BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

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TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	SK	SK	RS/DM
TITLE	765kV REACTOR AND NGR			SIGN			
				DATE	08.09.17	11/09/17	
				GROUP	TBEM	W.O. No	86009
CUSTOMER	Tamilnadu Transmission Corporation Limited (TANTRANSCO)						
PROJECTS	765/400kV AIS S/S Ariyalur						

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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS			
				Distribution	*TBMM*	*TBQM*	*TBCM*	*TBTS*
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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 PQR (Annexure-A)	
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 .....

ANNEXURE- A

TECHNICAL REQUIREMENT

Name of Project: - 765/400kV AIS S/S ARIYALUR **Name Of Item** : -**765kV Reactors**

Sr. No	Technical Requirement	Supporting documents	Reference of attached documents
1.	The manufacturer should have designed, manufactured, tested & supplied 715KV or higher voltage class one(1) number of three phase Reactor of at least 240MVAR capacity or a bank of three(3) single phase reactors ,each having a capacity of at least 80 MVAR . These Reactor(s) should have been in satisfactory operation # for more than two (2) years as on the date of award of contract (i.e. 31.03.2017).	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.	
	OR		
2.	The manufacturer should have designed, manufactured, tested & supplied 715KV or higher voltage class one(1) number of three phase Transformer of at least 500MVA capacity or a bank of three(3) single phase Transformers, each having a capacity of at least 166 MVA . These Transformers(s) should have been in satisfactory operation # for more than two (2) years as on the date of award of contract (i.e. 31.03.2017).	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. 3. PO Copy Bidder 4. Inspection/ dispatch clearance Bidder 5. LR details Bidder 6. Commissioning Report/ Handing over document	

TECHNICAL REQUIREMENT

3	**OR** These reactor(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 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. * Satisfactory operation means certificate issued by the Employer certifying the operation Without any adverse remark.	1 .Bidder to Provide Compliance/Confirmation of fulfilling Sl. No. 3 of Technical Requirement. 2. Performance certificate /Letter /MOM etc. issued by end customer for Satisfactory operation. 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 the parent company / collaborator/subsidiary company for additional Performance Guarantee of 10% of the Cost of Reactor . 8. Authorization letter from parent company Etc.	

Signed with Seal of Bidder.

Date .....

SECTION-1
SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES

1.1 SCOPE-

This specification covers design, 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 80MVAR , 765kV Reactor with on line Bushing monitoring system and NGR etc .

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.

80MVAR , 765kV Reactor 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 Reactor
Section-2B : Technical Specification of Reactor
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 Reactor and NGR

For 80MVAR , 765kV Reactor		
1.	Rated Voltage (Un)	765/√3 kV
2.	Maximum continuous operating voltage(Um)	800/√3 kV
3.	Connection (3 phase)	**Star with neutral brought out**
4.	Rated frequency	50Hz
5.	Creepage distance of HV Bushing	20000mm
6.	Creepage distance of Bushing neutral side	3625mm
7.	Cooling system	ONAN
8.	Duty	Continuous at 800kV/√3

9.	One minute power frequency withstand voltage (for HV winding)	830kVrms (ph.-Earth) for 5 min (to be tested)
10.	Max. Design Ambient Temp. (°C)	50 °C
11.	Max partial discharge level of bushing at Um	
	HV	<10 pC
	Neutral	<10 pC
12.	Max. partial discharge level	<100 pC at 1.58Ur /√3
13.	Neutral	Solidly earthed
Neutral grounding reactor (NGR)		
1.	Rated voltage from insulation strength consideration	145kV
2.	Rated frequency	50Hz
3.	Type	Dry type air core for outdoor application
4.	Cooling system	ONAN
5.	Insulation	Graded/Uniform
6.	Connection	Between neutral of reactor and ground
7.	Maximum continuous current (rms)	20A
8.	Rated short time current (rms) (60 secs.)	140A(However the NGR shall be designed for a current rating of 600A rms short time current to ensure mechanical robustness which will be verified during design review
9.	Rated impedance at rated short time and continuous current	(1) 1200 Ohms (applicable for NGR used for 765kV Thiruvulam double circuit line). (2) NGR impedance of 765kV NCPS double circuit line reactor and 765kV Bus reactor shall be provided during detailed engineering stage.
10.	Lightning impulse withstand voltage insulation level of winding	
	(1) Line side	550kVp
	(2) Ground side	550kVp
11.	One minute Power frequency withstand voltage of winding	
	Line side	275kVrms
	Ground side	275kVrms
12.	Mounting of NGR	Pedestal insulator
	Type	Porcelain/Silicon rubber
	Minimum creepage	438mm
	One minute Power frequency withstand voltage	55kVrms
	Lightning impulse withstand voltage	125kVp
13.	Method of grounding	Solidly connected between neutral of shunt reactor and earth

1.2.2 Maximum Permissible Losses for 80MVAR Reactor at Rated Voltage , frequency at 75°C will be 103kW.

Note: Bidder is required to offer the Reactor with above specified losses at rated voltage , frequency at 75°C for the reactor . In case the losses are found to be more than above specified during testing factory /site the Reactor shall be summarily rejected.

Please refer Section-2A for amendments of section 2B and Section 2B for detailed specific Technical requirements of Reactor, NGR etc.

1.3 GENERAL TECHNICAL REQUIREMENTS-

1.3.1 Paint System and Procedure

Bidder to follow paint system and procure as per **Clause 8.0 of Section-2B.**

1.3.2 Grounding / Earthing work

As per Clause no. 18 of Section 2B.

1.3.3 Cabling work

(1) All special cables mentioned below shall be in bidder scope.

(a) Between Reactor/on line monitoring system and individual marshalling box (IMB).

(b) Between individual marshalling box (IMB) and common marshalling box (CMB).

(c) Between common marshalling box (CMB) and switchyard panel room/ control room .

(2) All power, control and OFC (optical fiber cable) mentioned below shall be in bidder scope.

(a) Between Reactors /on line monitoring system and individual marshalling box (IMB).

(b) Between individual marshalling box (IMB) and common marshalling box(CMB).

(3) BHEL will supply only control cable , auxiliary power cable , armoured OFC cable between common marshalling box(CMB) and switchyard panel room/ control room only.

(4) Bidder scope cabling also includes supply of glands, lugs, ferruling etc.

1.3.4 Auxiliary Supply

3 phase Auxiliary power supply and 220V DC supply of common marshalling box(CMB) shall be provided by BHEL. Suitable Terminals in common marshalling box for external power supply shall be provided by bidder.

1.4 BILL OF QUANTITIES-

1.4.1 Quantity (Lot-1)-

Sr. No.	Description of Item	Unit	Quantity
1.	765KV, 80MVAR , single phase **bus Reactor** complete in all respect as per Specification	Nos.	6
2.	765KV, 80MVAR , single phase **line Reactor** complete in all respect as per Specification **(for 765kV NCPS double circuit line)**	Nos.	6
3.	Online tan delta Bushing monitoring system of **line /bus reactor** as per clause no. 48 of section 2B complete with PC, Communication System, Software ,Cables etc. **1Set is equal to bank of 3 nos. 765KV, 80MVAR, single phase Reactor**	Set	4
4.	145kV Neutral grounding Reactor**(NGR) air core type** , single phase alongwith **pedestal support insulator** complete in all respect as per Specification **(for 765kV NCPS double circuit line)**	Nos.	2
5.	145kV Neutral grounding Reactor**(NGR) air core type** , single phase alongwith **pedestal support insulator** complete in all respect as per Specification **(for 765kV Bus reactor)**	Nos.	2
6.	Supervision of Erection , Testing and commissioning of 765KV, 80MVAR , single phase bus/line Reactor	Nos.	12
7.	Supervision of Erection , Testing and commissioning of Online tan delta Bushing monitoring system of line /bus reactor as per clause no. 48 of section 2B complete with PC, Communication System, Software ,Cables etc. **1Set is equal to bank of 3 nos. 765KV, 80MVAR, single phase Reactor**	Set	4
8.	Supervision of Erection , Testing and commissioning of 145kV Neutral grounding Reactor(NGR) air core type single phase alongwith **pedestal support insulator**	Nos.	4
9.	Oil Sampling bottles of capacity 1Liter	Nos.	2

1.4.2 Quantity (Lot-2)-

Sr. No.	Description of Item	Unit	Quantity
1.	765KV, 80MVAR , single phase **line Reactor** complete in all respect as per Specification **(for 765kV Thiruvalam double circuit line)**	Nos.	6
2.	Online tan delta Bushing monitoring system of **line reactor** as per clause no. 48 of section 2B complete with PC, Communication System, Software ,Cables etc. **1Set is equal to bank of 3 nos. 765KV, 80MVAR, single phase Reactor**	Set	2
3.	145kV Neutral grounding Reactor**(NGR) air core type** , single phase alongwith **pedestal support insulator** complete in all respect as per Specification **(for 765kV Thiruvalam double circuit line)**	Nos.	2

4.	Supervision of Erection , Testing and commissioning of 765KV, 80MVAR , single phase line Reactor	Nos.	6
5.	Supervision of Erection , Testing and commissioning of Online tan delta Bushing monitoring system of line /bus reactor as per clause no. 48 of section 2B complete with PC, Communication System, Software ,Cables etc. **1Set is equal to bank of 3 nos. 765KV, 80MVAR, single phase Reactor**	Set	2
6.	Supervision of Erection , Testing and commissioning of 145kV Neutral grounding Reactor(NGR) air core type single phase alongwith **pedestal support insulator**	Nos.	2

Note:

1. Evaluation will be done on Lot -1 + Lot -2 quantities. Lot-1 quantities will be ordered. Lot 2 quantities will be ordered after confirmation from customer.
2. Quantity is subject to change by **±40%.**
3. Optional quantities shall be decided at contract award stage after receipt of confirmation from customer .
4. Six percent **(6 %)** 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.
5. All required foundation bolt, nut and washer of Reactor and marshalling box shall be in bidder Scope.
6. Suitable clamping devices for prevent Reactor movement shall be in scope of bidder scope.
7. Supply of ultra-high vacuum oil treatment plant is not in bidder scope.
8. Bushing turrets CT of Reactor as per specification requirement will be in bidder scope.
9. Neutral formation of Bus/Line Reactor are not in bidder scope. Necessary support insulator may be mounted on Reactor tank for neutral connection to 3" Al tube bus (Exact requirement if required shall be intimated during details engineering stage).
10. Terminal connector for bushing of Reactor, NGR, 132kV LA and neutral CT are not in bidder scope.
11. 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 Reactor.
12. Refer Section 2A for amendment of Reactor specification .
13. On line insulation oil drying system & on line DGA is not applicable for Reactor.
14. Plinth level of switchyard is 300mm above FGL.
15. Bushing CT shall be provided as per Annexure-M.
16. 1 no. single phase outdoor current transformer shall be provided for neutral earthing of each three phase bank of line and bus reactor through NGR. Supply of single phase Neutral current transformer for earthing of bus and line reactor shall be in bidder scope.

17. 132kV Surge Arrester is not in bidder scope.
18. Supply of NGR and neutral current transformer structure shall be in BHEL scope .
19. Spare unit of line /bus Reactor is not applicable for this project .
20. Online system for Reactor shall have provision for integration with SAS based on IEC 61850 communication protocol. For SAS integration purpose necessary Ethernet switch , LIU , patch cards, protocol converter etc. in common marshalling box shall be in bidder scope .
21. The insulating oil, to be used and supplied with the Reactor, shall be of EHV grade conforming to IS:335 of latest issue. No inhibitors shall be used in the oil.

1.5 TECHNICAL REQUIREMENT OF LINE /BUS REACTOR -

1.5.1 The manufacturer should have designed, manufactured, tested & supplied 715KV or higher voltage class one(1) number of three phase Reactor of at least 240MVAR capacity or a bank of three(3) single phase reactors ,each having a capacity of at least 80 MVAR . These Reactor(s) should have been in satisfactory operation # for more than two (2) years as on the date of award of contract (i.e. 31.03.2017).

OR

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

OR

These reactor(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 fittings –As per cl. No. 35 of section 2B.

1.6.3 Factory tests–As per cl. No. 34 of section 2B.

Note – Type test sl. No. 20, 21, 22, 23 and 24 as per cl. No. 34 of section 2 B shall be carried out at first unit manufactured against the PO at each manufacturing plant.

1.7 Further, a legally enforcement undertaking by manufacturer shall be furnished during contract stage for guarantee quality, timely supply, performance and supervision of erection, testing and commission of the 765kV line/bus Reactor.

1.8 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**.

1.9 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.

1.10 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.**

1.11 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.

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SHUNT REACTOR BUSHING CT DETAILS OF ARIYALUR

765kV SHUNT REACTOR (LINE SIDE, On Each Single Phase Reactor)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	300/1 A	-	300	40	1	TPS	REACTOR DIFF/REF
2	300/1 A	-	300	40	1	TPS	REF/ SPARE
3	300/1 A	-	300	40	1	TPS	REACTOR BACK-UP/SPARE
4	300/1 A	10	-	-	-	0.2, ISF ≤ 5	METERING/ SPARE

765kV SHUNT REACTOR (NEUTRAL SIDE, On Each Single Phase Reactor)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	WTI CT SUITABLE FOR THE OFFERED REACTOR						
2	3000-2000-500/1 A	-	3000-2000-500	40 at highest tap	12-8-2	TPS	DISTANCE PROTN/SPARE
3	3000-2000-500/1 A	-	3000-2000-500	40 at highest tap	12-8-2	TPS	DISTANCE PROTN/SPARE
4	300/1 A	-	300	40	1	TPS	REACTOR DIFF

REACTOR NGR NEUTRAL SIDE OUTDOOR CT

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	300/1 A	-	300	40	1	TPS	REF

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~~ Section -2B					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 reeactor.

SECTION-2A
Amendments of section 2B

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/√3/400/√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 Section -2B					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.

SL No.	ENQUIRY SPECIFICATION					Bid Specification Stipulation	Statement of clarification sought	TANTRANSCO REPLY
	Specification	Chapter / Section	Title	Page	Clause			
33	VI/Tech. Spec./Section-3/765 kV Shunt Reactor/8.0/274					Paint system and procedures	Please note that the reactor 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

section-3 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			
34	VI/Tech. Spec./Section-3/765 kV Shunt Reactor/Annexure-A, 1/329					**Reactance and loss measurement** ..... The following details shall be recorded under the heading of losses on the test certificate: ..... • the power reading; • total losses measured; ..... • corrections made to power and current results, due to non-sinusoidal wave forms of voltage and current; • The magnetization curve of the reactor.	Kindly it may be noted that as per our adopted practice loss measurement is done by Schering Bridge method. Hence power reading; measured total losses and correction made to power and current results, due to non-sinusoidal wave forms of voltage and current etc. are not applicable. This is same as Knee point voltage measurement test which is conducted separately as "Type Test". Hence it is not required. Kindly confirm.	As per specification
35	VI/Tech. Spec./Section-3/765 kV Shunt Reactor/Annexure-A, 3/330					**Two hours excitation test** • Each reactor to be excited at Um. 800 kV for 2 hours except type tested unit • Measure reactance, loss and vibration • DGA rate interpretation shall be as per IEC/ CIGRE/ IEEE guidelines	Kindly it may also be noted that as per BHEL practice we are conducting DGA before and after electrical test that will also cover the 2 Hours excitation test. Kindly confirm.	As per the specification

Section-3 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			
36	VI/Tech. Spec./Section-3/765 kV Shunt Reactor/Annexure-A, 4/330					**Temperature rise test (As per IEC-60076)** ..... Infra red images from all sides every 30 minutes with colour photographs of the same for reference. ..... The temperature rises recorded by infrared shall not be more than 10°C above top oil temperature or 15°C above the local oil temperature. ..... Top oil temperature rise test A log of the following parameters taken at 30 minute intervals:	Kindly it may be noted that because of low value of current in the reactor, temperature rise test is terminated after 24 hours and hence it is proposed to conduct the thermal scanning during the last hour, before termination of the test. Please note that the maximum allowable temperature on the tank hot is 130 deg C as per Cl. No. 7.10 page 274 of technical specification. Hence, this requirement should not be applicable. Kindly it may be noted that that mentioned parameters shall be recorded hourly as per IEC and prevalent industrial practice	As per the specification
37	General					Price Schedule	Please provide the editable copy of price schedules in excel format.	As per specification

Section-3 to be read as Section 2B

	PACKAGE NAME		765/400KV AIS SUBSTATION AT ARIYALUR	
	CLIENT		TANTRANSCO	
SL. NO.	VOLUME/SECTION	CLAUSE/DRAWING NO.	BIDDER'S QUERY	CLIENT'S REPLY
6	Section-VI ITB	Clause no.4.VII (page no 110)	As per referred clause,Transformer manufacturer with technological support of parent company can also supply for the said package.In the similar way,request you to kindly include parent company clause for 765kV reactor also, enabling the reactor manufacturer with technological support of parent company to participate.	The following is included in the technical requirement of Reactors under para(Vi): These reactor(s) should have been supplied as on the date of award of contract 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 1.1 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.
7	General		We presume that TANTRANSCO shall provide "Form C" for the supply of Steel Structures as required in Civil Schedule. Kindly confirm.	The Form-C will be issued to the contractor as per the provisions of CST Act. However split up of price may be furnished in the schedule
8	General		Type test reports for all equipments shall be submittted on award of contract.Please confirm.	Yes
9	Reactor specification		As per the reactor specification there is no fixed loss mentioned for reactor. We understand that bidders have to declare loss figures for reactor,with regard to the same request you to kindly provide the loss capitalization value for the same. Also kindly provide GTP format for Reactor.	As per latest IS/IEC. Capitalisation of loss not applicable. ~~Please refer Annexure IV~~

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
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 Dobble.	Any reputed equivalent make is acceptable

Sechin-3 to be read as Sechin-2B

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

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

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. (For Information only NOT IN SCOPE)

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

winding of singlephase spare shunt reactors can be disconnected or connected to either of the three phase banks unless approved otherwise. All material like Bus post 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.

2.Reactor Oil

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

V.SECTION 05(CURRENT TRANSFORMER):

1. Placement of secondary Core in one side in the design of CT: accepted for 765KV only provided the type test reports shall be submitted for the same design.
2. CT insulator: In respect of 765KV,Polymer insulator can also be accepted only on submission of relevant type test certificates and successful performance certificate from the end user.
3.Aluminium/copper primary winding accepted for 765KV CT only provided the type test results are submitted for the same design.

VI.SECTION 06(SURGE ARRESTORS):

1. LA insulator: In respect of 765KV,Polymer insulator can also be accepted only on submission of relevant type test certificates and successful performance certificate from the end user.

VII.SECTION 08(ISOLATORS):

1.Isolater Terminal Pads

a)As per specification for 400 KV isolators.

b)For 765KV isolators all current carrying parts shall be made from high conductivity electrolytic copper/aluminium.

2. For 800 & 420 KV AB Switches each phase shall be suitable for both manual & Electrical operation. Manual operation by individually and ganged electrically.

3.Isolater Blade/Arm: Shall be made from high conductivity electrolytic copper/ aluminium.

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	
35	Section-3, Shunt Reactor	Clause no. 48	As per cluase 48.0 ,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 Shunt Reactor.	Yes
36	General Arrangement	765/400kV SS, ARIYALUR IN KALLAKURICHI EDC and Electrical Layout	Height of 765kV Jack bus tower from bottom to peak top is specified 42.9 m , however general practice is 39 m + 6 m peak total 45 meter . Please clarify	confirmed-45 meters.

Section 3 to be read as section 2B

SECTION-2B

765 KV,80 MVAR,SINGLE PHASE SHUNT REACTOR WITH NEUTRAL GROUNDING REACTOR ANDSURGE ARRESTER

1.0 TECHNICAL SPECIFICATION FOR SHUNT REACTOR, NEUTRAL GROUNDING REACTOR AND SURGE ARRESTER

1.1 General

This specification covers design, engineering, manufacture, testing at manufacturer's works, delivery at site including all materials, accessories, spares, unloading, handling, proper storage at site, erection, testing and commissioning of the single phase 80 MVAR 765KV Reactor with nitrogen injection system for fire protection.

2.0 Type of Reactor

2.1 The shunt reactor shall be of either gapped core type or magnetically shielded air core type (shell type) construction.

2.2 The impedance ratio (X0/X1) specified shall be achieved by any one of the following methods:

a) Adopting single phase construction in separate tanks.

b) Adopting 5 limb core construction.

2.3 In case of coreless construction following requirements are stipulated.

a) A magnetic shield shall be provided around the coreless coils.

b) Non-magnetic material sheet shall form the central core to minimize the vibrations.

3.0 Transportation

The Contractor shall be responsible to select and verify the route, mode oftransportation and make all necessary arrangement with the appropriateauthorities for the transportation of the equipment. The dimension of theequipment shall be such that when packed for transportation, it will complywith the requirements of loading and clearance restrictions for the selectedroute. It shall be the responsibility of the contractor to coordinate thearrangement for

transportation of the reactor for all the stages from themanufacturer's work to site. All metal blanking plates and covers which arespecifically required totransport the reactor shall be considered part of thereactor and handed over to the Purchaser after completion of the erection.Bill of quantity and relevant drawings of these items shall also be included inthe 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/ improvementto existing road, bridges, culverts etc. shall be included in the scope of thebidder. The contractor shall carry out the route survey along with thetransporter and submit the detail proposal and methodology fortransportation of reactor for approval of Purchaser within three months fromthe date of award.

The Contractor shall despatch the reactor filled with oil or in an atmosphereof nitrogen or dry air at positive pressure. In the former case, the contractorshall take care of the weight limitation on transport and handling facility atsite. In the latter case, necessary arrangement shall be ensured by thecontractor to take care of pressure drop of nitrogen or dry air during transitand storage till completion of oil filling during erection. The total duration ofstorage at site with dry gas shall preferably be limited to three months afterwhich the reactor shall be processed and filled with oil. The nitrogen or dryair cylinder provided to maintain positive pressure can be taken back by thecontractor after oil filling. A gas pressure testing valve with necessarypressure gauge and adaptor valve shall be provided. Reactor shall also befitted with sufficient number of Electronic impact recorders (on returnablebasis) during transportation to measure the magnitude and duration of theimpact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment duringtransportation and handling shall be submitted by the contractor duringdetailed engineering. The recording shall commence in the factory beforedespatch and must continue till the unit is installed on its foundation. Thedata of electronic impact recorder(s) shall be down loaded at site and a softcopy of it shall be handed over to Engineer-in-charge. Further, within threeweeks the contractor shall communicate the interpretation of the data.

4.0 Normative references

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

This specification may contain references to older versions of IEC, but sinceall standards are subject to revision, bidder shall offer equipment based onthis Specification are required to apply the latest revision of IEC standardsWhere this Specification fails to give specific guidelines or rules, preferenceshall be given to those published by IEC or Cigre. If these are also notavailable the provisions of IEEE/NEMA shall be used.

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

Normative References

IEC 60076-6	Reactors
IEC60076	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 IEC 60050	Current transformers International Electrotechnical Vocabulary
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 Reactor 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 60296	Specification for Unused Mineral Oil for Transformers and Switchgear
IEC 60076-7	Loading Guide for Oil-Immersed Transformers
IEC 60422 IEC 60475	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 Oilfilled 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 pressurevessels
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 substrates before application of paints and related products
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
IS-2026	Part 1 to 5 Power transformer
IS-4691	Degrees of protection provided by enclosure for rotating electrical machinery
IS-325	Three phase induction motors
IS-13947 part 1 to5	Specification for low voltage switchgear and controlgear
IS:3400	Methods of test for vulcanised rubber
IS:7016 part 1 to14	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 storagetanks.
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:325 / IEC -60034	Performance of cooling fan / oil pump motor
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

5.0 Performance

5.1 Shunt Reactors will be connected to the 800 kV transmission system for reactive load compensation and shall be capable of controlling the dynamic over voltage occurring in the system due to load rejection. Typical line parameters of 800 kV and & 400kV Transmission Lines are given below:

Sl No.	Line	Positive sequence impedance ohms/km	Zero sequence impedance ohms/km	Susceptance mhos/km Positive	Zero
1.	800 kV S/C lines	0.0114+j0.295	0.233+j0.939	$3.91x10^{-6}$	$2.67x10^{-6}$
2.	800 kV D/C lines	0.0122+j0.249	0.227+j0.932	$4.63x10^{-6}$	$2.63x10^{-6}$
3.	400 kV D/C Line	0.0265+j0.309	0.263+j1.1326	$3.69x10^{-6}$	$2.17x10^{-6}$
4.	400 kV S/c line	0.0264+j0.3294	0.2015+j1.095	$3.356x10^{-6}$	$2.646x10^{-6}$

5.2 Shunt Reactors shall be capable of operating continuously at a voltage5% higher than their rated voltage and thermal and cooling system shall be designed accordingly.

5.3 The neutral grounding reactors are required for grounding of the neutral point of shunt reactors to limit the secondary arc current and the recovery voltage to a minimum value.

5.4 The reactors shall be subjected to switching surge overvoltage of1.9 p.u. and temporary over voltage of the order of 1.4 p.u. for about 10 cycles followed by power frequency overvoltage upto 830 kVrms for about five minutes. The reactor shall withstand the stress due to above transient dynamic conditions which may cause additional current flow as a resultofchanged saturation characteristics/slope beyond 1.25 p.u. voltage.

5.5 Dissolved Gas Analysis (DGA) of oil shall be periodically monitored by the Purchaser during the service of the reactor and the interpretation ofDGA 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 reactor during this period.

5.6 The reactor shall be designed to withstand the following overvoltges repeatedly without risk of failure:

1.05 Um for 10 minutes

1.25 Um for 1 minute

1.50 Um for 5 seconds

Where maximum continuous operating voltage Um = 800/√3 kV,

Nominalvoltage Un= 765/√3 kV

5.7 The magnetic circuit will be designed such that the reactor is linear upto 125% maximum operating voltage.

6.0 Design review

The reactors shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality controlto 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 reactors provided long life with least maintenance.Design reviews shall be conducted by Purchaseror an appointed consultantduring the procurement process for reactors,however the entireresponsibility of design shall be with themanufacturer.Purchaser may also visit to the manufacturers works to inspect design, manufacturing and test facilities.

6.1 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 reactor 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 reactor 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 design to take into the 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

7.0 Construction Details

The features and construction details of the reactor shall be in accordancewith the requirement stated hereunder.

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 reactors 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 beforepainting, dye penetration test shall be carried out on welded parts of jacking bosses, liftinglugs and all load bearing members.

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 preferably 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 reactor when filled with oil without structural damage to any part of the reactor. 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 reactor is loaded on the transport vehicle.

(b) A minimum of four jacking pads in accessible position to enable the reactor 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 reactor 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 reactor unit by skidding in any direction without injury when using plates or rails. Unless otherwise approved reactor base shall have a thickness not less than as specified below.

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

8.0 Paint system and procedures

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

The painting details for reactor main tank, pipes, conservator tank, radiator,control cabinet/ marshalling box / oil storage tank etc. shall be as givenbelow. The detailed painting procedure shall also be submitted along withthe bid which shall be finalized before award of the contract. The quality ofpaint should be such that its

colour does not fade during vapour phasedrying 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 (30-40•m)	Epoxy high build Micaceous iron oxide (HB MIO) (75•m)	Aliphatic polyurethane (PU) (Minimum 50•m)	Minimum 155•m	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 30•m	Glossy white for paint
Radiator (external surfaces) •	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40•m)	Epoxy base Zinc primer (30-40•m)	PU paint (Minimum 50•m)	Minimum 100•m	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes upto 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 & IS:6005	Zinc chromate primer (two coats)	-----	EPOXY paint with PU top coat	Minimum 80•m	RAL 7035 shade for exterior and interior

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

9.0 Tank Cover

9.1 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

9.2 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.

9.3 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.

9.4 Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil fromthe tank.

9.5 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.

9.6 Currents flowing in tank cover and bushing turrets

To allow for the effect of possible induced and capacitive surgecurrent, the tank cover and bushing turret shall be fixed to the reactor in such a way that good electrical contact is maintained around the perimeter of the tank and turrets.

9.7 The reactor 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 reactor for maintaining vacuum in the tank.

9.8 Gas venting

The reactor cover, and generally the internal spaces of the reactor and all pipe connections shall be designed so as to provide efficient venting of any gas in any part of the reactor 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 reactor will be mounted.

10.0 Axles and Wheels

10.1 The reactor shall be mounted on concrete plinth foundation directly.

10.2 One complete set of flanged bi-directional wheels and axles shall be provided for each sub-station. This set of wheels and axles shall besuitable for fixing to the under carriage of shunt reactor to facilitate its movement on rail track.

10.3 The rail track gauge shall be 1676 mm.

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

11.0 Foundation and Anti Earthquake Clamping Device

11.1 To prevent reactor movement during earthquake, suitable clamping devices shall be provided for fixing the reactor to the foundation.

12.0 Conservator & Oil Preservation System

12.1 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 with low oil level potential free contacts.

12.2 Conservator tank and pipe work

12.3 Conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the

reactor 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 reactor shall be able to carry the specified overload without overflowing of oil.

12.4 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.

12.5 Conservator shall be positioned so as not to obstruct any electrical connection to reactor.

12.6 An oil filling aperture of at least 65 mm diameter fitted with air tight gasketed cover shall provided on the top of each conservator. A double flange valve of preferably 50 mm size shall be provided to fully drain the oil from the main tank conservator.

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

12.8 To prevent oil filling into the air cell, the oil filling aperture shall beclearly marked.

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

12.10 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 whenthe reactor is fully installed.

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

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

12.13 The feed pipe to the reactor tank shall enter the reactor cover plate at its highest point and shall be straight for a distance not les than fivetimes its internal diameter on the reactor side of the Buchholz relay and straight for not less than three times that diameter on the conservator side of the relay

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

12.15 The feed pipe diameter for the main conservator shall be not less than 75 mm.

12.16 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 reactor side of the relay.

13.0 Oil Preservation Equipment

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

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

13.2 The temperature of oil in the conservator is likely to rise up to 100 deg C during operation. As such air cell used shall be suitable for operating continuously at least at 100 deg C.

13.3 The conservator tank and piping shall be designed for complete vacuum filling of the main tank and conservator tank. Provision shall 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.

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

13.5 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 The model of the equipment shall be submitted to Purchaser for approval during detail engineering.

14.0 Dehydrating Filter Breather

Conservator shall be fitted with a dehydrating filter breather. Connectionshall be made to a point in the oil conservator not less than 50 mm abovethe maximum working oil level by means of a pipe with a minimum diameterof 25 mm. Breathers having a mass less than 10 kg may be supported bythe connecting pipe , whereas units of 10 kg and above shall be supportedindependent of the connecting pipe.

Connecting pipes shall be securelycleated to the reactor, or other structure supplied by the contractor, in such amanner so as to eliminate undesirable vibration and noise. In the casewhere a breather of less than 10 kg is supported by the pipe, there shall be acleat 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.

Two breathers (of identical size) shall be connected in parallel by three

15.0 Pressure Relief Device

Adequate number of pressure relief devices but at least 2 numbers shall beprovided at suitable locations preferably close to bushing turret/ cover.These shall have opening diameter of at least 100 mm for rapid release ofany pressure that may be generated in the tank and which may result indamage to equipment. The device shall maintain its oil tightness under staticoil pressure equal to the static operating head of oil plus 20 kPa. The deviceshall operate and attain its full opening in not more than 2.5 ms when subjectto an internal pressure impulse equal to static operating head of oil plus 50kPa. It shall be capable of withstanding full internal vacuum at sea level. Itshall be mounted directly on the tank. One set of electrically insulatedcontacts per device shall be provided for alarm/tripping. Following routinetests shall be conducted on PRD.

a. Air pressure test

b. Liquid pressure test

c. Leakage test

d. Contact test

e. Dielectric test.

16.0 Buchholz Relay

Two numbers double float/reed type Buchholz relay shall be provided inseries in the connecting pipe between the oil conservator and the reactor tankwith at least a distance of five pipe diameters between them. Any gasevolved in the reactor shall collect in this relay. The relay shall be providedwith a test cock suitable for a flexible pipe connection for checking itsoperation and taking gas sample. A copper/stainless steel tube shall beconnected from the gas collector to a valve located about 1200 mm aboveground level to facilitate sampling with the reactor in service. Each deviceshall be provided with two electrically independent ungrounded contacts, onefor alarm on gas accumulation and the other for tripping on sudden rise ofpressure.

The use of pipe or relay aperture baffles shall not be used to decease thesensitivity of the relay. The relay shall not maloperate for through faultconditions or be influenced by the magnetic fields around the reactor duringthe external fault conditions.

17.0 Temperature Indicators

17.1 Oil Temperature Indicator (OTI)

All reactors shall be provided with a dial type thermometer of around 150mm diameter for top oil temperature indication. The thermometer shallhave adjustable, electrically independent ungrounded alarm and tripcontacts, maximum reading pointer and resetting device shall be providedin the OTI. A temperature sensing element suitably located in a pocket ontop oil shall be furnished. This shall be connected to the OTI by means ofcapillary tubing. Temperature indicator dials shall have linear gradations toclearly read at least every 2 deg C. Accuracy of OTI shall be ±3 deg C orbetter.

The setting of alarm and tripping contacts shall be adjustable at site andtypical 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 remoteindication of oil temperature:

a) Signal transmitter

Signal transmitter shall have additional facility to transmit signal for recordingoil temperature at Employer's data acquisition system, for which duplexplatinum RTD with nominal resistance of 100 ohms at zero degree centigradeshall be supplied. The RTD shall be three wire ungrounded system. Thecalibration shall be as per SAMA (USA) standard or equivalent. The RTDmay be placed in the pocket containing temperature sensing element andimage 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 panel. This shall not be repeater dial of local OTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connection betweencooler control cabinet and remote OTI control circuit, shall be in the scope ofContractor.

17.2 Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of winding shall be providedon shunt reactors. It shall comprise the following:

i) Temperature sensing element.

ii) Image coil.

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

iv) 150 mm dia (approximate) local indicating instrument with maximumreading pointer and two adjustable electrically independent,ungrounded contacts; besides that required for control of coolingequipment if any, one for high winding temperature alarm and one fortrip. Temperature indicator dials shall have linear gradations to clearlyread at least every 2degC.

v) Calibration device.

vi) Accuracy of WTI shall be ±3 deg C or better.

The setting of alarm and tripping contacts shall be adjustable at siteand 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 forremote indication of winding temperature for each reactor.

a) Signal transmitter

Signal transmitter shall have additional facility to transmit signalfor recording winding temperature at Purchaser's dataacquisition system, for which a duplex platinum RTD withnominal 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 orequivalent. The RTD may be placed in the pocket containingtemperature sensing element and image coil for WTI systemwhich will be used for both remote WTI and DAS. Necessaryequipment for sending the signal to remote WTI and DAS shallbe provided. In lieu, separate RTD for each of the functions shallbe provided.

b) Remote winding temperature indicator shall be suitable for flushmounting on Purchaser's panel. This shall not be repeater dial oflocal WTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connectionbetween marshalling box and remote WTI control circuit, shall bein the scope of Contractor. Drawing showing the mountingdetails of RWTI shall be submitted to the Purchaser within twomonths from the date of award of the contract.

17.3 Optical sensors

Adequate no of optical temperature sensors of at least 16 numbers with theunit which is to be type tested and at least 8 numbers with each other unitsshall be fitted. This optical sensors measuring system shall be of directmeasurement non calibrating type. All the sensors shall be brought out toindividual Marshalling box to facilitate measurement of temperature duringservice life.

A temperature measuring system having at least 16 channels shall bemounted on one individual Marshalling box for each substation (preferablytype tested unit) to measure the temperature from the optical sensors. In allindividual marshalling boxes of other units provision shall be kept to connectthe same measuring unit in future.

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

Location of optical temperature sensors inside the reactor shall be decidedduring design review.

18.0 Earthing Terminals

18.1 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.

18.2 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.

19.0 Core

Magnetic Circuit

19.1 The leg magnetic packets (cheeses) shall be made from state of the art low loss electrical steel.

19.2 The "Cheeses" shall be designed to minimize losses and equalize the distribution of flux in the legs.

19.3 The "cheeses" shall be bonded using high temperature epoxy resins to assure that they will remain bonded in service at the maximum temperatures that will occur in the magnetic circuit and for the full expected life. Vacuum impregnation is preferred.

The contractor shall present data on the characteristics of the packets at the time of design review.

19.4 Material with high temperature withstand capability material such as ceramic/ slate spacers shall be used to separate the packets. High temperature, mechanically stable material shall be used between the end packets and the top and bottom yokes. Special care shall betaken not to impede the cooling in these areas.

19.5 Means shall be provided to distribute the flux from the "cheeses" and the windings to the top and bottom yokes to prevent concentrations of flux with resulting high temperatures in the yokes.

19.6 The yokes shall be designed such that high temperatures resulting from unequal distribution of the flux in the yokes will not occur.

19.7 The spaces between "cheeses" will be designed so that high temperatures will not result due to fringing of flux at the oil gaps between them. The designer shall calculate the temperatures resulting from fringing.

Internal structural design

19.8 The structural design shall be made so that pressure will be maintained to prevent loosening resulting from thermal expansion and contraction during all loading cycles.

19.9 The design shall be made in such a way that excessive vibration does not occur in the windings, structural supports of the windings and magnetic circuit and this will be subjected to design review.

19.10 The structure shall be designed to withstand the clamping and magnetic forces. The calculated magnetic forces will be furnished at the time of design review.

Calculation of hot spots

19.11 The winding hot spots shall be calculated using the maximum localized losses, insulation thickness at the maximum loss positions, and the oil flow patterns in the winding. The oil temperature rise in the windings shall be used to determine hot spots rather than the bulk top oil temperature.

19.12 The hot spot temperatures and surface temperatures in the magnetic circuit shall be calculated. The maximum allowed hot spot temperature will be 125 deg C. The maximum allowed surface temperature will be 120 deg C.

19.13 The hot spot for all leads shall be calculated and it shall not exceed the calculated hot spot of the windings.

19.14 The hot spot in the windings and magnetic circuit shall be calculated for the over voltage conditions specified.

19.15 Core and supporting structure temperatures

19.16 Under normal operation, the temperature of any part of the core or its support structure in contact with oil shall not exceed 120 deg C.

19.17 The temperature of these parts shall not exceed 130 deg C under the most extreme operating circumstances.

19.18 Also, the most onerous temperature of any part of the core and its supporting structure in contact with insulation or non-metal material shall not exceed the safe operating temperature of that material.

19.19 Adequate temperature margins shall be provided to maintain long life expectancy of these materials.

19.20 Earthing of core and clamping structure

19.21 If grounding of the core cheeses are required a separate strap shall be brought to a terminal located in a waterproof enclosure on the tank. Separate ground leads will be routed from the top and bottom yokes to separate terminals in the enclosure.

19.22 The core shall be earthed to the core clamping structure at one point only, through a removable external link suitably located and protected to facilitate testing after installation of the reactor. 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.

19.23 Unless otherwise approved, no core earthing connection shall be of minimum size of 80 sq.mm copper with exception of the connections inserted between laminations which may be reduced to a cross-sectional area of 20 sq.mm tinned copper where they are clamped between the laminations.

19.24 Where the core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the laminations, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

A drawing showing the details of the earthing design and connection shall be furnished as part of the manual.

20.0 Windings

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

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

20.3 The insulation of reactor 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 reactor oil during service.

20.4 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.

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

20.6 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalize the distribution of currents and temperature along the winding.

20.7 The windings shall be designed to withstand the dielectric tests specified .The type of wingding used shall be of time tested and in successful operation for atleast 5 year in 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 systemwill not always be in the new factory condition.

20.8 The barrier insulation including spacers will 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.

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

20.10 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.

20.11 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.

Bracing of windings

20.12 All winding insulation shall be processed to ensure that there will be nodetrimental shrinkage after assembly. All windings shall be pre-sized before being clamped.

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

20.14 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.

20.15 Full details of the winding clamping arrangements, and their adjustment in or out of the tank together with relevant drawings and values, shall be submitted for evaluation and approval and shall form part of the instruction manual.

Current carrying connections

20.16The design of all connections shall be subjected to Design Review.

20.17The mating faces of bolted connections shall be appropriately finished and prepared for achieving good long lasting, electrically stable and effectivecontacts.

20.18All lugs for crimping shall be of the correct size for the conductors.

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

Winding terminations into bushings

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

20.21 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.

20.22 Allowances shall be made on the winding ends for accommodatingtolerances 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.

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

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

21.0 Unused inhibited Insulating oil :

21.1 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 / reactor and only thereafter be brought up to the specified parameter by circulation within the transformer/reactor.

Sl. No.	**Property**	**Test Method**	**Limits**
A1.	**Function**		
1a.	Viscosity at 100degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.) 3 mm2/s
1b.	Viscosity at 40degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)12 mm2/s
1c.	Viscosity at -30degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)1800 mm2/s
2.	Appearance	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent and free from suspended matter or sediment
3.	Pour point	ISO 3016 or ASTM D97	(Max.)- 40degC
4.	Water content a) for bulk supply b) for delivery in drums	IEC 60814 or ASTM D1533	(Max.) 30 mg/kg 40 mg/kg
5.	Electric strength (breakdown voltage)	IEC 60156 or ASTM D1298	(Min.) 50 kV(new unfiltered oil) / 70 kV (after treatment)
6.	Density at 20 deg C	ISO 3675 or ISO12185 or ASTM D 4052	0.820 - 0.895 g/ml
7.	Dielectric dissipation factor (tan delta) at 90 deg C	IEC 60247 or IEC 61620 Or ASTM D924	(Max) 0.0025
8.	Resistivity at 90 deg C	IEC 60247	150 X 10 12 Ohm –cm, (Min.)

9.	Negative impulse testing KVp @ 25 deg C	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 at27degC	ISO 6295 or ASTM D971	(Min) 0.04 N/m
3.	Total sulfur 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 90degC	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 2 mg/kg)

21.2 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 X 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: 500hour for inhibited oil)
   a) Acidity : 0.3 (mg KOH /g) (max.)
   b) Sludge : 0.05 % (max.)
   c) Tan delta at 90 °C : 0.05 (max.)
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 purchaser.

21.3 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 21.2 ii) above. The oil test results shall form part 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. For ONAN/ONAF cooled transformers / reactors, sample shall not be taken earlier than 2 hours after shut down.

The acceptance norms with reference to various gas generation rates shall beas per IEC 61181.

21.4 **Particles in the oil**

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

21.5 **Moisture content in the solid insulation**

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

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

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

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

Before application of vacuum and oil filling in the reactor, it will beensured that moisture content in the dummy insulation test block is less than0.5%.

Oil filling

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

21.7 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 reactor tank and should be less than 1mbar.

21.8 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 reactor 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 reactor. For this purpose the reactor shall first be drained to expose all insulation material.

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

21.10 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 reactor 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 a adjustable range from 40·C to 80·C

22.0 **Terminal Arrangements**

Bushings

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

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

Bushing for voltage of 145 kV shall be of the hermetically sealed Oil filled condenser type/ RIP bushing with porcelain or composite insulator.

22.3 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.

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

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

22.6 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.

22.7 Clamps and fittings shall be of hot dip galvanised steel or of stainless steel.

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

22.9 No arcing horns shall be provided on the bushings.

22.10 Bushings shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout and movement

alongwith the spare reactor with bushing erected and provided with proper support from one foundation to another foundation within the substation area.

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

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

Terminal Marking

22.13The terminal marking and their physical position shall be as per IEC: 60076.

Neutral Earthing Arrangement NOTE IN SCOPE, FOR INFORMATION ONLY)

22.14 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.

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

22.16 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. The connection shall be made by using two (2) bolted neutral grounding terminals with necessary accessories.

23.0 Cooling Equipment

23.1 Oil immersed with natural cooling (ONAN)

23.2 The radiator bank of the shunt reactor shall be either tank mounted or separately mounted based on manufacturer's standard practice. Forneutral grounding reactor, the radiator, if required, may be tank mounted.

23.3 Radiators shall be made from pressed steel.

23.4 Each radiator bank shall be provided with the following accessories:

(a) Top and bottom shut off valve

(b) Drain Valve and sampling valve

(c) Air release plug

(d) Two grounding terminals for termination of two (2) Nos. 75x12 mm galvanised steel flats.

(e) Thermometer pockets with captive screw caps at cooler inlet and outlet.

(f) Lifting lugs

23.5 Each radiator bank shall be detachable and shall be provided with flanged inlet and outlet branches.

23.6 Expansion joint, if required, shall be provided on top and bottom cooler pipe connection.

Valves

23.7 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.

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

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

23.10 All valves flanges shall have machined faces.

23.11 All valves in oil line shall be suitable for continuous operation withinsulating oil at 115 deg C.

23.12 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 rubberhose of 10 mm size to facilitate oil sampling.

23.13 Valves or other suitable means shall be provided to fix the on line condition monitoring system to facilitate continuous monitoring. The location & size of the same shall be finalised during detail engineeringstage.

23.14 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.

23.15 All valves shall be painted with a shade (preferably red or yellow distinct and different from of main tank surface and as per thepainting system)

23.16All hardware used shall be cadmium plated/electro galvanised.

24.0 Marshalling Box

24.1 A sheet steel marshalling box of a suitable construction shall be provided for the reactor ancillary apparatus and this shall be vermin, dust &weather proof. All the terminals for remote indication shall be wired upto the marshalling box from the reactor accessories. Necessary shorting of CTsecondary terminals shall be done at the marshalling box.

24.2 The sheet steel used shall be at least 2.5mm thick hot rolled or 2mm thick cold rolled. The degree of protection shall be IP-55 in accordance with IS:13947. The marshalling box shall be free standing floor mounted type or tank mounted type. In case of tank mounted type suitable antivibration pad shall be provided so that vibration from tank is not transferred to the marshalling box. The marshalling box shall have domed or sloping roof. It shall have double hinged doors and shall be provided with padlock and padlocking arrangement. The exterior and interior painting shall be in accordance with painting clause.

24.3 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 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 ifnecessary 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 arrange.

24.4 The marshalling box shall accommodate the following:

(a) Temperature indicator for winding and oil,

(b) Terminal blocks and gland plates for incoming and outgoing cables.

24.5 The temperature indicator shall be so mounted that the dials are about 1200 mm above ground level. Glass doors of suitable size shall be provided for convenience of reading. A space heater and cubicle lighting with ON-OFF switch shall be provided. It shall be so designed that with the space heater switched on

continuously, the temperature inside the marshalling box does not exceed the safe operating limits at the service conditions.

25.0 Fittings

25.1 The following fittings shall be provided with each shunt reactor and (if applicable) for neutral grounding reactor covered under this specification.

25.2 Conservator for reactor main tank with filling hole and cap, drain valve, isolating valve, vent pipe and magnetic oil level gauge/ prismatic oillevel gauge with low level alarm contacts.

25.3 Air release devices.

25.4 Dehydrating breather complete with first fill of activated silicagel.

25.5 Inspection openings and covers.

25.6 Rating & diagram plate for reactors and current transformers. These plates shall be of material capable of withstanding continuous outdoor service.

25.7 Terminal marking plate conforming to IEC-60076-6.

25.8 Two earthing terminals each on shunt reactor tank, radiators & marshalling box, SA structures etc.

25.9 Suitable neutral bus connection.

25.10 Double float/reed type Buchholz relay with alarm and trip contacts.

25.11 Bottom oil sampling valve and drain valves.

25.12 Filter valves at top and bottom.

25.13 Shut off valves on the pipe connection between radiator bank and reactor tank.

25.14 Shut off valves on both sides of Buchholz relay at accessible height.

25.15 Sampling gas collectors for Buchholz relay at accessible height.

25.16 Minimum four jacking pads.

25.17 Lifting lugs or eyes for the cover.

25.18 Suitable terminal connectors on bushings and surge arrester.

25.19Individual Marshalling box and common marshalling box for a bank ofthree 1-Phase unitsCommon marshalling box for a bank of three single phase unit :

All the circuit connections from individual marshalling box of three single phase unit (and spare unit, if applicable) of a bank to purchasers Control panels

shall be routed through common marshalling box. Common marshalling box shall have following arrangement:

a) In case of connection arrangement for spare unit is in such a way that spare unit of reactor 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 in common marshalling box of all the banks. Necessary arrangement in schematic of Common marshalling box is required to facilitate changeover of all the signals of faulty units to spare unit of reactor, to ensure flow of control, protection and indication signals between purchasers Control panels and individual units under operation(i.e any designated unit for bank or spare unit, if it replace any designated unit)

b) In case of connection of spare unit in place of faulty unit, require physical displacement of faulty unit and spare unit then common marshalling box shall be used only for routing all the control, protection and indication circuit connections form individual marshalling box of three single phase unit of a bank to purchasers Control panels. .In such case, control, protection and indication signals of spare unit are not required in common marshalling box.

25.20 Haulage lugs.

25.21 Bushing CT

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

X 25.23 On line insulating oil drying system.

X 25.24 On line dissolved hydrogen gas and moisture monitor.

25.25 Flow sensitive conservator Isolation valve for Fire Control in 765 kV class Reactors

a) In order to restrict the supply of oil in case of a fire in reactor, provision shall be made to isolate the conservator oil from the main tank.

b) 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 valve shall be located in the piping between the conservator and the buchholz relay and shall not affect the flow of oil from and to the conservator in normal conditions.

X see amendment sechin 2A

c) 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.

25.26 The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of the reactors aredeemed to be included.

26.0 Inspection and Testing

The Contractor shall carry out a comprehensive inspection and testingprogramme during manufacture of the equipment. An indication of inspection envisaged by the Purchaser is given under 6.28 below. Thisis however not intended to form a comprehensive programme as it isContractor's responsibility to draw up and carry out such a programme inthe form of detailed quality plan duly approved by Purchaser for necessaryimplementation.

26.1Inspection

26.1.1Tank and Conservator

26.1.2 Certification of chemical analysis and material tests of plates.

26.1.3 Checks for flatness

26.1.4 Electrical interconnection of top and bottom tank by braided tin flexible.

26.1.5 Welder's qualification and weld procedure.

26.1.6 Testing of electrodes for quality of base materials.

26.1.7 Inspection of major weld preparation.

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

26.1.9 Measurement of film thickness of

(a) Oil insoluble varnish

(b) Zinc chromate paint

(c) Light grey paint

26.1.10 Check correct dimensions between wheels, demonstrate turning of wheels through 900 and further dimensional check.

26.1.11 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 test (NDT).

26.1.12 Leakage test of conservator.

26.1.13 Certification of all test results.

27.0 Core

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

27.2 Check on the quality of varnish if used on the stampings.

(a) Measurement of thickness and hardness of varnish on stampings.

(b) Solvent resistance test to check that varnish does not react in hot oil.

(c) Check over all quality of varnish on stamping, ensure uniform shining colour, no bare spots, no over burnt varnish layer and no bubbles on varnished surface.

27.3 Check on the amount of burrs.

27.4 Bow check on stampings.

27.5 Check for the overlapping stampings. Corners of the sheets are to be apart.

27.6 Visual and dimensional check during assembly stage.

27.7 Check for interlaminar insulation between core sections after pressing.

27.8 Visual and dimensional check for straightness and roundness of core.

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

27.10 Check of pressure during dimensional stabilisation of winding/core assembly.

27.11 Certification of all test results.

28.0 Insulation Material

28.1 Sample check for physical properties of material.

28.2 Check for dielectric strength.

28.3 Visual and dimensional checks.

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

28.5 Dimensions stability test at high temperature for insulating material.

28.6 Tracking resistance test on insulating material.

28.7 Certification of all test results.

29.0 Winding

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

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

29.3 Sample check on insulating paper for pH value, electric strength.

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

29.5 Check for the bonding of the insulating paper on conductor.

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

29.7 Check for absence of short circuit between parallel strands.

29.8 Check for brazed joints wherever applicable.

29.9 Measurement of impedance by low voltage to be carried out when core/yoke is completely restacked and all connections are ready.

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

29.11 Conductor flexibility test.

29.12 Heat shrink test for enamelled wire.

29.13 Certification of all test results.

30.0 Checks before drying process

30.1 Check conditions of insulation on the conductor and between the windings.

30.2 Check insulation distance between high voltage connection cables and earth and other live parts.

30.3 Check insulation distance between low voltage connections and earth and other parts.

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

30.5 Check for proper cleanliness and absence of dust etc.

30.6 Certification of all test results.

31.0 Checks during drying process

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

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

31.3 Certification of all test results.

32.0 Assembled Reactor

32.1 Check completed reactor against approved out line drawing provision for all fittings, finish level etc.

32.2 Jacking test on all the assembled reactors.

32.3 Dye penetration test shall be carried out after Jacking tests.

33.0 Bought Out Items

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

33.1 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.

(a) Buchholz relay

(b) Axles and wheels/Trolley for transportation.

(c) Winding temperature indicators for local and remote mounting

(d) Oil temperature indicators

(e) Bushings

(f) Bushing current transformer

(g) Individual Marshalling box and common marshalling box for a bank of three 1-Phase units

(h) Radiators

(i) Pressure relief device

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

34.0 Factory Tests

The manufacturer shall be fully equipped to perform all the required tests as specified. Bidder shall confirm the capabilities of the proposed manufacturing plantin 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 possibleto carry out at his own works.

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

All tests shall be done in line with IEC: 60076 and the test procedures as mentioned in "Annexure-A". Complete test report shall be submitted to purchaserafter proper scrutiny and signing on each page by the test engineer of thecontractor.

	Test on Shunt Reactor	
No	Item	Test Category
1	Measurement of winding resistance	Routine
2	Reactance and loss measurement (Measured in Cold and Hot state for the unit on which temperature rise test is performed & in Cold state for all otherunits)	Routine
3	Measurement of insulation resistance & Polarization Index	Routine
4	Measurement of insulation power factor and capacitance betweenwinding and earth	Routine
5	Lightning impulse test	Routine
6	Switching impulse test	Routine
7	Separate source voltage withstand test	Routine
8	Induced over voltage test with Partial Discharge measurement	Routine
9	Gas-in-oil analysis Routine	Routine
10	Oil leakage test on Reactor tank	Routine
11	Appearance, construction and dimension check	Routine
12	Frequency Response analysis (Soft copy of test report to be submitted to site along with test reports)	Routine
13	High voltage with stand test on auxiliary equipment and wiringafter assembly	Routine

14	2-Hour excitation test	Routine
15	Tank vacuum test	Routine
16	Tank pressure test	Routine
17	Vibration & stress measurement	Routine
18	Core assembly dielectric and earthing continuity test	Routine
19	Lightning impulse test on Neutral	Routine
20	Temperature rise test	* Type
21	Measurement of harmonic content of current (Measured in Coldstate)	* Type
22	Measurement of acoustic noise level (Measured in Cold and Hotstate of temperature rise test)	* Type
23	Knee point voltage measurement of reactor (Measured in Cold state)	* Type
24	Measurement of zero-sequence reactance (For three phaseshunt reactor only)	* Type

Tests on NGR (Air core type)

No.	Item	Test Category
1	Measurement of winding resistance	Routine
2	Measurement of impedance by V/I	Routine
3	Measurement of insulation resistance & Polarization Index	Routine
4	Lightning impulse test Routine	Routine
5	Separate source voltage withstand test	Routine
6	Isolation Test Routine	Routine
7	Appearance, construction and dimension check	Routine

8	High voltage with stand test on auxiliary equipment and wiringafter assembly	Routine

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

35.0 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 ~~as per the Clause no. 2.9.2 of Section – GTR.~~ The list of fittings and the type test requirement is:

1. Bushing (Type Test as per IEC:60137 including snap back/seismic test for 400kV and above voltage class bushing)
2. Buchholz relay
3. Marshalling box and common marshalling box (IP-55 test)
4. Pressure Relief device Test
5. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.
6. Air Cell (Flexible air separator).
7. OTI & WTI
8. Terminal connectors
9. Bus post insulators
10. Disc insulator and hardware
11. Conductor(s)

36.0 Pre-Shipment Checks at Manufacturer's Works

36.1 Check for interchangeability of components of similar reactors for mounting dimensions.

36.2 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, marshalling kiosk, connecting pipes, conservator etc.

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

36.4 Gas tightness test to confirm tightness.

36.5 Derivation of leakage rate and ensure the adequate reserve gas capacity.

37.0 Inspection and Testing at Site

The Contractor shall carry out a detailed inspection and testing programmefor field activities, namely covering areas right from the receipt of materialstage up to commissioning stage. It is Contractor's responsibility to draw upand carry out such a programme duly approved by the Purchaser. Testingof oil sample at site shall be carried out ~~as per Cl.4.3.4 above~~.

38.0 Receipt and Storage Checks

38.1 Check and record condition of each package, visible part of the reactors etc. for any damage

38.2 Check and record the gas pressure in the reactor tank as well as in the cylinder.

38.3 Visual check for wedging of core and coils before filling up with oil and also check for condition of core and winding in general.

38.4 Check and record reading of impact recorders at receipt and verify the allowable limits as per manufacturer's recommendation.

39.0 Installation Checks

39.1 Check the whole assembly for tightness, general appearance etc.

39.2 Oil leakage test

39.3 Leakage check on bushing before erection.

39.4 Measurement of capacitance and tan delta of the bushings before Fixing/connecting to the reactor. Contractor shall furnish these values for site reference.

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

40.0 Commissioning Checks

40.1 Check the colour of silicagel breather.

40.2 Check the oil level in the breather housing, conservator tank, cooling system, condenser bushing etc.

40.3 Check the bushings for conformity of connection to the line etc.

40.4 Check for correct operation of all protection devices and alarms.

(a) Buchholz relay

(b) Excessive winding temperature

(c) Excessive oil temperature

(d) Low oil flow

(e) Low oil level indication

40.5 Check for adequate protection of electric circuit supplying the accessories.

40.6 Insulation resistance measurement for :

(a) Control wiring

(b) Main winding

(c) Bushing current transformer

40.7 Two kV/minute test between bushing CT terminal and earth.

40.8 Check for cleanliness of the reactor and the surrounding.

40.9 Measure vibration and noise level

40.10 DGA of oil sample just before commissioning and after 24 hours of commissioning.

40.11 Capacitance and tan delta measurement of winding & bushing.

40.12 Frequency Response Analysis (FRA). FRA equipment shall be arranged by purchaser.

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

41.0 FIRE PREVENTION SYSTEM BY INJECTING NITROGEN GAS (NOT IN SCOPE. FOR INFORMATION AND INTERFACE ONLY)

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

41.2 Technical specification

41.2.1. 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).

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

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

41.2.4. 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.

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

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

41.2.7. 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.

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

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

41.2.10. 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.

41.2.11. 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.

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

41.2.13 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.

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

41.3.0. 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.

41.4.0. 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.

41.5.0. 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 insulting 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.

41.6.0 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.

41.7.0. 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.

41.7.1 Auto Mode:

The system should activate upon reception of the following signals.

a) For prevention of Fire :
1) Differential Relay Operation
2) Pressure Relief valve or RPRR (Rapid Pressure Release Relay)
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).

41.7.2. 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.

41.8.0. Cabinet:

It shall be made of 3 mm thick steel frame, painted darn 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 sesmic mechanical protection
- All electrical cables inside panel must be routed and channelled with cover.

41.9.0. 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

41.10. 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.

41.11. 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 V 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
- Deferential relay trip
- PRV/RPRR trip
- Transformer trip
- System Out of service
- Auto/Manual/ Off
- lamp test
- Visual / Audio Alarm

41.12. 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.

41.13. 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/141C 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.

41.14. Signal Box

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

41.15. 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.

41.16. Pipes

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

41.17. 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.

41.18. 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) set of hose pipes with fittings.
c)25 meters. Of linear heat detector/ 6nos. fire detectors

41.19 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.

41.20. Technical Particulars

Fire Extinction Period

On commencement of Nitrogen Injection : Maximum 30 seconds

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

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

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

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

Capacity of Nitrogen Cylinder : 10 m^3 gas at pressure of 150 kg/cm^2 up to 60000 litres oil capacity of transformer tank and 20 m^3 gas at pressure of 150 kg/cm^2 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-B

42.0TERMINAL CONNECTORS

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.

43.0 Technical Parameters

43.1 The parameters pertaining to the shunt reactor and neutral grounding Reactor furnished under this specification are listed below:

43.2 Shunt Reactor 80 MVAR single phase at $765/\sqrt{3}$ kV

43.3 a) Rated Voltage (Un) $765/\sqrt{3}$ kV

b) Maximum continuous operating voltage(Um) $800/\sqrt{3}$ kV

43.4 Connection (3 phase) Star with neutral brought out

43.5 Insulation level (for winding)	
(a) Lightning impulse withstand voltage	1950 kVp
(b) Switching surge impulse withstand voltage.	1550 kVp
(c) Tan delta of winding Less than Corrected at 20deg C	0.005
(d) one minute power frequency withstand voltage = 630kV rms (Ph-earth) for 5 minute (To be Tested)	
43.6 Maximum admissible temp. rise over an ambient temp. of 50°C and at 800/√3 kV :	
(a) of top oil measured by thermometer	40 deg C
(b) of average winding measured by resistance method	45 deg C
(c) of winding hot spot	59 deg C
43.7 Cooling System Natural Oil circulation (ONAN)	
43.8 Insulation level of neutral	
(a) Impulse withstand voltage	550 kVp
(b) Power frequency voltage	230 kV (rms)
(c) Whether neutral is to be brought out	Yes (through 145kV class bushing)
43.9 Ratio of zero sequence reactance to positive reactance (X0/X1)	Between 0.9 & 1.0.
43.10 Range of constant impedance bidder shall furnish complete saturation characteristics of the Reactors up to 1.5 p.u. Voltage)	Up to 1.25 p.u. voltage (the
43.11 Tolerance on current phase unit	i) 0 to +5% for a single
ii) +1% for between units	

43.12 Harmonic content in phase	The crest value of the third harmonic component inphase current not to exceed 3%of the crest value of fundamental when reactor is energised at rated voltage with sinusoidal wave form.	
43.13 Permissible current unbal ance among different phases.	± 1%	
43.14 Noise level at 800/√3 kV and rated frequency	80 dBA	
43.15 Bushing	Line side	Neutral side
(a) Rated voltage	800 kV	145 kV
(b) Creepage distance (total)	20000 mm	3625 mm
(c) Lightning impulse withstand voltage (kVp)	2100	650
(d) Switching impulse withstand voltage (kVp)	1550	-
(e) One minute power frequency withstand voltage (kVrms)	970	305
(f) Rated current (A) (Min.)	2500	1250
(g) Tan delta of bushings Corrected at 20deg C	..... Less than 0.004	
43.16 Vibration and stress level at 800/√3 kV	The maximum vibration amplitude in any panel shall not exceed 200 microns peak to peak at rated voltage and frequency. Average vibrations shall not exceed 60 microns peak to peak. Tank stresses shall not exceed 2.0kg/sq.mm at any point on the tank. The measurements are to be made	

	at Um.
43.17 Maximum partial discharge level at 1.5 pu	100pC

44.0 Neutral Grounding Reactor

44.1 Rated voltage from insulation strength considerations	145kV
44.2 Rated frequency	50Hz
44.3 No. of phases	One
44.4 Type application	Dry type air core for outdoor
44.5 Insulation	Graded/uniform
44.6 Max. continuous current (rms)	20 A
44.7 Rated short time current (rms) (60secs.)	240A(however the NGR shall be designed for a current rating of 600 Amp rms short time current to ensure mechanical robustness)
44.8 Rated impedance at rated short time and continuous current	As per project system studies
44.9 Connection Between neutral of reactor and ground	shunt

44.10 Insulation level for winding	Line side	Ground side
(i) Lighting impulse withstand voltage (kVp)	550	95
(ii) One minute power frequency withstand voltage (kVrms)	230	38

44.11 Method of grounding	Solidly connected between neutral of shunt reactor and earth.
44.12 Mounting of NGR	
(i) Pedestal insulator	
a) Type	Porcelain/ Silicon rubber

b) Minimum Creepage 438 mm

c) 1 min. Power frequency withstand voltage 55 kV rms

(d) Lighting impulse withstand voltage (kVp) 125 kVp

(ii) Mounting structure Non magnetic material

Note: The reactor shall be mounted high above ground level to allow free and safe access at ground level for personnel.

45.0 Current Transformer

45.1 Bushing Current Transformer

45.2 Current transformers shall comply with IEC-60044.

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

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

45.6 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.

45.7Technical Parameters

45.8 Current Transformer Parameter for 765kV Shunt Reactor

		Shunt Reactor (on each phase connection)	
		Line Side	Neutral side
45.9 Ratio	Core 1	300/1A	to be decided by contractor for WTI
	Core 2	300/1A	3000-2000-500/1A

Core 3	300/1A	3000- 2000- 500/1A
Core 4	300/1A	300/1A
45.10 Minimum knee point voltage or burden and accuracy class		
Core 1	300V	suitable for WTI
Class	PS	
Core 2	300V	3000 V
Class Class	PS PS	
Core 3	300V	3000 V
	Class	Class
	PS	PS
Core 4	10VA	300 V
	Class	Class
	1.0	PS
45.11 Maximum CT Resistance		
Core 1	1 ohm	--
Core 2	1 ohm	12-8-2 ohm
Core 3	1 ohm	12-8-2 ohm
Core 4	--	1 ohm
45.12 Application		
Core 1	Reactor Winding	Temperature
	Differential	Indicator
Core 2	Restric-	Line
	ited Earth	Protection
	Fault	(Main-I)/
		Tzone
		differential

		Protn./spare
Core 3	Reactor Backup	Line Protection (Main-I)/ Tzone differential Protn./spare
Core 4	Metering	Reactor Differential Protection.

46.0 Neutral Current Transformer (IN BIDDER SLOPE), OUTDOOR

46.1 Current transformers shall comply with IEC 60044-1.

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

46.3 Technical Parameters

Common Neutral Side (for each three phase bank)

(a) Ratio :	300/1 A
(b) Minimum knee point voltage :	300 V
(c) Accuracy class :	PS
(d) Maximum CT Resistance :	1.2 Ohms
(e) Application :	Earth fault protection
(f) Maximum magnetization current (at knee point voltage) :	60 mA

46.4 Note :

a) The secondary excitation current of class PS shall not be more than 4 % of rated secondary current at 25% of knee point voltage.

b) Accuracy class PS as per IEC.

c) Class (for the relevant protection and duties) as per IEC 60044-1

47.0 SURGE ARRESTER – (NOT IN SCOPE)

47.1 General

The surge arresters shall conform in general to IEC-60099-4 except to the extent explicitly modified in the specification.

47.2 The bidder shall offer surge arresters of gapless type without any series or shunt gap.

47.3 Arresters shall be hermetically sealed units, of self supporting construction, suitable for mounting on structures.

47.4 Duty Requirements

47.5 The surge arresters shall be of heavy duty station class type. It shall be physically located between the neutral of 765kV shunt reactor (brought out at 145kV class bushing) and neutral grounding reactor and shall be electrically in parallel with the latter.

47.6 The surge arresters shall be capable of discharging over voltage occurring during switching of unloaded transformers and reactors.

47.7 The surge arresters shall be able to withstand wind load.

47.8 The gapless arrester, if provided, shall meet following additional requirements.

47.9 It shall be fully stabilized thermally to give a life expectancy of 100 years under site conditions and shall take care of the effect of direct solar radiation.

47.10 The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

47.11 Constructional Features

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

47.12 Gapless Type Surge Arrester

47.13 The non linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent electrical and mechanical properties even after repeated operations.

47.14 The surge arresters shall be fitted with pressure relief devices and arc diverting parts suitable for preventing shattering of porcelain housing and providing path for flow of rated fault currents in the event of arrester failure.

47.15 The arresters shall incorporate anti-contamination feature to prevent arrester failure consequent to uneven voltage gradient across the stack in the event of contamination of the arrester porcelain.

47.16 Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

47.17 Outer insulator shall be porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfection that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impressions to moisture. Glazing of porcelain shall be of uniform brown colour, free from blisters, burrs and other similar defects.. Porcelain housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester.

47.18 The end fittings shall be made of non-magnetic and corrosion proof material.

47.19 The name plate shall conform to the requirement of IEC incorporating the year of manufacture.

47.20 The arrester shall be supplied with suitable support structure either of tubular GI pipe or lattice steel galvanised.

47.21 The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer formed across each block to be furnished. Metallised coating thickness for reduced resistance between adjacent discs to be furnished alongwith procedure for checking the same. Details of thermal stability test for uniform current distribution of current on individual disc to be furnished.

47.22 Fittings and Accessories

47.23 Each arrester shall be complete with insulating base, support structure and terminal connector. The height of the support structure shall not be less than 2500 mm. The structure would be made of galvanized steel generally conforming to IS: 802. The surge arrester can also be mounted on the neutral grounding reactor in lieu of separate support structure.

47.24 Self contained discharge counter, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation, shall be provided for each unit. The counter shall be visible through an inspection window from ground level.

The counter terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends.

47.25 Suitable milliammeter on each arrester with appropriate connections shall be supplied to measure the resistor grading leakage current. The push buttons shall be mounted such that it can be operated from ground level.

47.26 Discharge counter and milliammeter shall be suitable for mounting on support structure of the arrester.

47.27 Grading/Corona rings shall be provided on each complete arrester unit as required for proper stress distribution.

Tests

47.28 The surge arresters shall conform to type tests and shall be subjected to routine tests as per IEC-60099-4.

47.29 Surge arrester shall be subjected to additional acceptance tests.

(i) Construction check (visual check)

(ii) Measurement of insulation resistance by 1kV megger.

47.30 Gapless Surge Arrester

47.31 Rated arrester voltage	132 kV
47.32 Rated system voltage	145 kV
47.33 Rated system frequency	50Hz
47.34 System neutral earthing	Effectively earthed
47.35 Installation	Outdoor
47.36 Nominal discharge current wave	10kA of 8/20 microsec
47.37 Class of arrester	10kA heavy duty type
47.38 Minimum discharge capacity voltage)	5 kJ/kV (referred to rated
47.39 Continuous operating voltage at 50oC	106 kV
47.40 Maximum switching surge residual voltage (1kA)	280kVp
47.41 Maximum residual voltage at	
(i) 5kA	320kVp
(ii) 10kA nominal discharge	340kVp

current	
47.42 Long duration discharge class	3
47.43 High current short duration test value (4/10microsec. wave)	100kAp
47.44 Current for pressure relief test	50kArms
47.45Low current long duration test value (2000microsec.)	1000Apeak
47.46 Min. total creepage distance.	3625 mm.
47.47 One minute dry power frequency withstand voltage of arrester housing.	275kVrms
47.48 Impulse withstand voltage of arrester housing with 1.2/50 microsec. wave	+ 550KVp
47.49 Pressure relief	class A
47.50 RIV at 92 kVrms.	Less than 500microvolts
47.51 Partial discharge at 1.05 continuous over voltage	Not more than 50pC
47.52 Seismic acceleration	As specified in section project (0.3g)
47.53 Reference ambient temperature	50 deg C

48.0 On-line tan delta monitor for HV Bushing : (see amendment sechm 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.

  i) Absolute change in Power/Dissipation factor.

  ii)Rate of change in Power/ Dissipation factor

  iii)Absolute change in capacitance.

  iv)Rate of change in capacitance.

  - Dobble make system (IDD) is preferred.

49.0 OIL SAMPLING BOTTLE

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

49.2 Oil sampling bottles shall be made of stainless steel having a capacity of one litre.

49.3 Oil Sampling bottles shall be capable of being sealed gas-tight and shall be fittedWith cocks on both ends.

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

49.5 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.

49.6 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 fromshock 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 ofIEC-60567.

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

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

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

General

The syringe shall be clearly marked with graduations of 2.0 ml and10.0 ml 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.

50.0 Cabling

All interconnecting control and power cables between various parts of Reactor like turret CT, MBs, Buchholz, PRD etc. shall be routed through covered cable tray or GI conduit and shall be properly dressed. All cables shall be armoured type. Un-armouredcables (if provided) in any circuitry, shall be through GI conduit and no part shall beexposed. Cable terminations shall be through stud type TB and ring type lugs. Contractor shall provide type tested cables from approved sources. No type testing for cables is envisaged.

Annexure -A (Test Procedures)

1) Reactance and loss measurement

- The type tested unit shall be measured in the cold and hot state.
- In other units, measurement shall be carried out in the cold state and corrected as per factors derived from the type test.
- Measurement shall also be carried out during 2-hour excitation test.

The following details shall be recorded under the heading of losses on the test certificate:

- the voltage readings taken;
- the mode of response and scaling of the voltmeters;
- the current reading;
- the power reading;
- total losses measured;
- Total losses corrected to 75°C winding temperature
- the frequency reading ;
- the instrument constants and corrections;
- corrections made to power and current results, due to onsinusoidal wave forms of voltage and current;
- The magnetization curve of the reactor.

2) Core assembly dielectric and earthing continuity tests.

The insulation of the magnetic circuit, and between the magnetic circuitand the core clamping structure, including core-bolts, bands and/ orbuckles shall withstand the application of a test voltage of either 2 kVacor 3 kV dc for 60 seconds.

The continuity of the single-point earthing shall be verified beforedespatch.

The results of the works tests shall be recorded on the test certificate,and shall include the resistance reading obtained from a measurementmade between the core and core clamping structure by means of at least1.5 kV ac or 2 kV dc.

The test shall be done before tanking prior to dispatch.

During erection, the contractor shall repeat this measurement on arrival at site.

The records of these tests shall also be included in the manual.

3) Two hours excitation test

- Each reactor to be excited at Um. 800 kV for 2 hours.
- Measure reactance, loss and vibration
- DGA rate interpretation shall be as per IEC/ CIGRE/ IEEE guidelines

4) Temperature rise test (As per IEC-60076)

Oil sample shall be drawn before and after heat run test and shall betested for dissolved gas analysis. Oil sampling to be done 2 hours priorto commencement of temperature rise test. For ONAN/ONAF cooledtransformers/reactors, sample shall not be taken earlier than 2 hoursafter shut down.

The acceptance norms with reference to various gas generation ratesshall be as per IEC 61181.

During this test the following shall be measured.

- Reactance and loss
- Audible sound
- Vibration
- Infra red images from all sides every 30 minutes with colour photographs of the same for reference
- Temperature measurement with internal probes as agreed during design review.

The heat run type test results shall serve as a "finger print" for the otherunits to be routine tested.

Specified winding hotspot temperatures shall not be exceeded.

The temperature rises recorded by infra red shall not be more than 10°Cabove top oil temperature or 15°C above the local oil temperature.

The tests shall be done for a minimum of 24 hours each with saturatedtemperature for at least 4 hours.

Full details of the test arrangements, procedures and conditions shall beprovided with the test certificates and the following shall at least beincluded.

- Purchaser's order number and reactor site designation.
- Manufacturer's name and reactor serial number.
- Ratings of reactor:
- MVA
- Voltage:
- Frequency
- Rated currents:
- Class of cooling
- Measured load losses at 75° C.
- Altitude of test bay.

Top oil temperature rise test

A log of the following parameters taken at 30 minute intervals:

- time
- Voltage
- Current
- Total power
- Ambient temperature measured on not less than three thermometers
- Top oil temperature: and
- Cooler inlet and outlet oil temperatures.
- Infra red pictures during the heating up phases

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 parameters as for the top oil temperature rise test.

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

••Time after shut- down:

••Time increment:

••Winding resistance:

••Resistance increment:

••X, where x is the time after shut-down divided by thethermal time constant of the winding: and

••Y, where Y = 100 (1-e –x)

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

••Provide a record of all calculations, corrections and curves leadingto the determination of the winding temperatures at the instant ofshut-down of power.

••Record any action taken to remedy instability of the oil surgedevice during initiation of the oil circulating pumps.

Temperature measurements as per special probes or sensors placed atvarious locations shall also be recorded.

5) Tank Vacuum Tests

All shunt reactor tanks shall be subjected to the specified vacuum.The tankdesigned for full vacuum shall be tested at an internal pressure of 3.33KN/sq.m absolute (25 torr) for one hour. The permanent deflection of flatplates after the vacuum has been released shall not exceed the valuesspecified below:

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
above 3000	19.0

6) Tank Pressure Test

All shunt reactor tanks of each size ,its radiator, conservator vessel andother fittings together or separately shall be subjected to a pressurecorresponding to twice the normal head of oil or normal pressure plus 35KN/sq.m whichever is lower, measured at the base of the tank andmaintained for one hour. The permanent deflection of the flat plate afterthe excess pressure has been released shall not exceed the figuresspecified above for vacuum test.

7) Oil leakage test on reactor tank

All tanks and oil filled compartments shall be completely filled with air or oilof a viscosity not greater than that of insulating oil conforming to IEC60296 at the ambient temperature and subjected to a pressure equal tonormal tank pressure plus 35 kN/sq.m(5 psi) measured at the base of thetank. This pressure shall be maintained for a period of not less than 12hours for oil and 1 hour for air during which no leakage shall occur.

Annexure-B (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 – 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 Kgf/Sqmm
(xii)	Altitude above MSL	: <1000M

(xii) Basic Wind Speed : **39 m/s (Zone -2)**

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	400kV
2.	Maximum operating voltage of the system(rms)	800kV	420kV
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	300mm above FGL	300mm 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) asmentioned 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 rom 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 PAINTING, 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

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,

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.

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 (Guaranteed Technical Particulars)

A. SHUNT REACTOR

1.	Manufacture name & country	1.	
2.	Type of reactor (Gapped/ Air core)	2.	
3.	Standards applicable	3.	
4.	Rated MVAr capacity	4.	
5.	Rated voltage (kV)	5.	
6.	Type of cooling	6.	
7.	Thermal data	7.	
a)	Temperature rise in oil above ambient temperature (deg.C)	a)	
b)	Temperature rise of winding by resistance above ambient temperature (deg.C)	b)	
c)	Rated frequency (Hz)	c)	
8.	Number of phases	8.	
9.	Guaranteed max. losses at rated voltage and frequency at rated output at 75 deg.C (kW)	9.	
10.	Noise level & reference (db)	10.	
11.	Insulation level (winding & bushing)	11.	Winding Line/ Neutral — Bushing Line/ Neutral
a)	Lightning impulse (1.2/50 microsecs.) withstand voltage (kVp)	a)	
b)	Power frequency withstand voltage (kVrms)	b)	
c)	Switching surge withstand voltage (kVp)	c)	
12. a)	Range of voltage upto which impedance will be constant (p.u.)	12.a)	
b)	Impedance value at 1.3 pu (ohms)	b)	

	c)	Impedance value at 1.5 pu (ohms)	c)
13.		X0/X1	13.
14.	a)	Vibration & maximum stress on the tank	14.a)
	b)	Vacuum withstand capacity of tank	b)
15.		Harmonic content in phase current	15.
16.		Shipping weights & Dimensions	16.
	a)	Size of largest package (mm)×(mm)×(mm)	a)
	b)	Weight of largest package (kg)	b)
	c)	Gross weight to be handled (kg)	c)
	d)	Gross volume to be handled (cu.m)	d)
	e)	Approx. overall dimension (l×b×h) (mm)	e)
	f)	Approx. quantity of oil required for first filling	f)
	g)	Untanking height	g)
17.		Proposed method of transportation	17.
18.		Compliance to technical specification w.r.t. parameter specified for	18.
	a)	Oil	a)
	b)	Bushing CT	b)
	c)	Bushings	c)
	d)	Terminal connectors	d)
19.		Whether similar equipment are type tested & are in successful operation for at least two years	19.
20.		Overall general arrangement drawing of Shunt Reactor with all accessories to be enclosed	20.

B. NEUTRAL GROUNDING REACTOR

1.	Manufacture name & country of manufacture	1.
2.	Type of reactor (gapped/ air core)	2.
3.	Standards applicable	3.
4.	Type of cooling	4.
5.	Rated voltage (kV)	5.
6.	Max. continuous current (Amps)	6.
7.	Rated short time current at 10 sec. (Amps)	7.
8.	Rated reactive capacity for continuous operation at rated voltage (MVAR)	8.
9.	Thermal data:	9.
a)	Temperature rise in oil at rated current above ambient temperature of 50^0C (Deg.C)	a)
b)	Temperature rise of winding over ambient temperature of 50^0C (Deg.C)	b)
10.	Rated frequency (Hz)	10.
11.	Guaranteed max. losses at rated voltage and frequency at rated output (kW)	11.
12.	Insulation level (winding & bushing)	12.
a)	Lightning impulse (kVp)	a)
b)	Power frequency (kVrms)	b)
c)	Neutral brought out at (kV)	c)
13.	Type of insulation (Graded or Uniform)	13.
14.	Overall dimensions & weights	14.
a)	Length with coolers (mm)	a)
b)	Breadth with coolers (mm)	b)

Section -4 (Guaranteed Technical Particulars)

	c)	Height with bushing (mm)	c)
	d)	Quantity of oil (KL)	d)
	e)	Untanking heights (mm)	e)
15.		Shipping data	15.
	a)	Size of largest package (mm)×(mm)×(mm)	a)
	b)	Weight of largest package (kg)	b)
	c)	Gross weight to be handled (kg)	c)
	d)	Gross volume to be handled (cu.m)	d)
16.		Compliance to technical specification w.r.t. parameter specified for	16.
	a)	Oil	a)
	b)	Bushing CT	b)
	c)	Bushings	c)
	d)	Terminal connectors	d)
17.		Whether similar equipment are type tested & are in successful operation for at least two years	17.
18.		Overall general arrangement drawing of Shunt Reactor with all accessories to be enclosed	18.

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 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 80MVAR Reactor/NGR 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	Additional Supply(s)/ Service(s) required	Yes

	to be attached, if required and prices for same deemed to be included in prices of main items.		
3	Maximum Permissible Losses for 80MVAR Reactor at Rated Voltage , frequency at 75°C will be 103kW	Confirmed	Yes
4	**Technical Particulars of Reactor**		
4.1	Rated Voltage (Un)	765/√3 kV	Yes
4.2	Maximum continuous operating voltage(Um)	800/√3 kV	Yes
4.3	Connection (3 phase)	Star with neutral brought out	Yes
4.4	Rated frequency	50Hz	Yes
4.5	Cooling system	ONAN	Yes
4.6	Duty	Continuous at 800kV/√3	
4.7	Permissible current unbalance among different phases	± 1%	Yes
4.8	Ratio of zero sequence reactance to positive reactance (X0/X1)	Between 0.9 & 1.0	Yes
4.9	Maximum admissible temperature .rise over an ambient temperature of 50deg C and at 800/√3 kV		
	of top oil measured by thermometer	40 deg C	Yes
	of average winding measured by resistance method	45 deg C	Yes
	of winding hot spot	59 deg C	Yes
	Tan delta of winding less than corrected at 20 deg C	0.005	Yes
4.10	Insulation level (for winding)		
	Lightning impulse withstand voltage	1950 kVp	Yes
	Switching surge impulse withstand voltage	1550 kVp	Yes
	One minute power frequency withstand voltage (for HV winding)	830kVrms (ph.-Erath) for 5 min (to be tested)	Yes
4.11	Insulation level of neutral		
	Impulse withstand voltage	550 kVp	Yes
	Power frequency voltage	230kVrms	Yes
4.12	Noise level at 800/√3 kV and rated frequency	80dBA	Yes
4.13	HV bushing of Reactor line side		
	Rated voltage	800kV	Yes
	Creepage distance (total)	20000mm	Yes
	Lightning impulse withstand voltage (kVp)	2100	Yes
	Switching impulse withstand voltage (kVp)	1550	Yes

	One minute power frequency withstand voltage (kVrms)	970	Yes
	Rated current (A) (Min.)	2500	Yes
	Tan delta of bushings Corrected at 20deg C	Less than 0.004	Yes
4.14	Bushing of Reactor neutral side		
	Rated voltage	145kV	Yes
	Creepage distance (total)	3625mm	Yes
	Lightning impulse withstand voltage (kVp)	650	Yes
	One minute power frequency withstand voltage (kVrms)	305	Yes
	Rated current (A) (Min.)	1250	Yes
	Tan delta of bushings Corrected at 20deg C	Less than 0.004	Yes
4.15	Max partial discharge level of bushing at Um		
	HV	<10 pC	Yes
	Neutral	<10 pC	Yes
4.16	Max. partial discharge level	<100 pC at 1.58Ur /√3	Yes
5	**Technical Particulars Neutral grounding reactor (NGR)**		
5.1	Rated voltage from insulation strength consideration	145kV	Yes
5.2	Rated frequency	50Hz	Yes
5.3	Type	Dry type air core for outdoor application	Yes
5.4	Cooling system	ONAN	Yes
5.5	Insulation	Graded/Uniform	Yes
5.6	Connection	Between neutral of reactor and ground	Yes
5.7	Maximum continuous current (rms)	20A	Yes
5.8	Rated short time current (rms) (60 secs.)	140A(However the NGR shall be designed for a current rating of 600A rms short time current to ensure mechanical robustness which will be verified during design review	Yes

5.9	Rated impedance at rated short time and continuous current	(1) 1200 Ohms (applicable for 2 nos. NGR used for 765kV Thiruvulam line). (2)NGR impedance of 765kV NCPS line and 765kV bus reactor shall be provided during detailed engineering stage.	Yes
5.10	Lightning impulse withstand voltage insulation level of winding		
	Line side	550kVp	Yes
	Ground side	550kVp	Yes
5.11	One minute Power frequency withstand voltage of winding		
	Line side	275kVrms	Yes
	Ground side	275kVrms	Yes
5.12	Mounting of NGR	Pedestal insulator	Yes
	Type	Porcelain/Silicon rubber	Yes
	Minimum creepage	438mm	Yes
	One minute Power frequency withstand voltage	55kVrms	Yes
	Lightning impulse withstand voltage	125kVp	Yes
6	**Technical Deviations**		Yes
6.1	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
6.2	Schedule of Technical Deviation is enclosed.	Confirmed	Yes
7	**General Requirements**		
7.1	**Paint System and Procedure:** Bidder to follow paint system and procure as per **Clause 8.0 of Section-2B.**	Confirmed	Yes
7.2	**Grounding:** As per Clause no.18 of Section 2B.	Confirmed	Yes

7.3	**Cabling:** Cabling as per cl. No. 1.3.3 of section -1. are in bidder Scope.	Confirmed	Yes
7.4	**Auxiliary Supply:** Terminals in marshalling box for external power supply coming into marshalling box shall be suitable to requirement (as per cl. No. 1.3.4 of section -1).	Confirmed	Yes
7.5	Online system for Reactor shall have provision for integration with SAS based on IEC 61850 communication protocol. For SAS integration purpose necessary Ethernet switch , LIU , patch cards, protocol converter etc. in common marshalling box shall be in bidder scope .	Confirmed	Yes
8	**Testing**		Yes
8.1	**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
8.2	**Type Test for fitting-** As per cl. No. 35 of section 2B	Confirmed	Yes
8.3	**Factory tests**–As per cl. No. 34 of section 2B.	Confirmed	Yes
8.4	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
9	**Inspection and Testing at Works**		Yes
9.1	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**		
10.1	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**		
11.1	Information/ documents to be furnished at the TENDER STAGE shall be as per Technical Specification	Confirmed	Yes

12.	**Standards**		
12.1	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
13	**Documents to be submitted with Technical Offer**		
13.1	All documents as mentioned in Technical Specification are enclosed.	Confirmed	Yes
13.2	OGA drawings are enclosed	Confirmed	Yes
13.3	Documents for meeting Qualifying Requirements are enclosed.	Confirmed	Yes
13.4	Bidder will submit detailed bar chart/ activity schedule indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning.	Confirmed	Yes
14	All required foundation bolt, nut and washer of Reactor and marshalling box shall be in bidder Scope.	Confirmed	Yes
15	Bushing turrets CT and neutral CT of reactor as per Annexure-M and as per Specification to be provided by Bidder	Confirmed	Yes
16	A legally enforcement undertaking by manufacturer (in case of bidder comply Technical requirement) shall be furnished during contract stage for guarantee quality, timely supply, performance and supervision of erection, testing and commission of the 765kV line/bus Reactor.	Confirmed	Yes

Signed with Seal of Bidder

Date .....