

TANGEDCO

2X660 MW ENNORE TPS

VOLUME – II

TECHNICAL SPECIFICATION FOR
OIL FILLED SERVICE TRANSFORMERS

SPECIFICATION NO : PE-TS-412-302-E001
REV-0



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, UTTAR PRADESH, INDIA – 201301



**TECHNICAL SPECIFICATION FOR
OIL FILLED SERVICE TRANSFORMERS**

SPECIFICATION NO. PE-TS-412-302-E001

VOLUME II

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2X660 MW ENNORE TPS

REVISION 0 | DATE: 17.05.17

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SPECIFICATION NO. PE-TS-412-302-E001

VOLUME-II

COMPLIANCE CERTIFICATE

REVISION 00

DATE: 17.05.17

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same
2. There are no deviation with respect to specification other than those furnished in the 'schedule of deviations'
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ-Cum-Price schedule' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

BIDDER'S STAMP & SIGNATURE

SECTION 'I'

SPECIFIC TECHNICAL REQUIREMENTS

	TITLE : TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS	SPECIFICATION NO. PE-TS-412-302-E001
		VOLUME NO. : II
		SECTION : I
		REV NO. : 00 DATE : 17.05.17
		SHEET : of

1.0 SCOPE OF ENQUIRY

This specification covers the design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to site of **OIL FILLED SERVICE TRANSFORMERS** as mentioned in different sections of this specification, complete with all accessories for efficient and trouble-free operation.

- 1.1 It is not the intent to specify herein all the details of design & manufacture. However, the equipment shall conform in all respect to high standards of design engineering and workmanship and shall be capable of performing in continuous commercial operation.
- 1.2 Standard technical requirements of the oil filled service transformers are indicated in Section-II. Project specific requirements/changes are listed in Section-I.
- 1.3 **The requirements of Section-I shall prevail and govern in case of conflict between the corresponding requirements of Section-I and Section-II.**

2.0 BILL OF QUANTITIES:

- 2.1 Quantity requirements shall be as per BOQ-cum-price schedule as part of NIT.

3.0 SPECIFIC TECHNICAL REQUIREMENTS

<u>S.No.</u>	<u>Reference Clause No. of Section-II</u>	<u>Specific Requirement/ Change</u>
1	7.00.00 COMMISSIONING SPARES, SPECIAL TOOLS & TACKLES AND O & M SPARES	This clause stands deleted
2	2.00.00 Codes and standards	Additionally codes and standards indicated in customer specification portion shall also be followed as applicable.

4.0 DOCUMENTATION

- 4.1 Documents required along with technical offer shall be as per annexure-I.
- 4.2 Documents required after award of LOI shall be as per annexure -II.

All equipments provided under the specification shall in general, conform to the latest issue of the following standards:

Indian Standards	Title	International standards
(1)	(2)	(3)
IS: 2026	Power transformers	IEC: 60076
IS: 3639	Fittings & accessories for power transformers	
IS: 335	Insulating for alternating voltages switchgear	IEC: 60296, BS:148
IS: 2099	Bushing for alternating voltages above 1000 V	IEC: 60137, BS: 223
IS: 2705	Current transformers	IEC: 60185
IS: 325	Three phase induction motors	IEC: 60034-1
IS: 375	Marking & arrangement for switchgear bus bars, main connections & auxiliary wiring.	
IS: 3637	Gas operated relays	
IS: 10028	Code of practice for selection installation & maintenance of transformers	
IS : 5	Colours for ready mix paints	
IS: 1866	Code of practice for maintenance & Supervision of mineral insulating oil in equipment	
IS: 6272	Industrial cooling fans	
IS: 6600	Guide for Loading of oil immersed transformers	IEC: 60354
IS: 3347	Specification for dimensions of porcelain bushing	
IS:2071	High voltage test technique	IEC: 60060



IS:2165	Insulation co-ordination	IEC: 60071
	NEMA standard publication for Power transformers	NEMA-TR-1
IS: 10597	Code of practice for selection, Installation operation & maintenance of pumps for industrial applications	
IS: 9434	Guide for sampling & analysis of free & dissolved gas & oil from oil filled electrical equipment	IEC:60567
IS: 12676	Dimensions for OIP insulated condenser bushings	
IEEE: 32	IEEE standard requirement terminology& test procedure for neutral grounding device	

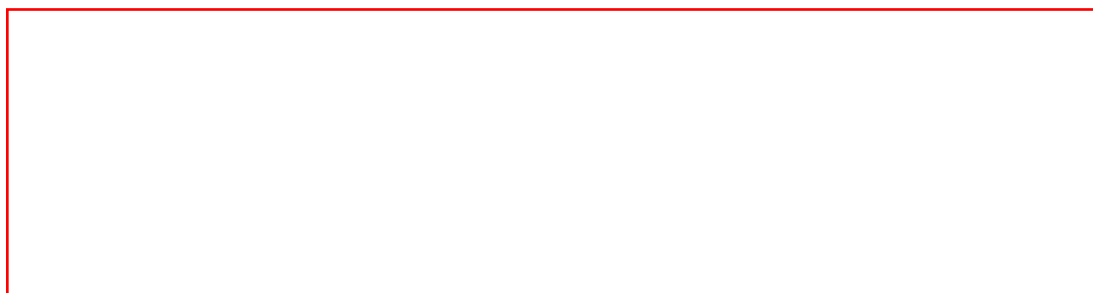
The electrical installation shall meet the requirements of Indian Electricity Rules 1956 & IS: 10028 'Code of practice' for selection, installation & maintenance of transformers as named up to date.

CHAPTER – 6

STEP DOWN POWER TRANSFORMERS

STATION AUX TRF (SAT) , AHP AUX TRF(AHPAT), RO DM AUX TRF (ROAT),
EXT. CHP AUX TRF. (ECHPAT)

1.00.00



2.00.00

DESIGN CRITERIA

~~It will be the responsibility of the contractor to adequately size the transformers to cater for all the auxiliaries of the main equipment, mechanical systems and loads due to lighting, A/C & ventilation system, battery charger, cranes, plug points and all other loads (including FGD, recovery water pump house, ICHP pipe conveyor end load, etc) and based on the ambient temperature. The basis given below is the minimum requirement. In case during the operation of plant it is found that the rating selected is not adequate due to incorrect load assumptions or due to any other reason, it will be Contractor's responsibility to replace the transformer and associated switchgear and breaker.~~

2.01.00

~~**Start Up Transformer: (SUT)**~~

2.01.01

~~**One, 3 phase 3 winding, * MVA** station transformer, having voltage ratio of 400/11.5/11.5 kV, vector group Yyn0yn0, outdoor oil immersed, with ONAN/ONAF/OFAF cooling shall be provided to cater for initial boiler light up load of one unit and also to cater load of one station transformer or unit transformer (inclusive of MDBFP) in case of outage of either.~~

2.01.02

~~The HV terminal bushing shall be connected to the 400 kV switchyard gantries through overhead ACSR conductors/ cables. The LV phase terminals will be connected to 11 kV startup switchgears (SU A & SU B) through 11 kV SPBD.~~



2.02.00 Unit Transformers

2.02.01 ~~Two, 3 Phase, 2 winding, * MVA oil immersed transformers with a voltage ratio of generated voltage/11.5 kV shall be provided for each unit to supply the unit load.~~

2.02.02 ~~Two X 50% UT shall meet the load requirement of associated generator running at full load. The UT shall be rated such that it should be capable of starting the BFP motor. The unit transformers shall have the provision for FGD load of approximately 20 MVA.~~

2.02.03 ~~For the purpose of calculating the actual load, following factors with different conditions shall be taken.~~

- ~~a) Full load - 0.9 (or expected load factor at MCR of boiler)~~
- ~~b) Unit tripping- Contractor to indicate the factor and the loads to be run (Minimum shall be considered as 0.7)~~
- ~~c) Unit starting- 0.4 (if the no. Of auxiliaries is same as that at full load operation)~~

2.02.04 ~~Additionally, a margin of 10% over the MVA arrived shall be provided for variations of the loads. Due consideration shall be given for the reduction in nameplate MVA capacity due to regulations.~~

2.03.00 ~~Station Transformers~~

2.03.01 ~~Two, 3 Phase, 2 winding, * MVA oil immersed transformers with a voltage ratio of generated voltage/11.5 kV shall be provided for each unit to supply the 100% common station load (including all mechanical BOP auxiliaries).~~

2.04.00 ~~Unit Auxiliary Transformers~~

~~Power from 11 kV switchgears will be stepped down to 3.3 kV through Unit Auxiliary Transformers. The UAT's shall have voltage ratio 11/3.6 kV, vector group Dyn11. The UATs shall have 2 x 100% configuration. These transformers shall supply to the various plant auxiliaries such as the CHP, AHP, Raw water intake system and other Unit loads.~~



2.05.00 ICHP Transformers

~~Two, 3 Phase, 2 winding, * MVA oil immersed transformers with a voltage ratio of 11/36 kV shall be provided for catering the power supply requirement of ICHP Stage I and the sea water intake pump house at NCTPP Stage II. The transformer shall also have provision in capacity for future extension from ICHP Stage I. These Transformers shall feed 33 kV Switchgear.~~

~~Power from these transformers shall be stepped down to 11 kV through two 33/11.5 kV transformers for catering to the load requirements (including future ECHS expansion of approx. 7 MVA) of sea water intake pump house and the ICHP Stage I.~~

2.06.00 Bus Reactors

~~Reactor shall be designed for exceptional circumstances arising due to sudden fluctuation in supply voltage. The reactor shall be provided with radiator banks.~~

~~The crest value of the third harmonic component in phase current shall not exceed 3% of the crest value of fundamental when reactor is energized at rated voltage with sinusoidal wave form.~~

2.06.00 General technical Particulars**I. Step Down Power Transformers (UT, ST and Unit Auxiliary Transformer (UAT))**

		Unit	SUT	UTs	UATs	ST	ICHP Transformers	
a)	Rating	MV A	*	*	*	*	*	*
b)	Quantity		1	4	16**	2	2	2
c)	Cooling method		ONAN/ ONAF	ONAN/ ONAF	ONAN	ONAN/ ONAF	ONAN/ ONAF	ONAN/ ONAF
d)	no. of windings		Three (3)	Two (2)	Two (2)	Two (2)	Two (2)	Two (2)
e)	Voltage ratio		400/11.5 kV	Rated generat or voltage	11/3.6 kV	Rated generat or voltage/	11/36 kV	33/11.5 kV



				/11.5 kV/11.5 kV		11.5 kV/11.5 kV		
f)	Rated Frequency	Hz	50	50	50	50	50	50
g)	No. of Phases		Three (3)	Three (3)	Three (3)	Three (3)	Three (3)	Three (3)
h)	Winding connection							
	HV		Star (neutral solidly earthed)	Delta	Delta	Delta	Delta	Delta
	LV		Star (neutral resistance earthed)	Star (Neutral resistance earthed)	Star (Neutral resistance earthed)	Star (Neutral resistance earthed)	Star (Neutral resistance earthed)	Star (Neutral resistance earthed)
i)	Vector Group		YNyn0 yn0	Dyn1	Dyn1	Dyn1	Dyn1	Dyn1
j)	Location		Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor
k)	Duty		Continuous	Continuous	Continuous	Continuous	Continuous	Continuous
l)	Impedance	pu	**	**	**	**	**	**
m)	Overload capacity		As per IS:660 0	As per IS:660 0	As per IS:660 0	As per IS:6600 0	As per IS:660 0	As per IS:660 0
n)	Short circuit withstand capability		Refer cl. 3.00.00 (c)					
o)	Temperature rise over 50°C ambient							



p)	Oil	° C	50	50	50	50	50	50
q)	Winding	° C	55	55	55	55	55	55
r)	Type of insulation							
	HV		Non uniform	Unifor m	Unifor m	Uniform	Unifor m	Unifor m
	LV		Unifor m	Unifor m	Unifor m	Uniform	Unifor m	Unifor m
s)	Windings Insulation Level							
	Rated power frequency withstand voltage HV/LV	kV _r ms	630 / 28	* / 28	28/ 10	* / 28	28/70	70/28
	Rated lightning impulse withstand voltage HV/LV	kVp	1300/7 5	* / 75	75/40	* / 75	75/170	170/75
t)	Bushing Insulation Level							
	Rated power frequency withstand voltage HV/LV	kV _r ms	630 / 28	* / 28	28/10	* / 28	28/70	70/28
	Rated lightning impulse withstand voltage HV/LV	kVp	1425/7 5	* / 75	75/40	* / 75	75/170	170/75
	Rated switching	kVp	1050/7 5	* / 75	75	*	*	*



	impulse withstand voltage							
u)	Tap Changer type		OLTC, CFVV	OLTC, CFVV	OCTC	OLTC, CFVV	OLTC, CFVV	OLTC, CFVV
v)	Tap range		+ 10% to (-) 10 on HV winding in steps of 1.25%	+ 10% to (-) 10 on HV winding in steps of 1.25%	$\pm 5\%$ in steps of 2.5%	+ 10% to (-) 10 on HV winding in steps of 1.25%	+ 10% to (-) 10 on HV winding in steps of 1.25%	+ 10% to (-) 10 on HV winding in steps of 1.25%

II. Neutral grounding Resistors

i.	Rated current	300A for 10 seconds
ii.	Type	Grid Type
iii.	Application	Grounding of LV winding of transformers
iv.	Resistance	As per system requirement
v.	Service	Outdoor
vi.	Resistor material & connection	Punched stainless steel grid element type
vii.	Maximum allowable temperature rise over ambient 50 °C	350 deg. C
viii.	Mounting	Suitable voltage grade insulators.
ix.	Terminal bushing	Suitable voltage grade insulators
	Rated Voltage	As per system requirement
	Rated current	300 A
	Basic impulse level	75 kVp for 11 kV 20 kVp for 3.3 kV
	Quantity	2 each
	Mounting	Roof of enclosure
x.	Degree of protection	IP 55 (With Weatherproof



		enclosure)
xi.	Terminal details To Transformer Neutral	Copper flats of min 50 mm x 6 mm Galvanized steel flat of size 50 mm x 10 mm

III. Technical Particulars for Bus Reactors

Sl.No.	Description	Unit	Data
1.	Rating	MVAR	80 MVAR
2.	HV		420 kV
3.	Frequency & Variation		50 Hz, +3%, -5%
4.	fault level (HV)	kA	63
5.	Short circuit withstand duration	Sec	3
6.	Type of cooling		ONAN
7.	Lightning Impulse withstand level(1.2/50 micro sec) , Phase	KVp	1300
8.	Switching surge impulse voltage, Phase	KVp	1050
9.	Ratio of zero sequence reactance to positive reactance (X0/X1)		Between 0.9 & 1.0.
10.	Range of constant impedance		Up to 1.5 p.u. voltage
11.	Harmonic content in phase current		
12.	Permissible current unbalance among different phases		+ 2%
13.	Lightning Impulse withstand level(1.2/50 micro sec), Neutral	KVp	550
14.	Switching surge impulse voltage, Neutral	KVp	230
15.	System earthing		
a)	HV side		Solidly grounded
16.	Terminal arrangement		
a)	HV side		Overhead line
b)	HV Neutral side		Ground conductor
17.	Phase Bushings		
a)	Rated Voltage	kV	420
b)	Bushings Creepage distance		31 mm /kV
c)	Lightning Impulse withstand level(1.2/50 micro sec) , Phase	KVp	1425
d)	Switching surge impulse voltage, Phase	KVp	1050



Sl.No.	Description	Unit	Data
e)	One minute Power frequency withstand voltage	kV	630
18.	Neutral Bushings		
a)	Rated Voltage	kV	145
b)	Bushings Creepage distance		31 mm /kV
c)	Lightning Impulse withstand level(1.2/50 micro sec) , Phase	KVp	650
d)	One minute Power frequency withstand voltage	kV	275
19.	Tap Changer		
a)	Type		OCTC
b)	Range of taps	%	+5% to -5% in steps of 2.5%

Notes:

- i. * - Quantities/ratings mentioned are tentative and subject to finalization during detailed engineering.
- ii. **- Ratings/ impedance values to be decided by Bidder and finalized during detailed engineering such that the short circuit fault current on the LV side is within the permissible limits and while starting of the largest motor with the transformer under loaded condition, the starting and running voltage drop of motor terminals should be restricted to 15% and 5% respectively.
- iii. The Transformer shall be capable of withstanding without damage 1.4 times the rated voltage at its termination for five (5) seconds.
- iv. The specified MVA rating shall be available at the lowest HV winding tap (-5%) also.

2.07.00~~Layout criteria for power transformers~~~~Refer chapter 1, cl. 4.00.00~~**3.00.00****GENERAL TECHNICAL REQUIREMENTS**

- a) Transformers shall be capable of operating under natural cooled condition up to the specified load as indicated. ~~The forced cooling equipment shall come into operation by preset contacts of winding temperature indicator & the transformer shall operate as a forced cooled unit as ONAF and also as ONAN.~~



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Project at Ash Dyke of NCTPS
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~~Total cooling system of transformer with oil natural & air forced (ONAF) cooling shall be so designed that during total failure of power supply to cooling fans, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140 deg. C. Also stopping of one of the cooling fan should not have any effect on the cooling system of transformers. The transformer filled with coolers each capable of dissipating 50% of losses at continuous maximum rating shall be capable of remaining in operation for 20 minutes in the event of failure of pump or fans associated with one cooler without exceeding hot spot temperature of 115° C.~~

- b) The maximum flux density in any part of the core & yoke at the rated MVA, voltage & frequency shall be such that under 110% continuous voltage condition it does not exceed 1.9 tesla.
- c) The transformer & all its accessories including CTs etc shall be designed to withstand without injury the thermal & mechanical effects of any external short circuit to earth & of short circuits at the terminal of any winding for a period of 3 secs. Contractor shall submit the short circuit withstands calculations.
- d) Transformers shall withstand, without injurious heating, combined voltage & frequency fluctuations, which produce the following over fluxing condition:
 - 110 %- continuous--
 - 125%- for one minute
 - 140%- for five seconds
- e) The air core reactance of HV winding of transformers shall not be less than 20%.
- f) The transformers shall be capable of being operated continuously with out danger on any tapping at the rated KVA with voltage variation of $\pm 10\%$ corresponding to the voltage of tapping.
- g) The transformers shall be capable of being loaded in accordance with IS: 6600 / IEC: 60354 up to load of 150 %. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.
- h) Radio Interference

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

- (j) Owner would undertake design review.



- (k) ~~OLTC~~, WTI and OTI shall be interfaced to EDMS / DDCMIS.

4.00.00 CONSTRUCTION

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

4.01.00 Tank and Tank Accessories

- a) Tank shall be of welded construction & fabricated from tested quality low carbon steel of adequate thickness. The welding procedure specified (WPS), procedure qualification record (PQR), shop welding schedule, welder's qualification shall be subject to Owner's approval. After completion of welding, all joints shall be subjected to dye penetration testing. Weld joints at all loads bearing member shall be left unpainted till carrying out of DP test during final inspection of transformer. Details of acceptance norms of welding shall be submitted for Owner's approval which shall include permissible undercut, overlap, surface crack, porosity, out of alignment of plate surface in butt joints, maximum gap due to incorrect fit up of fillet joint etc.
- b) Each tank shall be provided with :
 - 1. Lifting lug suitable for lifting the equipment complete with oil.
 - 2. A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic or mechanical screw jacks.
 - 3. Suitable haulage holes shall be provided for transformer wheeling in all four directions.
- c) The transformers are to be provided with flanged bi-directional wheels & axles & shall be mounted on wheels on foundation. Suitable locking arrangement shall be provided for the wheels to prevent accidental movement of transformer. The rail track gauge shall be 1676 mm along longer axis as well as along shorter axis.
- d) At least two adequately sized inspection openings one at each end of the tank shall be provided for easy access to bushing & earth connections. The



inspection covers shall not weight more than 25 Kg. Handles shall be provided on the inspection cover to facilitate lifting.

- e) Turrets & other parts surrounding the conductor of individual phase shall be non-magnetic.
- f) All bolted connections shall be fitted with weather proof, hot oil resistant, rubberized cork gasket in between for complete oil tightness. If gasket is compressible, metallic stops shall be provided to prevent over compression.
- g) The tank shall be designed in such a way that it can be mounted on the plinth directly.
- h) Wherever possible the transformers tank & its accessories shall be designed without pockets wherein gas may collect. Where pockets can not be avoided, pipes shall be provided to vent the gas into the main expansion pipe.
- i) The main tank body including tap changing compartment, radiators shall be capable of withstanding full vacuum.

4.02.00 ~~Transformer Online Oil Condition monitoring system~~

~~A Transformer online Oil Condition monitoring system (reputed make) providing continuous monitoring of dissolved hydrogen and moisture/water in oil shall be provided for the oil filled transformers. For specifications of equipments refer Cl. 3.00.00 (Sr. no. 4), Chapter 23 (Electrical Laboratory Equipments). The system shall be interfaced with EDMS.~~

4.03.00 ~~On-Line Partial Discharge Monitoring System~~

~~For continuous monitoring of the condition of insulation of the transformer it shall include the on line PD monitoring system. The method used for PD testing shall be in accordance with IEC 60076-3 and IEC 60270. The system shall be interfaced with EDMS.~~

4.04.00 Core

- a) The core shall be constructed from high-grade non-aging, cold rolled, ~~super~~ grain oriented, silicon steel laminations, ~~known as H-B steel trade name.~~
- b) The insulation of core to bolts & core to clamp plates shall be able to withstand a voltage of 2 kV (rms.) for 1 minute in air.



- c) The core earthing has to be done outside the tank with suitable bushing to facilitate core isolation test during pre-commissioning stage.
- d) Adequate lifting lugs will be provided to enable the core & windings to be lifted.

4.05.00 Windings

- a) The contractor shall ensure that windings are made in dust proof & conditioned atmosphere.
- b) The conductors shall be of electrolytic grade copper free from scales & burrs.
- c) All windings of the transformers shall be fully insulated.
- d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

4.06.00 Insulating Oil

The oil supplied with transformers shall conform to all parameters as per IS: 335 while tested at supplier's premises. No inhibitors shall be used in oil. Subsequently oil samples shall be drawn at:

- a) Prior to filling in main tank at site & tested for

1) BDV	60 kV(min)
2) Moisture content	50 ppm(max)
3) Tan delta at 90 deg. C	0.002 (max)
4) Resistivity at 90 deg. C	35×10^{12} ohm-cm
5) Interfacial tension	0.04 N/m (min)
- b) Prior to energization at site for following properties & acceptance norms:

1) BDV	60 kV (MIN)
2) Moisture content	15 ppm (max.)
3) Tan delta at 90 deg. C	0.05 (max.)
4) Resistivity at 90 deg. C	1×10^{12} ohm-cm
5) Interfacial tension	0.03 N/m (min)

4.07.00 Terminal Arrangements

4.07.01 Bushings



- a) The electrical & mechanical characteristics of bushings shall be in accordance with IS: 2099, IS: 3347 & IS: 12676. Bushings of rating below 52 kV shall be solid porcelain or oil communicating type.
- b) Condenser type bushings shall be provided with :
 - 1. Oil level gauge,
 - 2. Oil filling plug & drain valve (if not hermetically sealed)
 - 3. Tap for capacitance & tan delta test.
- c) Clamps & fittings shall be of hot dip galvanized steel.
- d) Bushing & fittings shall be provided with vent pipes that shall be connected to route any gas collection through the Buchholz relay.
- e) No arcing horns shall be provided on the bushings.

4.07.02

Bus Duct Terminations

- a) A flanged throat or equivalent connection shall be provided for termination of busduct enclosure. Transformer HT Side supply shall be through Cables, whereas LT side shall be connected through phase segregated busduct.

Phase segregation shall be achieved by metallic barriers. The winding termination shall be on outdoor type of bushings. The material of the busduct termination shall be non-magnetic. A drain with stopcock arrangement shall be provided at flange to drain leakage of oil/water at termination. ~~As bus duct will be pressurized stopcocks shall be airtight.~~

- b) Tolerance permissible for the height of the terminal connected to busduct over rail top level is ± 5 mm. Contractor has to ensure that radiator & conservator does not obstruct the path of the bus ducts in position & during movement of transformer. The contractor shall co-ordinate final design of terminal arrangement to suit bus duct arrangement.
- c) The transformer bushing enclosed in bus duct enclosure shall be designed for satisfactory operation in the high ambient temperature existing inside the bus duct enclosure.
- d) ~~HV side of unit aux. transformers shall have suitable terminal pads to facilitate the termination with the generator bus duct conductor. The bushing pads shall be silver plated.~~

4.08.00

Bushing Current Transformer

- a) Current transformer shall comply with IS: 2705. These CTs shall be mounted in the turret of bushing. Provision of the same inside the tank is not permitted.



- b) It shall be possible to remove turret mounted current transformers from the transformer tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents & local heat generated in the turret.
- c) All secondary leads shall be brought to a weatherproof terminal box near each bushing. These terminals shall be wired out to cooler control cabinet using separate cables for each core.

4.09.00**Terminal Marking**

The terminal marking & their physical location shall be as specified otherwise.

- a) One no. PS class CT for transformer differential protection to be provided in HV bushing of transformer.
- b) One no. two core CT to be provided in neutral bushing of transformer.
 - (i) core 1: 5P20 for Standby E/F protection.
 - (ii) core 2: PS class for REF protection.

4.10.00**Earthing Arrangement**

LV Neutral earthing shall be done by using an earthing resistor to limit the fault current to 300 A.

4.11.00**Cooler Control Cabinet (CCC) Unit**

- a) ~~Each transformer shall be provided with one cooler control cabinet housing all the cooler control, OTI, WTI for each winding etc. for one unit. Alternatively the contractor may provide two different boxes; one for housing cooler controls named as cooler control cabinet & separate box for housing OTI, WTI etc. named as Marshalling box. Each transformer shall also be provided with OLTC control cabinet, which will house the OLTC controls & indications.~~

OCTC TO BE PROVIDED

- b) The sheet steel used for all the cabinet boxes shall be at least 2.5 mm thick. The gasket used shall be of neoprene rubber. A space heater & cubicle lighting with on – off switch shall be provided in each cabinet. A circuit breaker/contactors with thermal overload device for controlling the AC auxiliary supply shall be provided.
- c) Terminal Blocks
 - 1. The terminal blocks to be provided shall be fully enclosed with removable covers & made of molded, non-inflammable plastic material with blocks & barriers molded integrally. The terminal blocks shall be 1100V grade & have 10 A continuous rating. Terminal blocks for current transformer secondary leads shall be provided with test links & isolating facilities. Also current transformer secondary leads shall be provided with short circuiting & earthing facilities. At least 20% spare terminals shall be



provided on each panel & these spare terminals shall be uniformly distributed on all terminal blocks.

2. Terminal blocks shall be suitable for connecting the following conductors on each side :

- i. Current transformer circuits – minimum of two No. of 2.5 sq. mm copper

wires each side

- ii. Other circuits - minimum of one No. of 2.5 sq. mm copper wire

each side

- d) The temperature indicators shall be so mounted that the dials are not more than 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.
- e) One ~~cooler control cabinet~~ / marshalling box of each type for each rating of transformer shall be tested for IP 55 protection in accordance with IS: 2147

4.12.00 Auxiliary Power Supply as applicable

- 4.12.01 Two Auxiliary Power Supplies at 415 V three phase four wire at marshalling box ~~cabinets~~.

- 4.12.02 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the CCC for transformers.

Design features of the transfer switch shall include the following:

- a) Provision for the selection of one of the feeder as normal source & other as standby.
- b) Upon failure of the normal source, the loads shall automatically transfer, after an adjustable time delay, to standby source.
- c) Indication to be provided for failure of normal source & for transfer to standby source.
- d) Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.
- e) Both the transfer & the re-transfer shall be dead transfers & AC feeders shall not be paralleled at any time.

- 4.12.03 The supplier shall derive AC feeders for cooler control cabinets after suitable selection at CMB/CCC for which description is given above. The supplier shall derive AC supply for control circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformer. If the control circuit is operated by DC



supply, then suitable main & standby converters shall be provided by the supplier to be operated from AC feeder.

4.13.00 Control Wiring & Cabling.

Supply, laying & termination of all cables & accessories required of proper termination from the CCC cabinet so as to make equipment complete & functional shall be in scope of supplier. The cable between the CCC & transformer shall be laid by the supplier through GI conduits/ pipes.

4.14.00 Painting

The paint inside the tank shall be of white colour. The internal & external surface including oil filled chambers & structural steel work to be painted shall be shot or sand blasted to remove all rust & scale or foreign adhering matter. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant, oil insoluble, insulating varnish. No grinding is permitted afterwards.

All steel surfaces exposed to weather shall be given a primary coat of Zinc chromate, second coat of oil & weather resistant varnish of a colour distinct from primary & final two coats of glossy oil & weather resisting non fading paint of colour corresponding to shade RAL 5012. Primary paint shall be as per IS: 104 & intermediate & final coats of paint shall be as per IS: 2932.

All paints shall be carefully selected to withstand heat & extremes of weather. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. The desired coating thickness & drying time are mentioned below:

	Thickness & Drying Time
Primary coat of Zinc Chromate	- 70 micron 4 hours.
Secondary coat of Varnish	- 70 micron 4 hours.
Under coat (First coat) Paint	- 70 micron 8 hours.
Final Paint	- 70 micron 6 hours.

4.15.00 Cooling Equipment

4.15.01 Cooling equipment shall conform to the requirement stipulated below:

- a) The cooler shall be designed using 2x50% radiator banks. ~~Design of cooling system shall satisfy the requirements as stipulated.~~



- b) Each radiator bank shall have ~~its own cooling fans~~, shut off valves at the top and bottom (80mm size) lifting lugs, top and bottom oil filling valves, air release plug at the top, a drain and sampling valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.
- c) ~~Cooling fans shall not be directly mounted on radiator bank which may cause undue vibration. These shall be located so as to prevent ingress of rain water. Each fan shall be suitably protected by galvanized wire guard. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.~~
- d) ~~Cooling fan motor shall be suitable for operation on 415 $\pm$ 10% V, three phase, and 50 Hz $\pm$ 3% - 5%, power supply & shall conform to IS: 325. Each cooling fan motors shall be provided with starter with thermal overload & short circuit protection. Motor shall have enclosure with degree of protection equivalent to IP 55 as per IS: 4691. The temperature rise of the motor shall be limited to 70 deg. C above ambient of 50 deg. by winding resistance method & shall comply with IS: 325.~~
- e) The cooler & its accessories shall preferably be hot dip galvanized or corrosion resistant paint should be applied to it.
- f) Fault Indicating device
~~For each transformer, an alarm contact shall be furnished to indicate the unintended stoppage of a fan. The contractor shall also indicate if any additional alarm/indication lamp is required to be provided in Central control room.~~
- g) ~~Following lamp indications shall be provided in CCR:~~
- ~~1. Cooler supply failure (main)~~
 - ~~2. Cooler supply changeover~~
 - ~~3. Cooler supply failure (standby)~~
 - ~~4. Control supply failure~~
 - ~~5. Common thermal overload trip~~
 - ~~6. Cooling fan failure for each bank~~
- ~~One potential free initiating contact for all the above conditions including alarm for "failure of supply changeover" shall be wired independently to the terminal blocks of CCR exclusively for elsewhere.~~

4.15.02

Cooling Equipment Control

- a) ~~Automatic operation control fans/pumps shall be provided (with temp. change) from contacts of winding temperature indicator. The Contractor shall recommend the setting of WTI for automatic change over of cooler control from~~



- ~~ONAN to ONAF. The setting shall be such that hunting i.e. frequent start-up operation for small temperature differential does not occur.~~
- b) ~~Suitable manual control facility for cooler fans shall be provided.~~
- c) ~~Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans manually.~~

5.00.00**FITTINGS**

For fittings to be provided with transformers refer chapter no. 5, cl. 3.15.00. ~~Oil surge relay shall also be provided for OLTC tank.~~

6.00.00**TRANSFORMER PROTECTION**

The following protection functions shall be provided for the ~~UT, ST, SUT & ICHP~~ Transformers

S.no	Description	
1.	Phase over current protection (50-51)	
2.	Transformer differential protection (87)	
3.	Local breaker backup protection	
4.	HV & LV Restricted earth fault protection (64 R)	
5.	HV Back-up earth fault protection (51N).	
6.	LV Back-up earth fault protection (51N-1).	
7.	Over fluxing protection	
8.	Buchholz relay with alarm & trip contact	
9.	Winding temperature high trip (49).	
10.	Oil temperature high trip (49).	
11.	Pressure relief device with trip contact (63)	
12.	OLTC oil surge protection (63)	
13.	Fire protection trip and isolation of power supply to cooling fans and pumps	



14.	Oil level low with alarm	✓	-
15.	Any other protection for successful operation	✓	✓

The protection system will comprise pre-engineered modular or discrete self contained system comprising relays of multifunction numerical type. If any of the protections are not covered in the numerical relay, separate discrete numerical relay will be provided. Licensed software to read, set, configure and analyze the relays shall also be supplied along with computer system.

No intermediate/ interposing current transformers shall be used.

In addition to the relays/protections mentioned in this specification, any additional protections/relays considered necessary by the contractor for his system shall be included and offered by the contractor.

Besides above, other equipment like auxiliary VTs, CTs, timers, auxiliary relays etc., will be provided as required.

Trip Matrix required for implementing tripping schemes will be provided by the CONTRACTOR and will be indicated in block interlock diagrams to be submitted.

7.00.00

INSPECTION AND TESTING

- a) The contractor shall carry out a comprehensive inspection and testing program during manufacture of the transformer. It is Contractor's responsibility to draw up and carry out such a program in the form of detailed quality plan duly approved for necessary implementation.
- b) The Contractor shall carry out all type tests and routine tests on the transformers. Special tests other than type and routine tests as listed in clause 7.01.00 (III) shall be carried out as per IS: 2026.

7.01.00

List of Tests to be conducted

I. Routine test

- (a.) All routine test in accordance with IS 2026 / IEC 60076 shall be carried out on all transformer. Measurement of no load losses & current shall be done at 90%, 100% & 110% of rated voltage. Impedance & load loss measurement are to be done at max., min & normal tap position. Dielectric test shall be carried out as per IEC- 60076-3.

- (b.) Following additional routine test shall be conducted on each transformer



- (1) Magnetic balance test
- (2) Repeat no load current/loss measurement after completion of all electrical tests.
- (3) Oil leakage test: This test shall be done on completely assembled transformer for the unit on which type test shall be done. On the other units this may be conducted without conservator & coolers.
- (4) Degree of Protection test.
- (5) 2 kV for one minute isolation test for core.
- (6) Measurement of no load current with 415 V, 50 Hz AC supply.
- (7) Measurement of capacitance & tan delta between winding & earth.
- (8) IR measurement.
- (9) Frequency response analysis test

II. Type Tests

Following type tests shall be conducted on one transformer of each rating:

- (a) Temperature rise test: Temperature rise test shall be performed at a tap corresponding to maximum losses. The test shall be carried out at minimum 110 % of rated current. Oil samples as per IEC 60567 shall be taken before & immediately after temperature rise test. DGA shall be conducted on this oil sample & the values shall be recorded in the report. For evaluation of gas analysis in temperature rise test the procedure shall be as per IS: 9434 (based on IEC: 567) & results will be interpreted as per IS: 10593 (based on IEC: 60599).
- (b) Tank vacuum test as specified elsewhere in this specification.
- (c) Tank pressure test as specified elsewhere in this specification.
- (d) Lightning impulse test on HV & LV winding for ~~UAT~~ as per Cl. 14 of IEC 60076-3.
- (e) Short circuit test: The test procedure shall be as per IEC 60076-5. All type tests other than tank tests shall be conducted only after S.C. test to ensure delivery of healthy & proven transformer. All dielectric routine tests shall be conducted before & after S.C. test at full value. Further following shall also be done before & after S.C. test:
 - (1) Dissolved gas analysis
 - (2) Frequency response analysis
- (f) Recurrence surge oscillograph Measurement.
- (g) Reports for Degree of Protection test - IP-55 test on ~~CCC~~ / CMB/~~OLTC~~ cabinet cable box of each type for each rating of transformer to be submitted.



III. Special Test

Following special test shall be conducted on the transformer of each rating

- (a.) ~~Power taken by cooling equipment~~
- (b.) No load harmonic measurement
- (c.) Noise level measurement as per NEMA TR-1
- (d.) Zero sequence impedance measurement

IV. Tank Test

(a) Routine test

Oil leakage test on assembled transformer:

All tank & oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of insulating oil conforming to IS: 335 at the ambient temperature & applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than 24 hours during which time no sweating shall occur. This test shall be repeated as a pre-commissioning test at site. The gaskets & flanges used shall be capable of meeting the above requirement. The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. Supplier shall also recommend quality & make of gaskets to be used for replacement during maintenance if required. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage are observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

(b) Type Tests

(1) Vacuum Test

Each transformer tank shall be subjected to the specified vacuum. the tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/sq. m absolute (25 torr) for one hour. The permanent deflection of the



plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length of Flat Plate (in mm)	Permanent deflection (in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

(2) Pressure Test

Transformer tank of each size shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN / sq. m whichever is lower, measured at the base of the tank & maintained for one hour. The permanent deflection of the plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

8.00.00 INSPECTION AND TESTING AT SITE

The Contractor shall carry out a detailed inspection and testing program for field activities covering areas right from the receipt of material stage up to commissioning stage. Testing of oil sample at site shall be carried out as specified elsewhere in this specification.

8.01.00 Receipt and Storage Checks

- (a.) Check and record condition of each package, visible parts of the transformer etc. for any damage.
- (b.) Check and record the gas pressure in the transformer tank as well as in the gas cylinder.
- (c.) Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.
- (d.) Check and Record reading of impact recorder at receipt and verify the allowable limits as per manufacturer's recommendation.



8.02.00 Installation Checks

- (a) Inspection and performance testing of accessories like tap changers, cooling fans, oil pumps etc.
- (b) Check the direction of rotation of fans and pumps.
- (c) Check the bearing lubrication.
- (d) Check whole assembly for tightness, general appearance etc.
- (e) Oil leakage test.
- (f) Check oil sample prior to filling
- (g) Leakage test on bushing before erection.
- (h) Capacitance & tan delta measurement of bushing before fixing / connecting to the winding, contractor shall furnish these values for site reference.

8.03.00 Commissioning Checks

- (a.) Check the colour of silica gel in silica gel breather.
- (b.) Check the oil level in the breather housing, conservator tanks, cooling system, condenser-bushing etc.
- (c.) Check the bushing for conformity of connection to the lines etc. and tan delta test for bushing
- (d.) Check for correct operation of protection devices and alarms:
 - (1) Buchhloz relay.
 - (2) Excessive winding temperature
 - (3) Excessive oil temperature
 - (4) Over fluxing relay
 - (5) Low oil level indication
 - (6) Fan and pump failure protection
 - (7) Oil flow failure
 - (8) Pressure relief valve
 - (9) Differential relay
 - (10) Overload relay
 - (11) Earth fault relay
 - (12) Restricted earth fault relay



- (13) Inter trip
- (14) Trip free check
- (e.) Check for the adequate protection on the electric circuit supplying the accessories.
- (f.) Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:
 - (1) Control wiring.
 - (2) Cooling system motor and control
 - (3) Main windings
 - (4) Tap changer motor and control
 - (5) Tank & turret mounted CTs
 - (6) Core and clamp
 - Core to earth
 - Core clamp to earth
 - Core to core clamp
- (g.) Check for cleanliness of the transformer and the surroundings.
- (h.) Check the following
 - (1) Direction and overload setting of cooling Accessories
 - (2) Buchholz, oil level indicator, pressure gauges, temp indicators etc. for fitting & operation.
 - (3) Earthing of main tank, marshaling Box, tap changer driving gear, pump and fan motor etc.
 - (4) Neutral earthing
 - (5) Calibration of WTI and OTI
 - (6) Earthing of bushing test tap
 - (7) Connection of WTI CT with its heater
 - (8) Tightness of CT secondary connection and shorting of unused CTs
 - (9) All valves for their correct opening and close sequence
- (i.) Phase out and vector group test.
- (j.) Ratio test on all taps.



- (k.) Magnetizing current test (HV winding & LV winding).
- (l.) Capacitance and Tan delta measurement of winding
- (m.) Measurement of noise level.
- (n.) Oil Dielectric strength test-the various tests on oil shall be conducted prior to filling in main tank at site & prior to energization at site as specified elsewhere in this specification. Oil samples are to be drawn from top & bottom of main tank, cooling system.
- (o.) DGA of oil before commissioning
- (p.) Core isolation test
- (q.) Magnetic balance test
- (r.) Short circuit impedance measurement
- (s.) Test on tank/turret mounted CTs
 - (1) IR value between secondary winding & earth and between windings
 - (2) Secondary resistance
 - (3) Polarity
 - (4) Ratio test
 - (5) Magnetization current
- (t.) Test on cooler fan & pump
 - (1) IR Value
 - (2) Starting current
 - (3) Running current
- (u.) WTI and OTI setting for alarm/trip, fan start/stop
- (v.) Final IR Value
 - (1) HV/E+LV
 - (2) LV/E+HV
 - (3) HV/LV
- (w.) Continuously observe the transformer operation at no load for 24 hrs. W.r.t. Voltage, no load current, temperature rise and noise.



- (x.) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

9.00.00 TRANSPORTATION

Nitrogen/dry air filled with sufficient number of impact recorders with necessary arrangement for maintaining the gas pressure during transit and storage.

The temperature and pressure at the time of gas filling shall be marked on a tag. A graph showing pressure vs. temperature shall be attached for reading pressures at different temperatures. Necessary valves, two-stage pressure regulators, filled up Nitrogen cylinder (in case of nitrogen gas is used) etc. along with other accessories required shall be provided with the tank for intermittent replenishment during transportation. The impact recorders will be taken back only after obtaining written permission from Purchaser's Site Incharge.



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ANNEXURE – I

DOCUMENTS REQUIRED ALONG WITH TECHNICAL OFFER

- a) The enclosed Data Sheet-B filled up completely for each rating/ type of transformers.
- b) Schedule of deviations.
- c) Schedule of BOQ cum price schedule. (Unpriced)
- d) 10% Extra oil price schedule (Unpriced)
- e) Schedule of Mandatory spares. (Unpriced)
- f) Schedule of Type test. (Unpriced)

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ANNEXURE – II

DOCUMENTS REQUIRED AFTER AWARD OF LOI

Sl No	DrawingNO	Drg Title
1	PE-V0-412-302-E302	8.0 MVA SERVICE TRANSFORMER (11/3.5 KV) OUTLINE GENERAL ARRANGEMENT DRAWING [OGA]
2	PE-V0-412-302-E303	8.0 MVA SERVICE TRANSFORMER (11/3.5 KV) RATING & DIAGRAM PLATE
3	PE-V0-412-302-E301	8.0 MVA SERVICE TRANSFORMER (11/3.5 KV) TECHNICAL DATA SHEET
4	PE-V0-412-302-E315	8.0 MVA TRANSFORMER (11/3.5 KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY
5	PE-V0-412-302-E304	8.0 MVA TRANSFORMER (11/3.5 KV) FOUNDATION PLAN
6	PE-V0-412-302-E305	8.0 MVA TRANSFORMER (11/3.5 KV) GENERAL ARRANGEMENT OF MARSHALLING BOX
7	PE-V0-412-302-E308	8.0 MVA TRANSFORMER (11/3.5 KV) H.V. BUSHING
8	PE-V0-412-302-E306	8.0 MVA TRANSFORMER (11/3.5 KV) HV CABLE BOX ARRANGEMENT DRAWING
9	PE-V0-412-302-E307	8.0 MVA TRANSFORMER (11/3.5 KV) LV BUS DUCT TRUNKING DRAWING / LV CABLE BOX
10	PE-V0-412-302-E313	8.0 MVA TRANSFORMER (11/3.5 KV) TRANSPORTATION DETAILS
11	PE-V0-412-302-E311	8.0 MVA TRANSFORMER (11/3.5 KV) VALVE SCHEDULE PLATE
12	PE-V0-412-302-E312	8.0 MVA TRANSFORMER (11/3.5 KV) WIRING DIAGRAM FOR MARSHALLING BOX
13	PE-V0-412-302-E382	3.5 MVA SERVICE TRANSFORMER (11/3.5 KV) OUTLINE GENERAL ARRANGEMENT DRAWING [OGA]
14	PE-V0-412-302-E383	3.5 MVA SERVICE TRANSFORMER (11/3.5 KV) RATING & DIAGRAM PLATE
15	PE-V0-412-302-E381	3.5 MVA SERVICE TRANSFORMER (11/3.5 KV) TECHNICAL DATA SHEET
16	PE-V0-412-302-E394	3.5 MVA TRANSFORMER (11/3.5 KV) BI- DIRECTIONAL ROLLERS

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17	PE-V0-412-302-E395	3.5 MVA TRANSFORMER (11/3.5 KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY
18	PE-V0-412-302-E384	3.5 MVA TRANSFORMER (11/3.5 KV) FOUNDATION PLAN
19	PE-V0-412-302-E385	3.5 MVA TRANSFORMER (11/3.5 KV) GENERAL ARRANGEMENT OF MARSHALLING BOX
20	PE-V0-412-302-E388	3.5 MVA TRANSFORMER (11/3.5 KV) H.V. BUSHING
21	PE-V0-412-302-E386	3.5 MVA TRANSFORMER (11/3.5 KV) HV CABLE BOX ARRANGEMENT DRAWING
22	PE-V0-412-302-E389	3.5 MVA TRANSFORMER (11/3.5 KV) L.V. BUSHING
23	PE-V0-412-302-E387	3.5 MVA TRANSFORMER (11/3.5 KV) LV BUS DUCT TRUNKING DRAWING / LV CABLE BOX
24	PE-V0-412-302-E390	3.5 MVA TRANSFORMER (11/3.5 KV) LVN BUSHING
25	PE-V0-412-302-E393	3.5 MVA TRANSFORMER (11/3.5 KV) TRANSPORTATION DETAILS
26	PE-V0-412-302-E391	3.5 MVA TRANSFORMER (11/3.5 KV) VALVE SCHEDULE PLATE
27	PE-V0-412-302-E392	3.5 MVA TRANSFORMER (11/3.5 KV) WIRING DIAGRAM FOR MARSHALLING BOX
28	PE-V0-412-302-E342	6.3 MVA SERVICE TRANSFORMER (11/3.5 KV) OUTLINE GENERAL ARRANGEMENT DRAWING [OGA]
29	PE-V0-412-302-E343	6.3 MVA SERVICE TRANSFORMER (11/3.5 KV) RATING & DIAGRAM PLATE
30	PE-V0-412-302-E341	6.3 MVA SERVICE TRANSFORMER (11/3.5 KV) TECHNICAL DATA SHEET
31	PE-V0-412-302-E354	6.3 MVA TRANSFORMER (11/3.5 KV) BI- DIRECTIONAL ROLLERS
32	PE-V0-412-302-E355	6.3 MVA TRANSFORMER (11/3.5 KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY
33	PE-V0-412-302-E344	6.3 MVA TRANSFORMER (11/3.5 KV) FOUNDATION PLAN
34	PE-V0-412-302-E345	6.3 MVA TRANSFORMER (11/3.5 KV) GENERAL ARRANGEMENT OF MARSHALLING BOX
35	PE-V0-412-302-E348	6.3 MVA TRANSFORMER (11/3.5 KV) H.V. BUSHING
36	PE-V0-412-302-E346	6.3 MVA TRANSFORMER (11/3.5 KV) HV CABLE BOX ARRANGEMENT DRAWING
37	PE-V0-412-302-E349	6.3 MVA TRANSFORMER (11/3.5 KV) L.V. BUSHING

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38	PE-V0-412-302-E347	6.3 MVA TRANSFORMER (11/3.5 KV) LV BUS DUCT TRUNKING DRAWING / LV CABLE BOX
39	PE-V0-412-302-E350	6.3 MVA TRANSFORMER (11/3.5 KV) LVN BUSHING
40	PE-V0-412-302-E353	6.3 MVA TRANSFORMER (11/3.5 KV) TRANSPORTATION DETAILS
41	PE-V0-412-302-E351	6.3 MVA TRANSFORMER (11/3.5 KV) VALVE SCHEDULE PLATE
42	PE-V0-412-302-E352	6.3 MVA TRANSFORMER (11/3.5 KV) WIRING DIAGRAM FOR MARSHALLING BOX
43	PE-V0-412-302-E901	QUALITY PLAN FOR SERVICE TRANSFORMERS
44	PE-V0-412-302-E802	SERVICE TRANSFORMER O & M MANUAL
45	PE-V0-412-302-E805	SERVICE TRANSFORMER TYPE TEST REPORTS

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LIST OF TYPE/SPECIAL TESTS

ANNEXURE – III

TYPE TEST	APPLICABLE (Y/N)	REMARKS
a) Measurement of winding resistance	N	
b) Measurement of voltage ratio and check of voltage vector relationship	N	
c) Measurement of impedance voltage/short-circuit impedance (principal tapping) and load loss	N	
d) Measurement of no-load loss and current	N	
e) Measurement of insulation resistance	N	
f) DIELECTRIC TYPE TEST INCLUDING CHOPPED WAVE IMPULSE TEST ON ALL THREE PHASES	Y	
g) Temperature-rise	Y	
h) DGA TEST ON OIL BEFORE AND AFTER TEMPERATURE TEST	Y	
i) Tests on on-load tap-changers, where appropriate	N	
J) Tank vacuum test	Y	
K) Tank pressure test	Y	
L) Lightning impulse test on HV & LV winding	Y	
M) Short-circuit test	Y	
N) Measurement of acoustic noise level as per NEMA TR-1	Y	
O) Measurement of the harmonics of the no-load current	Y	
P) Recurrence surge oscillograph Measurement	Y	
Q) Measurement of zero-sequence imp of 3-phase transformers	Y	
SPECIAL TEST		
a) DIELECTRIC TYPE TEST INCLUDING CHOPPED WAVE IMPULSE TEST ON ALL THREE PHASES	N	
b) Degree of Protection	Y	ROUTINE TEST
c) Measurement of the power taken by the fans and oil pumps	N	
D) PRD operation test (if PRD is applicable)	N	
E) Frequency response analysis test	Y	ROUTINE TEST

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DATA SHEET -A

11 /3.6kV Aux TRANSFORMER

<u>S. No.</u>	<u>Description</u>	<u>Unit</u>	<u>Particulars</u>
1.0	Quantity	Nos. & kVA	4 & 6300 kVA 2 & 3500 kVA 2 & 8000 kVA
2.0	Installation		Out Door
3.0	Type of insulating oil		Mineral
4.0	No. of phase	No(s)	03
5.0	Frequency	Hz	50
6.0	Type of cooling		ONAN
7.0	Rated Voltage		
	a) HV Winding	kV	11
	b) LV Winding	kV	3.6
8.0	No Load transformation ratio		11/3.6
9.0	Vector group		Dyn1
10.0	Impedance voltage at rated current and frequency (with tolerance as per IS)	%	3500 kVA : 5% 6300 kVA : 6% 8000 kVA : 9%
11.0	Total range of tapping's and tapping steps		± 5% in steps of 2.5%
12.0	Type of tap changing equipment		Off-Circuit

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13.0	Temperature rise		
	a) Top oil by thermometer	deg. C	50 deg. C above ambient of 50 deg.C
	b) Winding by resistance	deg. C	55 deg. C above ambient of 50 deg.C
14.0	System Highest Voltage		
	a) HV Winding	kV	12 kV
	b) LV Winding	kV	3.6kV
15.0	Phase Connection		
	a) HV Winding		Delta
	b) LV Winding		Star
16.0	Insulation Levels		
16.1	One minute power frequency withstand voltage		
	a) HV Winding	kV	28 (11kV)
	b) LV Winding	kV	10 (3.3kV)
16.2	Impulse withstand voltage		
	a) HV Winding	kVp	75 (11 kV)
	b) LV Winding	kVp	40 (3.3kV)
17.0	Terminal details		
	a) HV Line		Cable box (XLPE cables)
	b) HV Neutral		N.A.
	c) LV Line		Segregated phase Al Busduct
	d) LV Neutral		Cable box
18.0	System Fault Level		
	a) HV Winding	kA	50 kA RMS/3 Secs
	b) LV Winding	kA	40 kA RMS/3 Secs

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19.0	Method of System Earthing	
	a) HV System	N.A
	b) LV System	grounded through NGR
	c) Through fault withstand time	3 Sec.
20.0	Details of Cooling Equipment	Detachable tank mounted radiators
21.0	Provision/ accommodation of CTs LV Neutral	1 No HV bushing & 1 no 2 Core (Core-1 PS Class & Core-2 5P20) CT particulars shall be given to successful bidder during detail engineering. There shall be no commercial implication to BHEL on this account.
22.0	Colour Shade :	
	a) Interior (For M. Box)	Particulars shall be given to Successful bidder during detail engineering. There shall be no commercial implication to BHEL on this account.
	b) Exterior	Particulars shall be given to successful bidder during detail engineering. There shall be no commercial implication to BHEL on this account.
23.0	Space/ Layout Limitation if Any	
24.0	Cable details	
	a) HV side	
	i) Type	XLPE
	ii) Voltage Grade	12kV Unearthed
	iii) Conductor material & size	Stranded Aluminium, after award of contract
	iv) No. of cores & runs	Single core -300 Sq mm Al, one run /phase

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LV side

Connected through busduct

- | | | |
|------|---------------------------|-----------|
| i) | Type | N.A |
| ii) | Voltage Grade | kV N.A |
| iii) | Conductor material & size | N.A |
| iv) | No. of cores & runs | N.A |

25.0 Penalty for Losses

- | | | |
|-----|--------------------------|---|
| a) | Rates for bid evaluation | N.A. |
| b) | ‘A’ (for no load loss) | Losses not to exceed max. losses as per annexure-B to section-II, vol-II of the specification |
| ii) | ‘B’ (for load losses) | - Do- |
| c) | Rates for penalty | |
| i) | ‘A’ (for no load loss) | As per NIT |
| ii) | ‘B’ (for load loss) | As per NIT |

28.0 Creepage distance

25mm/kV

29.00 Painting Procedure

As per Cl no 4.14.00 of Customer Spec

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DATA SHEET –B

TECHNICAL PARTICULARS

[TO BE SUBMITTED ALOGWITH TECHNICAL OFFER]

FOR 11kV/3.6kV

S. No	Description	6.3MVA	3.5MVA	8 MVA
1.	Rating			
2.	No Load transformation ratio			
3.	Maximum No- load losses at rated frequency and 100% rated voltage			
4.	Maximum load losses at normal ratio, rated current and 75 deg. C			
5.	Overall Dimensions			
6.	Total weight			
7.	Total oil Quantity			

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DATA SHEET –C

TECHNICAL PARTICULARS

[*TO BE SUBMITTED AFTER AWARD OF CONTRACT*]

<u>S. No.</u>	<u>Description</u>	<u>Unit</u>	<u>Particulars</u>
1.0	Name of Manufacturer		
2.0	Reference Standards		
3.0	Installation		
4.0	Rated no load Voltage		
	a) HV Winding	kV	
	b) LV Winding	kV	
5.0	Type of cooling		
6.0	Rated kVA		
7.0	No. of phase	No(s)	
8.0	Rated Frequency	Hz	
9.0	Winding connections		
	a) HV Winding		
	b) LV Winding		
10.0	Vector group		
11.0	Impedance voltage at rated current and frequency for the principal tapping at 75 deg. C	%	
12.0	Off-Circuit tap changer		
	a) Total range of tapplings (+/-)	%	
	b) Size of tapping step	%	
	c) For HV/LV variation		
13.0	Impulse voltage withstand level		

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	a) HV Winding	kVp
	b) LV Winding	kVp
14.0	Power frequency withstand voltage for one minute	
	a) HV Winding	kV
	b) LV Winding	kV
15.0	Maximum No load losses at rated frequency and	
	a) 100% rated voltage	kW
	b) 110% rated voltage	kW
16.0	Maximum Load losses at normal ratio, rated current and 75 deg. C	
17.0	Tolerance on losses (+/-)	
18.0	Guaranteed maximum Temperature rise of	
	a) Top oil by thermometer	deg. C
	above ambient of 50 deg. C	
	b) Winding by resistance	deg. C
	above ambient of 50 deg. C	
19.0	Efficiency at 75 deg. C and unity power factor for	
	a) 100% full load	%
	b) 75% full load	%
	c) 50% full load	%
20.0	Voltage regulation at full load at 75 deg. C	
	a) Unity power factor	%
	b) 0.8 Power factor (Lagging)	%
21.0	External short circuit withstand capacity & duration	MVA, sec
22.0	Max. short time (30 sec.) rating of transformer	KVA
23.0	Type of magnetic circuit	Core/ Shell
24.0	Type of core joints	

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- 25.0 Type of winding
a) HV Winding
b) LV Winding
- 26.0 Type of insulation
a) HV winding
b) LV winding
c) Between core & adjacent winding
d) Between windings
- 27.0 HV terminal arrangement
a) Bushing with or without CTs
b) CT details (Ratio, ACC. Class, VA, Type)
c) Clearance between phases in air mm
d) Clearances to earth in air mm
- 28.0 LV terminal arrangement
a) Bushing with or without CTs
b) CT details (Ratio, ACC. Class, VA, Type)
c) Clearance between phases in air mm
d) Clearances to earth in air mm
- 29.0 Neutral terminal arrangement
a) No. of neutral terminals
b) Neutral CT provided or not
c) NCT details (Ratio, ACC. Class, VA, Type)
- 30.0 HV Bushing
a) Rated voltage class kV
b) Rated current A
- 31.0 LV Bushing
a) Rated voltage class kV
b) Rated current A
- 32.0 LV Neutral Bushing
a) Rated voltage class kV
b) Rated current A
- 33.0 Maximum flux density

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	a) At rated voltage	Wb/M2
	b) At 110% rated voltage	Wb/M2
34.0	Maximum current density for	
	a) HV Winding	Amp/mm2
	b) LV Winding	Amp/mm2
35.0	Magnetising current at rated voltage and frequency (% of full load current)	
36.0	Rollers	
	a) Type	
	b) Unidirectional/ Bidirectional	
	c) Quantity	
	d) Gauges	
	i) Longitudinal	mm
	ii) Transverse	mm
37.0	Pressure test withstand	
	a) Tank	Kg/M2
	b) Radiator and other fittings	Kg/M2
38.0	Vacuum withstand	
	a) Tank	mm of Hg
	b) Radiator and other fittings	mm of Hg
39.0	Approximate weight of	
	a) Core	Kg
	b) Windings	Kg
	c) Tank, Fittings & Coolers etc.	Kg
	d) Oil	Kg
	e) Total weight with oil	Kg
	f) Untanking weight (core & winding)	Kg
	g) Shipping weight of the heaviest package	Kg
40.0	Quantity of Insulating Oil	
	a) Oil in tank	Ltrs.
	b) Oil in cooling equipment	Ltrs.
	c) Total oil Quantity	Ltrs.
41.0	Dimensions	
42.1	Tank dimensions	
	a) Length	mm

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	b) Breath	mm
	c) Height	mm
42.2	Shipping dimensions of the largest package	
	a) Length	mm
	b) Breath	mm
	c) Height	mm
42.3	Overall Dimensions (LxBxH)	(mmXmmXmm)
43.0	Details of tank and other material	
	a) Thickness of tank side plate	mm
	b) Thickness of tank bottom plate	mm
	c) Thickness of tank cover plate	mm
	d) Thickness of radiator sheets	mm
	e) Minimum clearance height for lifting core and winding from tank	mm
44.0	Positive sequence impedance at	
	a) Maximum voltage tap	%
	b) Minimum voltage tap	%
45.0	Zero-sequence impedance at principal tap	%
46.0	Paint Shade	:
47.0	Voltage Variation	: CFVV
48.0	Noise Level	:
49.0	Degree of Protection	
	a) Marshalling Box	: IP55
	b) HV Cable Box	: IP55
	c) LV Flange Enclosure	: IP55
50.0	Creepage Distance	
	a) HV Bushing (mm/kV)	:
	b) LV Bushing (mm/kV)	:
	c) Neutral Bushing (mm/kV)	:
51.0	Material of Winding	
	a) HV/LV	:

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52.0	Insulation level separate source power frequency voltage withstand	
	h) HV winding (kV RMS)	:
	ii) LV winding (kV RMS)	:
	iii) HV Bushing	:
	iv) LV Bushing	:
	v) Neutral Winding	:
53.0	Temperature Class of Insulation	:
54.0	Over Excitation withstand time (sec)	
	100%	:
	110%	:
	125%	:
	140%	:
55.0	Thermal Time constant	:
56.0	Magnetizing Inrush Current	:
57.0	Radiator Details	
	a) No. of Radiators	:
	b) No. of Flutes	:
	c) Overall Dimensions	:
	d) Radiator sizing calculations furnished	:(YES/NO)

SECTION 'II'

STANDARD TECHNICAL SPECIFICATION

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1.00.00 SCOPE

1.01.00 This specification covers the design, manufacture, inspection & testing, packing at manufacturer's works and delivery to site of mineral oil filled service Transformers complete with all fittings & accessories for satisfactory operation at site.

1.02.00 TERMINAL POINTS

1.02.01 HV bushings with terminal connector for bus duct/ cable glands & lugs in case of cable connection.

1.02.02 LV bushings with terminal connector (3 Phase + ~~1 Neutral~~) for bus duct/ cable glands & lugs in case of cable connection.

1.02.03 For HV Earthing : (Applicable in case of star connection of HV) - neutral earth busbar brought near the base of transformer/ Cable glands & lugs in case of cable connection.

1.02.04 For LV Earthing : - neutral earth busbar brought near the base of transformer/ Cable glands & lugs in case of cable connection

1.02.05 Transformer earthing pads.

1.02.06 Terminals of marshalling box for external connection to equipment supplied by the purchaser.

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2.00.00 CODES AND STANDARDS

S.NO.	STANDARD NUMBER	STANDARD TITLE
1	IS:2026 IEC: 60076	POWER TRANSFORMERS
2	IS:1180	OUTDOOR TYPE OIL IMMERSSED DISTRIBUTION TRANSFORMERS UPTO AND INCLUDING 2500 kVA, 33kV - SPECIFICATION
2	IS:6600	GUIDE FOR LOADING OF OIL IMMERSSED TRANSFORMER
3	IS: 3639	FITTINGS & ACCESSORIES FOR POWER TRANSFORMER
4	IS: 335 IEC: 60296	NEW INSULATING OILS
5	IS: 2099 IEC: 60137	Bushing for alternative voltage above 1000 volts
6	IS: 3347	Dimension for porcelain transformer bushings
7	IS: 2705 IEC: 60185	Current transformers
8	IS: 3637	Gas operated relays
9	IS:1271 IEC: 60216	Classification of insulating material for electrical machinery & apparatus in relation to their thermal stability in service
10	IS/IEC: 60529	Classification of degrees of protection provided by enclosures of electrical equipment
11	IS: 2071 IEC: 60060	Method of high voltage testing
12	IS: 5	Colours for ready mixed paints & enamels
13	NEMA, STANDARD-TR1	Noise level
14	CBIP Publication (latest edition)	Manual on transformers

2.01.00 The equipment shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where the equipment is to be installed including Indian Electricity Act, Indian Electricity Rules and Bureau of Indian Standards.

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3.00.00 TECHNICAL REQUIREMENTS

- 3.01.00 Technical particulars of transformers are specified in Data Sheet –A of section-I, volume-II.
- 3.02.00 All windings shall be fully insulated. Material of the windings shall be electrolytic grade copper, free from scales and burrs. Winding shall be uniformly insulated.
- 3.03.00 The core shall be constructed from high grade, non-ageing, cold rolled, grain oriented silicon steel laminations.
- 3.04.00 Internal design of transformer shall ensure that air is not trapped in any location.
- 3.05.00 Nuts, bolts and pins used inside the transformer shall be provided with lock washers & locknuts
- 3.06.00 **Tank**
- 3.06.01 Under base of tank shall be fixed type.
- 3.06.02 Tank shall be of welded construction & fabricated from tested quality low carbon steel of adequate thickness. Tank shields, if provided, shall not resonate at natural frequency of equipment.
- 3.06.03 All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant oil in soluble insulating varnish.
- 3.06.04 Auxiliary transformers shall have suitable bi-directional skids, however auxiliary transformers above 2 MVA shall be provided with four no. of bi-directional detachable flat rollers. Suitable locking arrangement shall be provided to prevent accidental movement of transformer.
- 3.06.05 At least two adequately sized inspection openings, one at the each end of the tank for easy access to bushings and earth connections & suitable manhole shall be provided.
- 3.06.06 The main tank body including tap-changer compartment, radiators and coolers shall be capable of withstanding full vacuum.

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- 3.06.07 All tank and oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature and applying pressure equal to the normal pressure plus 35 kN/m² measured at the base of the tank.
- 3.07.00 **Tank mounting**
 Tank shall also be provided with lifting lugs and minimum four jacking pads. Rollers shall be provided with holding clamp plates (04 nos), required hardware and foundation bolts etc. for each transformer.
- 3.08.00 **Oil preservation**
 Conservator tank of adequate capacity for expansion of oil from minimum ambient to 100 deg. C shall be provided. The transformers rated 6.3MVA and above shall be provided with air bag breathing through silica gel breather. For lower rating transformers with conventional conservator with dry air filling of the space above oil and connected to silica gel breather shall be provided.
- 3.09.00 **Radiators**
 The radiators shall be detachable type, mounted on the tank. Each radiator shall be provided with a drain plug/valve at the bottom, an air release plug at the top, shut off valve at each point of connection to the tank.
- 3.10.00 **Insulating Oil**
 As per IS: 335. No external inhibitors are permitted.
- 3.11.00 All transformers shall be suitable for cable/ busduct termination as indicated in data sheet-A of section-I, volume-II.

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3.12.00 **Bushings/ Insulators**

- 3.12.01 The bushings shall conform to the requirements of IS: 2099 and IS: 3347 and shall be of porcelain and above 3150A for the LV bushing Epoxy bushing shall also be acceptable.
- 3.12.02 For 33kV windings 36kV bushing shall be provided. For 3.3kV, 6.6kV and 11 kV windings, 17.5kV bushing shall be provided. For 415V windings, 1.1kV bushings shall be provided.
- 3.12.03 The porcelain shall not engage directly with hard metal and, wherever necessary, gaskets shall be interposed between the porcelain and the fitting.
- 3.12.04 Clamps and fittings of steel or malleable cast iron shall be galvanised.
- 3.12.05 Where bushing current transformer is provided, the bushing shall be mounted so that it can be removed and replaced without disturbing the current transformers. CTs shall be cast resin type & suitable for operation at ambient temperature existing at its location on the transformer.
- 3.12.06 Creepage distance shall be as per data sheet-A of section-I, volume-II.
- 3.12.07 Minimum rated current for bushings shall be as under. However, same shall comply with IS-2099 and HV/LV system fault current mentioned in Clause No. 20.00 of Datasheet A of section-I, volume-II:
- 1) H V Bushing for 33kV
 - 7.5 MVA = 250A
 - 5.0 MVA = 100A
 - 2.0 MVA = 100A
 - 2) H V Bushing for 11kV & 6.6kV
 - 10.0MVA= 1000A
 - 8.0MVA = 1000A
 - 7.5MVA = 800A
 - 6.3MVA = 800A
 - 5.0MVA = 630A
 - 3.5MVA = 250A
 - 2.5 MVA = 250A

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2.0 MVA = 250A

1.6 MVA = 250A

1.0 MVA = 100A

630 kVA = 100A

2) H V Bushing for 3.3kV

2.5 MVA = 630A

2.0 MVA = 500A

1.6 MVA = 400A

1.0 MVA = 250A

630 kVA = 250A

3) L V Bushing for 11kV, 6.6kV & 3.3kV

10.0MVA= 2500A

8.0MVA = 2000A

7.5MVA = 1600A

6.3MVA = 1600A

5.0MVA = 1250A

3.5MVA= 1250A

4) L V Bushing for 433V/420V

2.5 MVA = 4000A

2.0 MVA = 4000A

1.6 MVA = 3150A

1.0 MVA = 2000A

630 kVA = 1000A

3.13.00 **Cable Box**

3.13.01 A dust tight air insulated type cable box with D.O.P. of IP: 55 shall be provided for terminating the cables directly of size and type specified in Data sheet-A of section-I, volume-II. The cable box shall also be provided with a suitable canopy. Suitable cable glands (double compression type) and lugs shall be provided for cable termination.

3.13.02 Dimensions of cable box shall be subject to purchaser's approval.

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- 3.13.03 Inspection cover for fixed portion of cable box shall be provided. Handles for lifting cable box shall be provided.
- 3.13.04 Creepage distance shall be as per data sheet-A of section-I, volume-II.
- 3.13.05 Provision shall be made for earthing the body of each cable box. Separate earthing pads shall be provided for this purpose, suitable for bolted connection to galvanised mild steel flat of size to be specified during contract engineering stage.
- 3.13.06 Gland plate for single core cable termination shall be of Aluminium.
- 3.13.07 Cable box(es) shall be provided with suitable air-insulated disconnecting chamber so that if required, transformer can be removed from its position without disconnecting the cables in the cable box(es). Independent supporting arrangement shall be provided for cable box(es) for this purpose. Supporting arrangement shall be supplied along with required hardware & foundation bolts etc.

3.14.00 **Busduct Termination**

If LV terminals are specified to be connected by means of a busduct, a flanged throat or equivalent connection shall be provided to suit purchaser's busducts. The winding termination shall be on outdoor type of bushing. Necessary flexibles shall be provided by purchaser to connect the bushing terminals to the busbars of the busduct. Details of busduct shall be furnished during detail engineering stage. Degree of protection of LV busduct flange enclosure shall be IP:55.

3.15.00 **Neutral Terminals**

~~Two (2) nos. neutral terminals shall be provided on LV side. One neutral terminal shall be part of phase connection arrangement busduct throat/ LV cable box (as applicable). Other neutral terminal shall be in a separate box and brought to tank bottom by means of earthing bar of 50x6 mm of copper, supported on porcelain insulators mounted on transformer tank. The neutral earthing bar brought to the tank bottom for connection to station earth shall be provided with holes and suitable connecting hardware. This earthing bar shall have fork type arrangement at the end. However neutral may be connected to NGR as per system requirement.~~

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3.16.00 **Neutral CT**

Bidder to provide neutral bushing CT as per details given in data sheet – A of section-I, volume-II for restricted earth fault protection or standby earth fault protection. In case neutral CT is tank mounted, CT box shall be weather proof having D.O.P. IP: 55. The Neutral CT box shall also be provided with a suitable canopy. CTs shall be cast resin type.

All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.

3.17.00 **Valves**

3.17.01 All valves upto and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings.

3.17.02 Sampling & drain valves should have zero leakage rate.

3.18.00 **Gaskets**

3.18.01 Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork.

3.18.02 If gasket is compressible, metallic stops shall be provided to prevent over compression.

3.18.03 The gaskets shall not deteriorate during the life of transformer/shunt reactor if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer.

3.19.00 **Voltage control (off circuit type)**

3.19.01 Off circuit tap-changing switch shall be three phase, hand operated, for simultaneous switching of similar taps on all the three phases by operating an external handle/ hand wheel. The position of off-circuit tap switch handle/hand wheel provided outside the transformer tank should be such as to enable an operator standing on ground to operate the same with ease. A caution plate indicating that switch shall be operated only when the transformer is de-energised shall be fitted near tap switch.

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- 3.19.02 Operating mechanism of tap changer shall be suitably labelled to show the direction of operation for raising secondary voltage & vice versa. Position markings shall be provided.
- 3.19.03 Arrangement shall be made for securing and padlocking the tap-changing switch at any working position. It shall not be possible to set and padlock in any intermediate position.
- 3.19.04 Tap position indicator and mechanical stops to prevent over-cranking of the mechanism shall be provided.
- 3.20.00 **Marshalling box**
- 3.20.01 Tank mounted vermin and dust proof marshalling box shall be provided to accommodate indication circuits and temperature indicators etc. and provided with proper lighting and thermostatically controlled space heaters.
- 3.20.02 The marshalling box shall be fabricated using sheet steel of at least 2.5mm thickness. The marshalling box shall have domed or sloping roof.
- 3.20.03 Marshalling box shall be complete with all internal wiring and identification ferrules, cables, conduits required for wiring between marshalling box and instruments on transformer. Wiring shall be by 1100 V grade, copper cable of size 2.5mm².
- 3.20.04 The terminal blocks shall be complete with insulating barriers and clip-on type terminals suitable for 2.5mm² stranded copper wire. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber.
- 3.20.05 The marshalling box shall have IP: 55 degree of protection.
- 3.20.06 CT terminals shall be with shorting and disconnecting facility. TB shall be stud type for all CT & power connection.
- 3.20.07 Wiring scheme shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door. Refer annexure-C for standard terminal block numbering.

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3.21.00 **Flux density**

Flux density in any part of the core & yoke on any tap position with $\pm 10\%$ voltage variation from voltage corresponding to the tap shall not exceed 1.9 Wb/m^2 .
Transformer shall also withstand following conditions due to combined voltage and frequency variations:

- Continuous operation for 110% flux density
- At least 1 minute operation for 125% flux density
- At least 5 sec. operation for 140% flux density

3.22.00 **Winding**

For 33kV, 11kV & 3.3kV winding, type of winding shall be continuous disc & for 433V/ 420V winding, type of winding shall be spiral type. The conductors shall be of Electrolytic grade copper.

3.23.00 **Noise & Vibration**

The design and manufacture of transformer, fittings and accessories shall be such as to reduce noise & vibration. Noise level shall not be more than as specified in NEMA Standard Publication TR-1, when measured with transformer energised at normal voltage and frequency.

3.24.00 All transformers and their accessories shall be capable of withstanding without damage any external short circuit at the terminals for duration of two seconds.

3.25.00 Maximum Transformer losses including tolerances shall be as per annexure – B, of section-I, volume-II.

3.26.00 **LOADING CAPABILITY**

Transformer shall be suitable for continuous operation at rated kVA on any tap with voltage variation of $\pm 10\%$ corresponding to voltage of the tap. Short duration overloading shall be in accordance with IS:6600 / IEC60076-7.

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4.00.00 Fittings & accessories

4.01.00 Transformer shall be provided with, but not restricted to following minimum fittings and accessories for satisfactory operation:

4.01.01 Conventional type conservator with drain valve and oil filling hole.

4.01.02 Magnetic oil level gauge with low-level alarm contact.

4.01.03 Prismatic & toughened glass oil level gauge.

4.01.04 Gaskets

4.01.05 Gasket protection covers.

4.01.06 Silica gel breather with oil seal.

4.01.07 Double float type Buchholz relay with alarm and trip contacts with suitable gas collecting device with two shut-off valve on both side.

4.01.08 Diaphragm type explosion vent for transformers of rating less than 2MVA

4.01.09 Pocket on tank cover for thermometer.

4.01.10 Protected type mercury in glass thermometer.

4.01.11 Dial type (150 mm) Oil temperature indicator (OTI) with two sets of electrical potential- free contact rated for 2A, 220V DC, for alarm and trip purpose. The OTI shall be provided with anti-vibration mounting. OTI shall have maximum reading pointer along with resetting device. For remote oil temperature metering, an independent 4-20 mA should be made available.

4.01.12 Dial type (150 mm) Winding temperature indicator (WTI) with two sets of electrical potential- free contact rated for 2A, 220V DC, for alarm and trip purpose. The WTI shall be provided with anti-vibration mounting. WTI shall have maximum reading position along with resetting devices. For remote winding temperature metering, an independent 4-20 mA should be made available.

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- 4.01.13 Drain Valves.
- 4.01.14 Sampling devices.
- 4.01.15 Filter valves.
- 4.01.16 Earthing terminals – 2 Nos.
- 4.01.17 Rating & Diagram plates.
- 4.01.18 Valve schedule plate.
- 4.01.19 Two sets of lifting lugs (one for transformer with oil and other for tank cover).
- 4.01.20 Jacking pads.
- 4.01.21 Skids and pulling eyes on both sides.
- 4.01.22 Air release devices.
- 4.01.23 Inspection cover.
- 4.01.24 Oil filling hole and cap.
- 4.01.25 Tank mounted marshalling box.
- 4.01.26 Detachable, flat, bidirectional rollers with 90 deg. swivel mechanism.
- 4.01.27 Clamping arrangement for rollers.
- 4.01.28 Ground support for cable box.
- 4.01.29 Neutral CT secondary box.
- 4.01.30 Haulage facilities.

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- 4.01.31 Two nos. spring operated pressure relief devices with extension pipe to bring oil to plinth level along with electrically insulated contact for alarm and tripping for transformer rating 2 MVA and above.
- 4.01.32 Gas collection device along with all accessories.
- 4.02.00 Breather shall be fitted at a height not exceeding 1.5 M.
- 4.03.00 Rating and diagram plate shall be fitted at a height of about 1.75 M above the ground level.
- 4.04.00 The WTI and OTI shall have accuracy class of ± 2 deg. C or better.
- 4.05.00 Rating/ Name/ Valve schedule plates shall be of white non-hygroscopic material with engraved black lettering. Such plates shall be bi- lingual (requirement will be finalised during detailed engineering) with Hindi inscription first, followed by English. Alternatively, two separate plates with Hindi & English inscription shall be provided.
- 5.00.00 **PAINTING**
- Paint shade shall be informed to successful bidder during detail engineering as applicable for specific project. Adequate quantity of touch up paint shall also be supplied. There shall be no commercial or delivery implication to BHEL on account of paint shade, paint specification/ procedure.
- 6.00.00 **QUALITY ASSURANCE, TESTING & INSPECTION**
- 6.01.00 BHEL's Standard QP (PE-QP-999-302-E001 Rev. 0) is enclosed as per Annexure-A of section-II, volume-II for reference. In case bidder has reference QP agreed with ultimate customer, same can be submitted for specific project after award of contract for BHEL/ ultimate customer's approval. There shall be no commercial or delivery implication to BHEL on account of QP approval.
- 6.02.00 All materials, components and accessories of the transformers shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan.

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- 6.03.00 Tests shall be performed in presence of Purchaser's representative. The bidder shall give at least fifteen (15) days advance notice of date when the tests are to be carried out.
- 6.04.00 All routine and acceptance tests as per relevant standards and specification shall be carried out by the vendor/ sub-vendor on all transformers.
- 6.05.00 Successful bidder shall furnish List of sub-vendors/ makes of items for BHEL/ customer approval at contract stage. This shall not have any commercial implication to BHEL.
- 6.06.00 For acceptance of short circuit reports for tests carried out earlier on similar transformers, successful bidder shall furnish the following documents for BHEL/ BHEL's customer acceptance without any commercial/ delivery implication to BHEL
- 6.06.01 Calculations and design considerations to prove ability to withstand the dynamic effects of short circuit.
- 6.06.02 Short circuit test report of previously tested similar transformer for validation by comparison. Criteria for similarity of transformer for acceptance of Short circuit test report shall be as given in the Annexure-B of IEC-60076-5.
- 7.00.00 COMMISSIONING SPARES, SPECIAL TOOLS & TACKLES AND O & M SPARES**
- 7.01.00 Commissioning spares are those, which may be required during commissioning of the equipment. Bidder to furnish list of commissioning spares along with technical offer as per annexure-IV of section-I, volume-II.
- 7.02.00 The bidder shall supply with the equipment, one unused complete set of all special tools & tackles required for the erection, assembly, disassembly and proper maintenance of the equipment. A list of such tools & tackles (price deemed to be included in the total bid price) shall be submitted by the bidder along with the offer as per annexure-V of section-I, volume-II.
- 7.03.00 O & M spares are those which are required for satisfactory & trouble free operation of equipment. List of O & M spares is enclosed as per Annexure-D of section-II, volume-II. O & M spares shall be quoted (if applicable) as per BOQ-cum-price schedule as part of NIT.

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS	SPECIFICATION NO. PE-SS-999-302-E001
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8.00.00 O & M MANUALS

- 8.01.00 O & M manuals for the installation, operation and maintenance of transformers shall be furnished at least three months before despatch of equipment.
- 8.02.00 Draft manual should first be submitted for purchaser's approval. The manual should contain minimum following details:
- 8.02.01 General description of equipment.
 - 8.02.02 Approved Technical Data Sheet
 - 8.02.03 All drawings
 - 8.02.04 Salient constructional features.
 - 8.02.05 Technical leaflets of fittings/ important parts.
 - 8.02.06 Type and routine test certificates.
 - 8.02.07 Instructions to be followed on receipt of equipment at site & for storage.
 - 8.02.08 Instructions for foundation arrangement.
 - 8.02.09 Erection procedures and checks.
 - 8.02.10 Pre-commissioning checks.
 - 8.02.11 Commissioning procedures.
 - 8.02.12 Withdrawal arrangement/ material handling instructions.
 - 8.02.13 Operation instructions.
 - 8.02.14 Maintenance instructions.
 - 8.02.15 Trouble-shooting.
 - 8.02.16 Safety instructions.

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ANNEXURE - A

STANDARD QUALITY PLAN

		QUALITY PLAN SHEET 1 OF 10		CUSTOMER : RPCL		PROJECT TITLE : 2 X 800MW YERAMARUS TPS		SPECIFICATION NO. : PE-TS-362-302-E001				
				BIDDER/ Esennar Transformers Private Limited		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE: TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS				
				VENDOR		ITEM :OIL FILLED TRANSFORMER		DOC. NO. : PE-V0-362-302-E314				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIALS & BOUGHT OUT ITEMS											
1.1	Mild Steel plate, MS Pipe, Channels, MS Angles	a) Thickness b) Surface defects c) Chemical composition d) Mechanical Properties e) Hydraulic test of pipes	Major Major Major Major Major	MEASURE VISUAL TEST TEST TEST	10% 100% - - -	'MANUFUF. STD / IS:2062 / IS:1239	'MANUFUF. STD / IS:2062 / IS:1239	QC Record. QC Record. Supplier's TC Supplier's TC Supplier's TC	3/2 3/2 3/2 3/2 3/2		1 2 - 2 2	
1.2	CRGO Steel	a) Thickness Dimension & Finish b) Grade of CRGO c) Cutting & burr d) Scratches, surface finish e) Waviness & edge camber f) Specific core loss g) Surface resistivity h) Stacking factor i) Permeability j) Bend test/ Ductility	Major Major Major Major Major Major Major Major Major Major	MEASURE MEASURE MEASURE VISUAL MEASURE TEST TEST TEST TEST MEASURE	10% - 10% 10% 10% - - - - -	DRG/DATA SHEET/ 'MANUFUF. STD / IS:3024 / IS:649	DRG/DATA SHEET/ 'MANUFUF. STD / IS:3024 / IS:649	QC Record. TC QC Record. QC Record. QC Record. Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 2 3/2 2 3/2 3/2 3/2 3/2 3/2		1 2 - 1 2 2 2 2 2	
1.3	Paper Insulated Copper Conductor	a) Dimensions b) Resistivity/Conductivity c) Elongation d) Tensile Strength e) Proof stress if applicable f) Insulation test between strands for bunched conductors g) Cu purity of CC rod h) Chemical composition i) Surface Finish	Major Major Major Major Major Major Major Major Major	MEASURE TEST TEST TEST TEST TEST TEST TEST VISUAL	100% 10% - - - - - - 100%	'MANUFUF. STD / IS:13730-P-27/IEC 60554	'MANUFUF. STD / IS:13730-P-27/IEC 60554	QC Record. Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC QC Record.	2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 2		1 1 2 2 2 2 2 2 2	
1.4	Insulating Paper	a) Dimensions b) Density & substance c) Tensile Strength d) Elongation e) Water absorption f) Moisture content g) pH value & conductivity aqueous extract h) Ash content i) Electrical strength j) Air permeability k) Tear index l) Heat stability	Major Major Major Major Major Major Major Major Major Major Major Major	MEASURE TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST	10% - - - - - - - - - - -	'MANUFUF. STD / IS:9335-P-2/IS:9335-P-III/IEC 60554	'MANUFUF. STD / IS:9335-P-2/IS:9335-P-III/IEC 60554	QC Record. Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2		1 2 2 2 2 2 2 2 2 2 2	
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE				BIDDER'S/VENDORS COMPANY SEAL						
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

		QUALITY PLAN SHEET 2 OF 10		CUSTOMER : RPCL		PROJECT TITLE : 2 X 800MW YERAMARUS TPS		SPECIFICATION NO. : PE-TS-362-302-E001				
				BIDDER/ Esennar Transformers Private Limited		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE: TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS				
				VENDOR		ITEM :OIL FILLED TRANSFORMER		DOC. NO. : PE-V0-362-302-E314				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.5	Insulation & Press-Board moulding (stock items)	a) Dimension b) Compressibility c) Density d) Tensile strength e) pH value/Conductivity of water extract f) Electrical strength in air & oil g) Shrinkage in air h) Flexibility i) Ash content j) Moisture content k) Cohesion between plies l) Elongation m) Oil absorption	Major Major Major Major Major Major Major Major Major Major Major Major	Measure Test Test Test Test Test Test Test Test Test Test Test	10% - - - - - - - - - -	'MANFUF. STD / IS:1576	'MANFUF. STD / IS:1576	QC Record. Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2	1 2 2 2 2 2 2 2 2 2 2		
1.6	Densified wood	a) Dimension b) Surface finish c) Electrical strength in oil d) Oil absorption e) Moisture content f) Compression strength g) Crossbreaking strength h) Tensile strength i) Specific gravity/ Density	Major Major Major Major Major Major Major Major Major	Measure Visual Test Test Test Test Test Test Test	10% 10% - - - - - - -	'MANFUF. STD / IS:3513	'MANFUF. STD / IS:3513	QC Record. QC Record. Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 2 3/2 3/2 3/2 3/2 3/2 3/2 3/2	1 - 1 - - - - - -		
1.7	Gasket(Rubber Bonded Cork sheet (if applicable)	a) Dimension b) Hardness c) Tensile strength d) Compressibility e) Recovery f) Compression set g) Flexibility h) Fluid resistance test i) Chloride/Sulphate content of water extract j) Density	Major Major Major Major Major Major Major Major Major Major	Measure Test Test Test Test Test Test Test Test Test	10% - - - - - - - - -	'MANFUF. STD / IS:4253	'MANFUF. STD / IS:4253	QC Record. Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2 3/2	- 1 - 1 - - - - - -		
1.8	Nitrile Rubber Cord and "O" Ring (if applicable)	a) Dimension b) Shore Hardness c) Tensile strength d) Elongation at break e) Compression set f) Accelerated Ageing in oil	Major Major Major Major Major Major	MEASURE Test Test Test Test Test	10% - - - - -	'MANFUF. STD / IS:4253	'MANFUF. STD / IS:4253	Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2 3/2	- - - - - -		
			PARTICULARS		BIDDER/VENDOR							
BHEL			NAME									
			SIGNATURE									
			DATE				BIDDER'S/VENDORS COMPANY SEAL					
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

[illegible]

		QUALITY PLAN SHEET 4 OF 10		CUSTOMER : RPCL		PROJECT TITLE : 2 X 800MW YERAMARUS TPS		SPECIFICATION NO. : PE-TS-362-302-E001				
				BIDDER/ Esennar Transformers Private Limited		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE: TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS				
				VENDOR		ITEM :OIL FILLED TRANSFORMER		DOC. NO. : PE-V0-362-302-E314				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	Bucholz Relay	a) Type, size & make b) Continuity for alarm & trip (Performance) c) Porosity test d) High voltage & IR test e) Element test f) Gas volume test g) Loss of oil & surge test	Major Major Major Major Major Major Major	Visual Test Test Test Test Test Test	100% - - - - - -	MANFUF. STD./ IS:3637	MANFUF. STD./ IS:3637	QC records Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2 3/2 3/2		1 2 2 2 2.1 2.1	
2.4	Pressure Relief Device	a) Type, size & make b) Operation (Pressure & flag indication) c) HV Test d) Switch contact operation	Major Major Major Major	Visual Test Test Test	100% - - -	MANFUF. STD./ IS:3637	MANFUF. STD./ IS:3637	QC records Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2		1 2.1 2.1 2	
2.5	Magnetic Oil Lavel Gauge (MOG)	a) Type, size & make b) Dial marking c) Switch continuity d) HV test e) Operation test	Major Major Major Major Major	Visual Visual Test Test Test	100% - - - -	MANFUF. STD'	MANFUF. STD.'	QC records Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2		1 2 2 2 2	
2.6	Off-Circuit Tap Changer/Switch (if applicable)	a) Dimensions b) Physical condition c) operation of switch d) Insulation resistance test e) Leak test of handle stuffing box f) Milli volt drop test	Major Major Major Major Major Major	Measure Visual Test Test Test Test	100% 100% - - - -	MANFUF. STD'	MANFUF. STD'	QC records QC records QC records Supplier's TC Supplier's TC Supplier's TC	2 2 2 3/2 3/2 3/2		- - - 2 2 2	
2.7	On load Tap Changer (if applicable)	a) Visual check b) Dimensional check c) Mechanical operation on Diverter & Selector switch, 4000 switching oper. (Min) d) HV test on Auxiliary circuit e) Sequence test f) Pressuure test of diverter switch compartment with oil g) Mechanical test of Tap selector with motor drive 500 satisfactory opm(in all) from one extreme position to the other in air h) Opm test of complete tapchanger i) Aux. ckt. HV test at 2 KV for 1 min.	Major Major Major Major Major Major Major Major Major	Visual Measure Verify Test Test Test Test Test Test	100% 100% - - - - - - -	IS:8468/IEC 60214	IS:8468/IEC 60214	QC records Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 2 3/2 3/2 3/2 3/2 3/2 3/2		- - 2 2.1 2.1 2.1 2.1 2.1	
			PARTICULARS		BIDDER/VENDOR							
BHEL			NAME									
			SIGNATURE									
			DATE									
							BIDDER'S/VENDORS COMPANY SEAL					
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

		QUALITY PLAN		CUSTOMER : RPCL		PROJECT TITLE : 2 X 800MW YERAMARUS TPS		SPECIFICATION NO. : PE-TS-362-302-E001				
				BIDDER/ Esennar Transformers Private Limited		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE: TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS				
				VENDOR		ITEM :OIL FILLED TRANSFORMER		DOC. NO. : PE-V0-362-302-E314				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.8	Gun Metal / Cast Iron Valves Gate/globe/ Butterfly)	a) Dimensional check b) Type, size & make c) Leakage test(Hydraulic test for Body & Seat) d) Operational test (close & open)	Major Major Major Major Major	Measure Visual Test Test Test	100% 100% - - -	Manf. Std./IS:778 Class 1	Manf. Std./IS:778 Class 1	QC Record QC Record Supplier's TC Supplier's TC	2 2 3/2 3/2	- - 2,1 2		
2.9	Bushing CT	a) Visual check/Dimensional check b) Routin test	Major Major	Measure/Visual test Test	100% -	Manf. Std./IS:2705 Manf. Std./IS:2705	Manf. Std./IS:2705 Manf. Std./IS:2705	Supplier's TC Supplier's TC	2 3/2	- 2,1		
2.10	Marshaling box/RTCC	a) Visual check for wiring b) Dimensional check c) Check for make of components d) 2 kV insulation test on auxiliary wiring e) Check for paint, shade & thickness f) Degree of Prot. By paper insertion	Major Major Major Major Major Major	Test Measure/Test Measure/Test Measure/Test Measure/Test Measure/Test	100% 100% 100% 100% 100% 100%	Drg./Manf. Std./IS:5/IS:13947	Drg./Manf. Std./IS:5/IS:13947	Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC Supplier's TC	3/2 3/2 3/2 3/2 3/2 3/2	2 2 2 2 2 2	- - - - - -	
2.11	OTI&WTI	a)Type size & make b) HV test c) Temperature calibration d) Switch setting & switch deferential e) Calibration & operation of switch	Major Major Major Major Major	Visual Test Test Test Test	100% - - - -	Manf. Std.	Manf. Std.	QC records Supplier's TC Supplier's TC Supplier's TC Supplier's TC	2 3/2 3/2 3/2 3/2	1 2,1 2,1 2,1 2,1		
2.12	Radiator	a) Type, Model, Rating b) Dimensions & No. of elements c) Paint shade, Finish & film thickness d) Pressure test e) Adhesion test on paint f) Welding quality	Major Major Major Major Major Major	Visual Measure Measure/test Test Test Visual/ DPTest	100% 100% 100% 100% 100% 100%	Drg./Manf. Std./IS:101	Drg./Manf. Std./IS:101	QC records QC records QC records Supplier's TC	3/2 3/2 3/2 3/2	2 2 2 2	1 - - 1	
2.13	Hardware	a) Dimensional check b) Tensile strength	Major Major	Measure Test	100% -	Manf. Std.	Manf. Std.	QC records Supplier's TC	2 3/2	- -		
			PARTICULARS		BIDDER/VENDOR							
BHEL			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

		QUALITY PLAN		CUSTOMER : RPCL		PROJECT TITLE : 2 X 800MW YERAMARUS TPS		SPECIFICATION NO. : PE-TS-362-302-E001				
				BIDDER/ Esennar Transformers Private Limited		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE: TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS				
		SHEET 6 OF 10		SYSTEM		ITEM :OIL FILLED TRANSFORMER		DOC. NO. : PE-V0-362-302-E314				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.14	Oil Pump Motor set (if applicable)	a) Type, Model, Rating b) Dimensional check c) Hv test at 2 kV for one minute d) Input power taken by pump e) Performance test (I/P,O/P,DISCH, NO LOAD, Locked Rotor te)	Major Major Major Major Major	Visual Measure Test Test Test	100% 100% - - -	Manf. Std.	Manf. Std.	QC records QC records Supplier's TC Supplier's TC Supplier's TC	2 2 3/2 3/2 3/2	- - 2,1 2,1 2,1		
2.15	Cooling Fan (if applicable)	a) Type, Model, Rating b) Dimensional check c) HV test at 2 KV for one minute d) IR test e) Power consumption & RPM	Major Major Major Major Major	Visual Measure Test Test Test	100% - - - -	Approved drgs/docs/spec./ IS:2312	Approved drgs/docs/spec./ IS:2312	QC records QC records Supplier's TC Supplier's TC Supplier's TC	2 2 3/2 3/2 3/2	- - 2,1 - 2,1		
2.16	Roller Assembly	a)Dimensions b) Mechanical & Chemical properties of Raw material used for Shaft & Roller	Major Major	Measure Measure	100% -	Manf. Drg./docs	Manf. Drg./docs	QC records Supplier's TC	2 3/2	- 2		
2.17	Terminal Connector (if applicable)	a) Dimensional check b) Surface finish c) Acceptance test	Major Major Major	Measure Visual Test	100% - -	Manf. Drg./docs/IS:5561	Manf. Drg./docs/IS:5561	QC records Supplier's TC Supplier's TC	2 3/2 3/2	- 2 2,1		
2.18	Air Cell for Conservator (if applicable)	a) Dimensional check b) Surface finish c) Acceptance test	Major Major Major	Measure Visual Test	100% 100% 100%	Manf. Drg./docs/PO	Manf. Drg./docs/PO	QC records Supplier's TC Supplier's TC	2 3/2 3/2	- 2 2,1		
2.19	Oil Flow Indicator (if applicable)	a) Type, Model, Rating b) Dimensional check c) Functional test	Major Major Major	Visual Measure Test	100% 100% -	Manf. Drg./docs/Spec.	Manf. Drg./docs/Spec.	QC records QC records Supplier's TC	2 2 3/2	- - 2,1		
2.20	Silicagel Breather	a) Type, Size, Model b) Pressure/ Leakage test c) Colour of silica gel	Major Major Major	Visual Test Visual	100% - -	Manf. Drg./docs/Spec.	Manf. Drg./docs/Spec.	QC records Supplier's TC Supplier's TC	2 3/2 3/2	- 2 2,1		
			PARTICULARS		BIDDER/VENDOR							
BHEL			NAME									
			SIGNATURE									
			DATE				BIDDER'S/VENDORS COMPANY SEAL					
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

		QUALITY PLAN SHEET 10 OF 10		CUSTOMER : RPCL		PROJECT TITLE : 2 X 800MW YERAMARUS TPS		SPECIFICATION NO. : PE-TS-362-302-E001				
				BIDDER/ Esennar Transformers Private Limited		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE: TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS				
				VENDOR		ITEM :OIL FILLED TRANSFORMER		DOC. NO. : PE-V0-362-302-E314				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		p) Verification of oil leakage test with all fitting & accessories at normal pressure plus 35KPA for 24 hours. q) Jacking Test followed by D.P. Test r) Paint shade & adhesion test s) Protection on M. Box by paper insertion t) 2 KV test on M.Box wiring & functional check for component of MB u) Slope and alignment of Buchholz relay v) DFT of paint	Major	Measure	100%	As per APPROVED DATA SHEET/IS:2026/MAN F. STD.	As per APPROVED DATA SHEET/IS:2026/MAN F. STD.	Manf. Test Records/QC Formats	2	1		
		Major	Measure	100%	2				1			
		Major	Measure	100%	2				1			
		Major	Measure	100%	2				1			
		Major	Measure	100%	2				1			
		Major	visual	100%	2				1			
		Major	Measure	100%	2	1						
6	Pre Shipment check & Despatch	a) Transformer- verification of final transportation. b) Dew points measurement of N2/Dry gas tightness/ Pr reading (Only applicable for transformers dispatched with Gas Filling) c) Packing of loose items							2			
									2			
									2			
			PARTICULARS		BIDDER/VENDOR			BIDDER'S/VENDORS COMPANY SEAL				
BHEL			NAME									
			SIGNATURE									
			DATE									
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION												

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS	SPECIFICATION NO. PE-SS-999-302-E001
		VOLUME NO. : II
		SECTION : II
		REV NO. : 00 DATE : 30/06/2016
		SHEET : 28 of 30

ANNEXURE - B

TRANSFORMER LOSSES

1. The No-Load and Load losses for transformers 2.0MVA & above and voltage ratio 33kV/6.9kV, 33kV/3.5kV, 11kV/6.9kV, 11kV/3.5kV, 6.6kV/3.5kV are given below:

Ratings	Maximum No-Load losses at rated frequency and 100%voltage	Maximum Load losses at normal ratio, rated current and 75 deg. C
<u>10.0 MVA</u>	9.0kW	72.0kW
<u>8.0MVA</u>	7.5 kW	57.0kW
<u>7.5 MVA</u>	7.2 kW	50.0kW
<u>6.3MVA</u>	6.5kW	45.0kW
<u>5.0MVA</u>	5.5kW	36.0kW
<u>3.5MVA</u>	4.5kW	32.0kW
<u>2.5 MVA</u>	2.8kW	30.0kW
<u>2.0MVA</u>	2.4 kW	24.0kW

The above indicated maximum No-Load and Load losses are inclusive of permissible tolerance as per IS-2026. Further tolerance on maximum losses is not permissible.

- ~~2. Transformers of rating 2.5MVA & below and voltage ratio 33kV/433V, 11kV/433V, 6.6kV/433V, 3.3kV/433V shall have Energy Efficiency Level 1 as per IS 1180. However, percent impedance shall be as per Data Sheet A of section I, volume II of technical specification.~~

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS	SPECIFICATION NO. PE-SS-999-302-E001
		VOLUME NO. : II
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		REV NO. : 00 DATE : 30/06/2016
		SHEET : 29 of 30

ANNEXURE – C

Terminal No.	Description	Remarks
T-01	230V, Single Phase, 50Hz, AC	
T-02	Supply	
T-03	MOG (Oil Level) Alarm	
T-04		
T-05	Buchholz Relay Alarm	
T-06		
T-07	Buchholz Relay Trip	
T-08		
T-09	PRV-1 Alarm	
T-10		
T-11	PRV-1 Trip	
T-12		If applicable
T-13	PRV-2 Alarm	
T-14		
T-15	PRV-2 Trip	
T-16		
T-17	OTI Alarm	
T-18		
T-19	OTI Trip	
T-20		
T-21	WTI-1 Alarm	
T-22		
T-23	WTI -1 Trip	
T-24		
T-25 to T-28	SPARE	If applicable
T-29	4-20 mA for OTI (DDCMIS)	
T-30		
T-31	4-20 mA for OTI (SCADA)	
T-32		
T-33	4-20 mA for WTI-HV (DDCMIS)	
T-34		If applicable
T-35	4-20 mA for WTI-HV (SCADA)	
T-36		
T-37 to T-50	SPARE	
T-51	WTI 1-CT	
T-52		
T-53	CT Shorting Terminal	
T-54	WTI 2-CT	
T-55		If applicable
T-56	CT Shorting Terminal	
T-57	LV Neutral CT (REF Protection)	
T-58		
T-59	CT Shorting Terminal	
T-60	LV Neutral CT (E/F Protection)	
T-61		
T-62	CT Shorting Terminal	
T-63	HV Neutral CT (REF Protection)	
T-64		
T-65	CT Shorting Terminal	
T-66	HV U-PHASE CT	
T-67		If applicable
T-68	CT Shorting Terminal	
T-69	HV V-PHASE CT	
T-70		
T-71	CT Shorting Terminal	
T-72	HV W-PHASE CT	
T-73		
T-74	CT Shorting Terminal	
T-75 to T-80	SPARE TBs (for CT)	

Notes:

- 1). The Terminals from T-01 to T-48 shall be designated as indicated in the chart for all outdoor transformers (ONAN cooling).
- 2). The Terminals which are not used for a particular Transformer shall be left as spare. e.g. in case there is only one WTI alarm & trip, then terminals T-25 to T-28 & T-38 to T-40 shall be left as spare terminals.
- 3). Provide 20% spare TBs.

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR OIL FILLED SERVICE TRANSFORMERS	SPECIFICATION NO. PE-SS-999-302-E001
		VOLUME NO. : II
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		REV NO. : 00 DATE : 30/06/2016
		SHEET : 30 of 30

ANNEXURE – D

LIST OF O & M SPARES

S. NO.	DESCRIPTION	QTY
1	HV bushing with metal parts & gaskets	1 no. for each rating
2	LV bushing with metal parts & gaskets	1 no. for each rating
3	WTI with alarm & trip contacts	1 no.
4	OTI with alarm & trip contacts	1 no.
5	Magnetic oil level gauge	1 no.
6	Diaphragm of explosion vent	1 no.
7	Buchholz relay	1 no.
8	Silica gel charge	Three charge
9	Floats with contacts for Buchholz relay	1 set
10	Set of gaskets	2 sets
11	Set of valves (1 no. of each size & Type)	1 set
12	Set of windings for one limb in a suitable oil container (container shall be completely filled with transformer oil)	1 no. of each rating & type of transformer.
13	Contact for tap changer	1 set
14	Pressure relief device for 2MVA & above transformers	1 no.
15	Hydraulic/screw Jacks	4 no.
16	Any other item considered essential by the bidder	

Note:

- 1) Wherever set is indicated above, it means the total parts/ accessories required to replace the particular item for a given equipment
- 2) O & M spares shall be supplied along with transformers and packed separately with proper inscription.