignee circle along with the initial supply of equipment's ordered.

- 1) Five copies of printed and bound volumes of operation, maintenance and erection manual in English along with the copies of approved drawings and type test reports etc.
- 2) Three sets of manuals detailed in item (1) shall be supplied to the TANTRANSCO/BHEL with in one week from the date of approval of drawings.
- 3) The spares for the Equipment's ordered under the scope of the Contract should also be supplied to the consignee circle along with initial supply of the breakers.
- 4) It should be noted that if the above conditions are not fulfilled the initial payment will not be released.

3.25 QUALITY ASSURANCE PLAN:

The bidder shall invariably furnish following information along with his offer. (i) Statement giving list of important raw materials including but not limited to:

- (a) Contact material
- (b) Insulation
- (c) Porcelain
- (d) Sealing material
- (e) Contactor, limit switches, etc. in control cabinet.

Name of sub-supplier for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of bidder's representative,

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copies of test certificates.

- (ii) Information and copies of test certificates as in
- (i) above in respect of bought out accessories.
- (iii) List of areas in manufacturing process, where such inspections are normally carried out for quality control and details of such tests and inspections.
- (iv) Special features provided in the equipment to make it maintenance free.
- (v) List of testing equipment available with the Bidder for final testing of breakers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements.

The supplier shall submit following information to the TANTRANSCO.

- 1) List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- 2) Type test certificates of the raw material and bought out accessories.
- 3) Quality assurance plan (QAP) withhold points for TANTRANSCO inspection. The quality assurance plan and hold point shall be discussed between the employer and supplier before the QAP is finalized.

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 breaker.

3.26 **TEMPERATURE RISE :**

The maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed to the direct rays of the sun shall not exceed 30 deg. Cover an ambient of 50 deg. C limits specified in relevant IEC. When the standard specify the limit of temperature rise these shall be exceeded when corrected for the difference between ambient temperature at site and that specified in the approved specifications. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

3.27 **FITTINGS AND ACCESSORIES :**

Following is a partial list of some of the major fittings and accessories to be furnished by contractor as an integral part of the equipment.

Operation mechanism housing complete with :

- (a) Locking arrangement.
- (b) Heaters equipped with automatic thermostatic control and control switch.
- (c) Cable glands.
- (d) Local/Remote change over switch.
- (e) Operation Counter.
- (f) Terminal Blocks.
- (g) Control switches to cut off control power supply.
- (h) MCCBs/MCBs are required with permanent identification marks for protection of D.C. circuits and A.C. circuits.
- (i) Two earthing terminals.

3.28 PACKING AND FORWARDING:

The equipment shall be packed in crates suitable for vertical/horizontal Transport, as the case may be and suitable to withstand handling transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit due to improper and inadequate packing and handling. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever 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.

The supplier shall provide such packing of the goods as is required to prevent their damage or deterioration during transit to their final destination as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling during transit to their final destination as indicated in the Contract and exposure to extreme temperatures, salt and precipitation etc., during transport and open storage. Packing case size and weights shall be taken into consideration wherever appropriate, the remoteness of the 'goods' final destination and absence of heavy mechanized handling facilities, at all points in transit.

The packing, marking and documentation within and outside the package shall comply strictly with such special requirements as shall be expressly provided for in the Contract or in any subsequent instructions issued by BHEL.

3.29 SPECIFICATION FOR NITRYL BUTYL RUBBER

The gaskets are to be used in tanks exposed to Transformer mineral oil/SF6 at about 110° C.

1. Hardness should be Shore A 70 ± 5 .
2. Tensile Strength should be min. 10.8N/sq.mm (Minimum)
3. Elongation strength should be 270% (Minimum)

3.30 APPROVAL PROCEDURE

The scheduled dates for the submission of drawings as well as for, any data/information to be furnished by the Employer would be as per the following schedule. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the BHEL/TANTRANSCO. The following schedule shall be followed generally for approval.

i.	First Submission	7 days after LOI/PO
ii.	Approval/comments/by employer on Initial submission	Reasonable time
iii.	Resubmission	Within 7 days (whenever from date of comments required) Including both ways postal time.
iv.	Approval or comments	Within 2 weeks of receipt of resubmission.
v.	Furnishing of distribution copies	2 weeks from the date of last approval.

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BHARAT HEAVY ELECTRICALS LIMITED (TBG)
765/400KV AIS SUB STATION ARIYALUR

Note: The supplier may please note that all resubmissions must incorporate, all comments given in the submission by the BHEL/TANTRANSCO failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings. Please refer below mention Title block for Submission of Documents.

Title Block

Customer	M/s Tamil Nadu Transmission Corporation Limited
Project:	765/400KV Air Insulated substation Ariyalur
Contractor	BHEL

3.31 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

Drawings, GTP ,Type Test Reports and List of Past Supplies. Drawings & Documents

submitted at the time of offer shall be subject to review at contract stage.

3.31 DOCUMENTATION SCHEDULE

Following Documentation schedule to be followed per project.

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
			Prints	Prints	CDs
1	Drawings and Data Sheets	1	7	10	5
2	Drawings "As Built "	-	-	10	
3	Type Test Reports	1	7	10	
4	Erection Manuals	-	7	10	
5	Operation and Maintenance Manuals	-	7	10	
6	Manufacturing Quality Plan	-	7	10	
7	Field Quality Plan	-	7	10	
8	Inspection Test Reports	-	7	10	

Note: Drawings will also be submitted in CD/DVD in Latest AUTOCAD-2004 or Later version or any other CAD package along with conversion files for all major items. Final Documentation shall be submitted in bound volumes with details of Customer & Project etc. written on top.

SECTION ⁴~~3~~ GENERAL TECHNICAL PARTICULARS
AUTO TRANSFORMER GTP



SI No.	ITEM	VALUES	
1.	Name of the manufacturer and address		
2.	Applicable standards.		
3.	Continuous ratings under conditions specified in I.S:2026(Part-I) 1977 Clause -3.		
(a)	Type of cooling	ONAN/ONAF/ODAF	
(b)	Rating in (MVA)	HV IV LV	
	With ONAN cooling		
(ii)	With ONAF cooling		
(iii)	With ODAF cooling		
(c)	Rated Voltage.		
	(i) HV (KV) (ii) IV (KV) (iii) LV (KV)		
(d)	Voltage variation		
	Rated frequency (Hz)		
(e)	Frequency variation		
	Number of phases.		
(f)	Current and power factor at rated load and voltage on principal tap		
(g)			
(h)	6.0. HV amps. 7.0. IV amps. 8.0. LV amps.		
4.	Connections: (i) HV, (ii) IV, (iii) LV		
5.	Connection Symbol.		

6.	Maximum Temperature rise (above peak ambient.		
(a)	Temperature rise of oil. (By thermometer) (°C)		
	(i) At full ONAN rating		
	(ii) At full ONAF rating		
	(iii) At full ODAF rating		
(b)	Temperature rise of winding (By resistance method) (°C)		
	1. At full ONAN rating		
	2. At full ONAF rating		
	3. At full ODAF rating		
(c)	Temperature gradient between winding and oil (°C)		
(d)	Limit of hot spot temperature for which the transformer is designed (°C)		
(e)	Time in minutes for which the transformer can be run at full load without exceeding the max. permissible temperature at reference ambient temperature when,		

	(i) Supply of fan is cut off but oil pumps are working		
	(ii) Supply of oil pump is cut off but fans are working		
	(iii) When supply of both fans and pumps are cut off		
	(iv) Ambient peak temperature specified Deg.C		

7.	Tappings on windings on HV side.		
(a)	Number of steps		
(b)	Range of tappings for variation		
8.	Losses (KW-MAX)		
(a)	No-load losses at rated voltage and Frequency at principal tap.		
(b)	Load-losses at rated output rated Frequency and corrected for 75°C		
(c)	Auxiliary losses at rated output, normal ratio, rated voltage, rated frequency and ambient temperature (KW)		
(d)	Total losses at normal ratio inclusive of auxiliary equipment losses (KW) corrected to 75°C.		
9.	Resistance per phase (ohms)		
(a)	H.V.winding.		
(b)	I.V.winding.		
(c)	L.V. winding		
10.	Positive sequence impedance on rated MVA base at rated current and frequency at 75°C winding temperature at, Principal tap percent.		
(a)	Highest tap percent.		
(b)	Lowest tap percent		
(c)			
11	Zero Sequence impedance at reference temperature of 75°C at principal tap percent .		
12	Noise level in decibels when energized at normal voltage and normal frequency at No-Load.		

18.(a)	Over load capacity of transformer duration for the following over loads starting with transformer unexcited (i) 10 % (ii) 20 % (iii) 30 % (iv) 50 % (v) 75 %		
(b)	Overload capacity of transformer duration For the following overloads, starting with Transformer after continuous running on Open circuit. (i) 10 % (ii) 20 % (iii) 30 % (iv) 50 % (v) 75 %		
(c)	Permissible emergency short time, loading of the transformer immediately following full load run (i) 2 seconds. (ii) 5 seconds. (iii) 10 seconds. (iv) 30 seconds. (v) 1 minute .		
19.	Terminal arrangement (i) High voltage (HV) (ii) Intermediate Voltage (IV) (iii) Low voltage (LV) (iv) Neutral		

13.	% Reactance at rated MVA base at rated Current and frequency percent (i) At unity power factor (ii) At 0.8 pf (lagging)		
14.	% 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 p.f. (lagging)		
15.	% Efficiency at 75°C winding temperature as derived from guaranteed loss figures and at UPF (a) Full load percent (b) 3/4 load (c) 1/2 load (d) 1/4 load		
16.	Short time rating for 2 seconds of (a) HV winding (b) L V winding		

17.	Permissible over loading (a) HV winding (b) L V winding		
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	<u>ADDITIONAL TECHNICAL PARTICULARS</u>		
1.	<u>Details of core</u>		
(a)	Type of core construction		
(b)	Type of core joints		
(c)	Flux density at rated voltage and frequency and at principal tap Tesla		
	i) at rated voltage.		
	ii) at 110% rated voltage.		
	iii) at 90% rated voltage		
(d)	Magnetising current on HV side at normal ratio at and frequency and at		
	(i) 85 % of rated voltage		
	(ii) 100 % of rated voltage		
	(iii) 110 % of rated voltage		
(e)	Power factor of magnetising current at normal voltage ratio and frequency		
(f)	(i) Material of core laminations (CRGO)		
	(ii) Thickness of core laminations (mm)		
	(iii) Specific loss of the core material watts per kg at working flux density		
(g)	(i) Whether core construction is without core bolts		
	(ii) Insulation of core bolt		
	(iii) Insulation of core bolt washers		
	(iv) Insulation between core lamination		
	(v) Core bolt insulation withstand voltage for 1 minute(kV rms)		
(h)	Insulation of clamping plate Describe location / Method of core grounding.		
(i)	Details of oil ducts in core		
			

20.	Insulating and cooling medium		
21.	Test Voltage (i) Lightning impulse withstand voltage (KVp) (ii) Power frequency withstand test voltage (dry and wet) (kV rms) (iii) Induced over voltage withstand voltage (kV rms) (iv) Voltage to earth for which star points of the transformer LV windings will be insulated.	HV IV LV	
22.	External short circuit withstand capacity (MVA) and duration (seconds)		
23.	Over flux withstand capacity of the transformer.		

2.	Method of making joints carrying current		
3.	<u>Details of winding</u>	HV	IV LV
(a)	Type of winding		
(b)	Material of winding conductor :-		
(c)	Maximum current density of windings (at rated current) and conductor area		
	4. H.V.		
	5. I.V.		
	6. L.V.		
(d)	Whether HV windings are interleaved		
(e)	Whether windings are preshrunk		
(f)	Whether adjustable coil clamps are provided for HV and LV windings		
(g)	Whether steel rings used for the windings if so, whether they are split		
(h)	Whether electro static shields are provided to obtain uniform voltage		

i)	Insulating material used for		
	(I) HV winding		
	(ii) IV winding		
	(iii) LV winding		
(j)	(iv) Regulating winding		
	Insulating material used between		
	(I) HV winding		
	(ii) IV winding		
	(iii) LV winding		
	(iii) Regulating winding and earth		
(k)	Type of axial coil supports		
	(i) H.V. Winding		
	(ii) I.V. Winding		
	(iii) L.V. Winding		
(l)	Type of radial coil supports		
	(i) H.V. winding		
	(ii) I.V. winding		
	(iii) L.V. winding		
	(iv) Regulating winding		
(m)	Maximum allowable torque on coil clamping bolts		

4.	Bushings:	HV	IV	LV
(a)	Make and type	& Neutral		
	(i) Rated Voltage class KV			
	(ii) Rated current (Amps)			
(b)	Lightning impulse withstand test voltage			
	(1.2x50 micro second (KV peak)			
(c)	Switching surge withstand test voltage			
	(KV peak)			
(d)	Power frequency withstand test voltage			
	(i) Wet for 1 minute (KV rms)			
	(ii) Dry for 1 minute (KV rms)			
(e)	Visible corona discharge voltage (KV rms)			
(f)	Partial discharge level			
(g)	Creepage distance in mm			
(h)	Creepage distance (protected)			
(i)	Whether test tap is provided			
(j)	Quantity of oil in bushing and specification of oil used (Kg)			
(k)	Weight of assembled bushing (Kg)			
(l)	Min. clearance height for removal of bushing (mm)			

8.	<u>Details of Tank</u>		
(a)	Type of tank		
(b)	Approximate thickness of sheet		
	(i) Sides (mm)		
	(ii) Bottom (mm)		
	(iii) Cover (mm)		
	(iv) Cooling tubes/Radiators (mm)		
(c)	Materials of tank and construction		Transverse Longitudinal Axis Axis
(d)	Vacuum to be maintained during oil filling in transformer tank (torr)		
(e)	Vacuum to which the tank can be subjected without distortion (torr)		
(f)	No of bi-directional wheels provided		
(g)	Track gauge required for the wheels		
(h)	Size of rail recommended for the track		
(i)	Type and quantity of pressure relief device/and pressure at which it operates		
(j)	Whether tank shields provided if so, details		
(k)	Details of painting at works and site		
9.	Conservator		
(a)	Total volume (Liters)		
(b)	Volume between the highest and lowest visible oil levels (Liters)		

10.	Oil		
(a)	Governing Standard		
(b)	Specific resistance at		
	(i) 27°C (ohms-cms)		
	(ii) 90°C (ohms-cms)		
(c)	Tan delta		
(d)	Water content		
(e)	Dielectric strength (Break down voltage)(KV)		
(f)	Characteristic of oil after ageing test as per ASTM D - 1934		
	(i) Specific resistance at 27°C		
	(ii) Tan delta		
	(iii) Sludge content		
	(iv) Neutralisation number		
(g)	Details oil preserving equipment offered		
11.	<u>Radiator</u>		
(a)	No. of banks attached whether attached/separate		
(b)	Overall dimensions (lxbxh) (mm)		
(c)	Total weight with oil (kg)		
(d)	Total weight without oil (kg)		
(e)	Thickness of radiator tube (mm)		
(f)	Type of mounting		
(g)	Vacuum withstand capability		

12.	<u>Cooling System</u>	Fan 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 (litres/min)		
(f)	Rated voltage (volts)		
(g)	Locked rotor current (Amps)		
(h)	Efficiency of motor at full load (percent)		
(i)	Estimated time constant in hours for ii) Natural cooling iii) Forced air cooling Temperature rise of motor at full load (°C)		
(j)	BHP of driven equipment		
(k)	Temperature range over which control is adjustable(°C)		
(l)			
(m)	Whether the fans suitable for continuous operation at 85 percent of their rated voltage		
13.	Gas and oil operated relay –make & type		
14.	Magnetic oil level gauge – make & type		
15	Temperature controllers 17.0 Make and Type (ii) Permissible setting ranges for alarm and trip (iii) Number of contacts (iv) Current rating of each contact (v) Diameter of the dial	oil winding	
16	(i) Minimum clearance height for lifting core and winding from tank cover : mm: (ii) Minimum clearance height for lifting tankcover: mm:		

17.	Shipping details Approximate weight of heaviest package :kg (a) Approximate dimension of largest package : (b) l x b x h	
18.	Transformer will be transported with oil / gas	
19.	Tap-changing equipment Make (a) Type (b) Power flow-unidirectional /bi-directional/ restricted bi-directional (c) Rated voltage to earth (KV) (d) Rated Current (Amps) (e) Step Voltage (Volts) (f) Number of steps (g) Control-Manual/Local electrical/Remote electrical (h) Line drop compensation provided/not provided. (i) Parallel operation (j) Protective devices (k) Auxiliary supply details (l) Approximate overall dimensions of tap changer (m) Approximate overall weight (n) Approximate mass of oil	

19.	Tap-changing equipment		
	Make		
(a)	Type		
(b)	Power flow-unidirectional /bi-directional/ restricted bi-directional		
(c)	Rated voltage to earth (KV)		
(d)	Rated Current (Amps)		
(e)	Step Voltage (Volts)		
(f)	Number of steps		
(g)	Control-Manual/Local electrical/Remote electrical		
(h)	Line drop compensation provided/not provided.		
(i)	Parallel operation		
(j)	Protective devices		
(k)	Auxiliary supply details		
(l)	Approximate overall dimensions of tap changer		
(m)	Approximate overall weight		
(n)	Approximate mass of oil		

(o)	Details of the Digital RTCC panel for installation in the control room		
(p)	(1) Tap change delay (2) Tap change out of step (3) Tap change drive motor trip (4) Oil temperature alarm (5) Winding temperature alarm (6) Winding temperature trip (7) Cooling Pump Trip (for working and standby pump) (8) Pressure relief device acted (9) Cooler supply failure (10) OLTC buchholz alarm (11) Low oil level alarm and other details etc., for complete operation of the remote Digital RTCC Panel		
20.	Driving mechanism box 2. Make and Type 3. Details of apparatus proposed to Be housed in the box.		
21.	Weight of copper used (kg)	HV IV LV	
22	Weight of core steel used (Kg)		
23.	Quantity of transformer oil used (K.litres) (including cooling system, OLTC & conservator)		

24.	Type of gaskets used in the transformer		
25.	Overall Dimensions.		
(a)	Length (mm)		
(b)	Breadth (mm)		
(c)	Height (mm)		
26.	Expected life of transformer		

SCHEDULE OF GUARANTEED PERFORMANCE AND OTHER

TECHNICAL PARTICULARS OF ONLINE CONDITION MONITORING SYSTEM

I) Online Oil and Winding Digital Temperature Monitor

1. Manufacturer's name and country -
2. Model/Type -
3. Measurement range and Accuracy and Resolution (in ° C) -
4. IS or equivalent standard -
5. Communication ports RS 232 and RS 485 and protocols -

II) Online Capacitance and Tan Delta Monitor

1. Manufacturer's name and country -
2. Model/Type -
3. Measurement range and Resolution -
4. Operating temperature range -
5. IS or equivalent standard -
6. Communication ports RS 232 and RS 485 and protocols -

SECTION-5 TECHNICAL CHECK LIST

Technical Checklist for information to be furnished with technical offer. Return this technical checklist as a part of technical offer duly signed

BHEL ENQUIRY. NO.:
BIDDER OFFER REF.:

It is to be noted that,

- a) The technical offer shall not be considered if this technical checklist duly filled, and signed are not enclosed with this technical offer.
- b) Bidder shall ensure the completeness of their technical offer in this regard.

Sr. No.	Description	Reply by Bidder	
1	Technical Qualifying Requirements		
1.1	Documents for meeting qualifying criteria submitted with the technical offer. *The evaluation of bidder against qualifying criteria specified under clause 1.5 and 1.7/1.8(which ever is applicable) of Section-1 of technical specification shall be based on the documentary proof submitted by bidder along with the technical offer.	Confirmed	Yes
1.2	The bid shall be submitted by the Supplier/ Manufacturer only. The bidder's scope includes supply and services & supervision etc.	Confirmed	Yes
1.3	All the documents shall be submitted in English. Translated pages should be attested by the bidder. All the dimensions shall be in SI units.	Confirmed	Yes
2	Un-priced Bill of Quantities		
2.1	Confirm that all items have been quoted. Confirmation shall be done by writing "Quoted" against each item. In case, if any item has not been quoted, the same shall be confirmed by writing "Not quoted" and reasons for the same is specifically brought out in Schedule of Technical Deviation	Confirmed	Yes
2.2	The Specification envisages design, type testing, engineering, manufacture, testing, delivery at site including all materials, accessories, spares, supervision of unloading, erection, testing and commissioning of the equipment specified/ 500MVA, 765/400//33kV Auto Transformer to the satisfaction of BHEL/TANTRANSCO.	Confirmed	Yes

2.3	Any other item/ service required for the execution for the complete work is deemed to be included in the offer, whether specifically mentioned in the specification or not. List of items required for completeness of work is to be attached, if required and prices for same deemed to be included in prices of main items.	Additional Supply(s)/ Service(s) required	Yes
3	Technical Requirements		
3.1	Maximum Permissible losses for Autotransformer		
3.1.1	Max. No Load Loss at rated voltage and frequency (kW)	80kW	Yes
3.1.2	Max. Load Loss at 75°C (kW)	575kW	Yes
3.1.3	Max. Auxiliary Loss at rated voltage and frequency (kW)	14kW	Yes
3.1.4	Bidder to ensure the Autotransformer with above specified losses.	Confirmed	Yes
4	Technical Particulars		
4.1	Rated Capacity		
	(i) HV	500MVA	Yes
	(ii) IV	500MVA	Yes
	(iii) LV (Tertiary)	167 MVA ,however continuous thermal rating shall be at least of 5 MVA active loading	Yes
4.2	Voltage ratio (Line to Line)	765/√3 / 400/√3/ 33 kV	Yes
4.3	Phase Design	Single Phase	Yes
4.4	Applicable Standard	IEC 60076	Yes
4.5	Frequency	50Hz	Yes
4.6	Cooling & Percentage Rating at different cooling	ONAN/ONAF/(OFAF or ODAF) : 60% / 80%/100% OR ONAN/ONAF1/ONAF2: 60% / 80%/100%	Yes
4.7	Type of Transformer	Auto transformer	Yes
4.8	Impedance at Principal tap at between 75 Deg C		
	(i) HV-IV	14%	Yes
	(ii)HV-LV	195 %	Yes

	(ii) IV-LV	180 %	Yes
4.9	Tolerance on Impedance (HV-IV)	As per IEC	Yes
4.10	Service	Outdoor	Yes
4.11	Duty	Continuous	Yes
4.12	Overload Capacity	IEC-60076-7	Yes
4.13	Temperature rise over 50deg C ambient Temp		
	(i) Top oil measured by thermometer	40 °C	Yes
	(ii) Average winding measured by resistance method	45 °C	Yes
	(iii) of winding hot Spot	59 °C	Yes
4.14	Windings		
	(i) System Fault level		
	HV	50kA for 1s	Yes
	IV	63kA for 1s	Yes
	LV	-----	Yes
	(ii) Lightning Impulse withstand Voltage		
	HV	1950KV _p	Yes
	IV	1300KV _p	Yes
	LV	250KV _p	Yes
	Neutral	170KV _p	Yes
	(iii) Switching Impulse withstand Voltage		
	HV	1550KV _p	Yes
	LV	1050 KV _p	Yes
	(v) Neutral Grounding	Solidly grounded	Yes
	(vi) Insulation		
	HV	Graded	Yes
	IV	Graded	Yes
	LV	Uniform	Yes
	(vii) Tertiary Connection	Ungrounded Delta	Yes
	(viii) Tan delta of winding	<0.005	Yes
4.15	Vector Group (3-ph)	YNaoD11	Yes
4.16	Tap Changer	OLTC with remote control panel	Yes
	Tap Range & No. of steps	± 5.5% of HV variation in the step in 22 step	Yes
4.17	Bushing		
	(i) Rated voltage		

	HV	800kV	Yes
	IV	420kV	Yes
	LV	52kV	Yes
	Neutral	36kV	Yes
	(ii) Rated current (Min.)		
	HV	2500A	Yes
	IV	2500A	Yes
	LV	3150A	Yes
	Neutral	2500A	Yes
	(iii) Lightning Impulse withstand Voltage		
	HV	2100KV _p	Yes
	IV	1425KV _p	Yes
	LV	250KV _p	Yes
	Neutral	170KV _p	Yes
	(iv) Switching Impulse withstand Voltage		
	HV	1550KV _p	Yes
	IV	1050KV _p	Yes
	(v) One Minute Power Frequency withstand Voltage		
	HV	970KV _{rms}	Yes
	IV	695KV _{rms}	Yes
	LV	105KV _{rms}	Yes
	Neutral	77KV _{rms}	Yes
	(vi) Minimum total creepage distances		
	HV	20000mm	Yes
	IV	10500mm	Yes
	LV	1300mm	Yes
	Neutral	900mm	Yes
	(vii) Tan delta of bushings		
	HV	<0.004	Yes
	IV	<0.004	Yes
	LV	<0.004	Yes
	Neutral	--	Yes
4.18	Max Partial discharge level at 1.5 P U. /√3	100pC	Yes
4.19	Max Noise level at rated voltage and at principal tap on full load and all cooling active		
	i) ONAN noise at principal tap	Less than or equal to 75 dB	Yes
	ii) Noise on full load and all cooling active	Less than or equal to 80 dB	Yes

4.20	No external or internal Transformers / Reactors are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.	Confirmed	Yes
4.21	Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.	Confirmed	Yes
4.22	Spare relay of DRTCC to provide as per note no.15 of BOQ of section 1	Confirmed	Yes
5	Technical Deviations		
5.1	Confirm that the Complete systems have been offered as per the requirements of Technical Specification and Technical Deviation sheet has been submitted. Deviations mentioned elsewhere in the bid will not be considered.	Confirmed	Yes
5.2	Schedule of Technical Deviation is enclosed.	Confirmed	Yes
6	General Requirements		
6.1	Paint System and Procedure: Bidder to follow paint system and procure as per Clause 7.11 of Section-2B.	Confirmed	Yes
6.2	Grounding: As per Clause no.10.9 of Section 2B.	Confirmed	Yes
6.3	Cabling: Cabling including glands, lugs, ferruling between OLTC drive mechanisms Box to individual, MB/CCC, Common MB are in bidder Scope.	Confirmed	Yes
6.4	Auxiliary Supply: Terminals in marshalling box for external power supply coming into marshalling box shall be suitable to requirement.	Confirmed	Yes
7	Type Testing		Yes
7.1	Type test of main item: Bidder shall submit valid type test reports (As per relevant IEC/IS standard) for the tests carried out within last ten years from the date of opening of the tender (i.e. 30.09.2016). The reports should have been conducted on identical or similar equipment/components to those offered. In case type test reports are more than 10 years old (from the date of opening of the tender) or the reports of type tests are found to be technically unacceptable , the type test shall be conducted by the vendor without cost and delivery implication to BHEL. The type test if conducted shall be witnessed by BHEL/Customer.	Confirmed	Yes
7.2	Type Test for bought out Components Bidder are requested to furnish type test certificate for	Confirmed	Yes

	the bought out components in full shape as conforming to relevant IS/IEC standards of latest issue obtained from a Government/Government Recognized Laboratory. The above type test should have been conducted not earlier than five years (5 years) as on date of tender opening date (i.e. 30.09.2016).		
7.3	Type /Special/Routine/factory test as per Section 2A and clause no. 27,39,39.4,39.5 & 40 of Section 2B	Confirmed	Yes
7.4	In case type test reports are found to be technically unacceptable to BHEL/TANTRANSCO, the type test shall be conducted without cost and delivery implication to BHEL/TANTRANSCO.	Confirmed	Yes
8	Inspection and Testing at Works		Yes
	The Bidder shall carry out a comprehensive inspection and testing programme during manufacture of the equipment as detailed in section-2A and section 2B .	Confirmed	Yes
10	Supervision of Erection, Testing and Commissioning at Site		Yes
	The Bidder shall supervise a comprehensive erection, testing and commissioning programme at site as per Technical Specification	Confirmed	Yes
11	Information to be furnished by the Bidder		
	Information/ documents to be furnished at the TENDER STAGE shall be as per Technical Specification	Confirmed	Yes
13.	Standards		Yes
	The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the originally scheduled date of bid opening i.e.30.09.2016) of standard specified under Section-2A, 2B unless specifically mentioned in the specification.	Confirmed	Yes
14	Documents to be submitted with Technical Offer		
14.1	All documents as mentioned in Technical Specification are enclosed.	Confirmed	Yes
14.2	OGA drawings are enclosed	Confirmed	Yes

14.3	Documents for meeting Qualifying Requirements are enclosed.	Confirmed	Yes
14.4	Bidder will submit detailed bar chart/ activity schedule indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning.	Confirmed	Yes
15	Foundation bolt of ICT to be provided by Bidder	Confirmed	Yes
16	Bushing turrets CT of ICT as per Specification to be provided by Bidder	Confirmed	Yes
17	A legally enforcement undertaking by manufacturer (in case of bidder comply Technical requirement through 1.5.1) shall be furnished during contract stage for guarantee quality, timely supply, performance and supervision of erection, testing and commission of the 765kV/400kV Inter connecting transformer.	Confirmed	Yes
18	A legally enforcement undertaking by parent company / collaborator/subsidiary (in case of bidder comply Technical requirement through 1.5.2) shall be furnished during contract stage for guarantee quality, timely supply, performance and supervision of erection, testing and commission of the 765kV/400kV Inter connecting transformer.	Confirmed	Yes

Signed with Seal of Bidder

Date