

KARNATAKA POWER CORPORATION LTD.

370MW YELAHANKA CCPP

VOLUME – II

TECHNICAL SPECIFICATION FOR
OIL FILLED SERVICE TRANSFORMERS

SPECIFICATION NO : PE-TS-409-302-E001
REV-0



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



**TECHNICAL SPECIFICATION FOR
OIL FILLED SERVICE TRANSFORMERS**

370MW YELAHANKA CCPP

SPECIFICATION NO. PE-TS-409-302-E001

VOLUME II

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REVISION 0 | DATE: 14.06.2016

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**TECHNICAL SPECIFICATION FOR
OIL FILLED SERVICE TRANSFORMER**

SPECIFICATION NO. PE-TS-409-302-E001

VOLUME-II

COMPLIANCE CERTIFICATE

REVISION 00

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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

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1.0 SCOPE OF ENQUIRY

- 1.1 This specification covers the design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to site of **BIS certified OIL FILLED SERVICE TRANSFORMERS (BIS Certification for rating upto 2.5 MVA, 33kV Class as per IS-1180 part-1, however the impedance value, list of tests, fittings shall be as per those mentioned in the specification) as mentioned in different sections of this specification, complete with all accessories for efficient and trouble-free operation.**
- 1.2 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.
- 1.3 Standard technical requirements of the oil filled service transformers are indicated in Section-II. Project specific requirements/changes are listed in Section-I.
- 1.4 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>	<i>Reference Clause No. of Section- II</i>	<i>Specific Requirement/ Change</i>
	NIL	NIL

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.

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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)
- g) List of special tools and tackles required for erection, commissioning and maintenance of equipment as per annexure-IV of section-I, volume-II.
- h) List commissioning spares for each transformer as per annexure-IV of section-I, volume-II.

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ANNEXURE – II

DOCUMENTS REQUIRED AFTER AWARD OF LOI

SI No	DrawingNO	Drg Title
1	PE-V0-409-302-E802	SERVICE TRANSFORMER O & M MANUAL
2	PE-V0-409-302-E147	1600KVA TRANSFORMER (6.6/0.433KV) LV BUS DUCT TRUNKING DRAWING
3	PE-V0-409-302-E149	1600KVA TRANSFORMER (6.6/0.433KV) L.V. BUSHING
4	PE-V0-409-302-E150	1600KVA TRANSFORMER (6.6/0.433KV) LVN BUSHING
5	PE-V0-409-302-E805	SERVICE TRANSFORMER TYPE TEST REPORTS
6	PE-V0-409-302-E142	1600 KVA SERVICE TRANSFORMER (6.6/0.433KV) OUTLINE GENERAL ARRANGEMENT DRAWING [OGA]
7	PE-V0-409-302-E144	1600KVA TRANSFORMER (6.6/0.433KV) FOUNDATION PLAN
8	PE-V0-409-302-E145	1600KVA TRANSFORMER (6.6/0.433KV) GENERAL ARRANGEMENT OF MARSHALLING BOX
9	PE-V0-409-302-E151	1600KVA TRANSFORMER (6.6/0.433KV) VALVE SCHEDULE PLATE
10	PE-V0-409-302-E152	1600KVA TRANSFORMER (6.6/0.433KV) WIRING DIAGRAM FOR MARSHALLING BOX
11	PE-V0-409-302-E141	1600 KVA SERVICE TRANSFORMER (6.6/0.433KV) TECHNICAL DATA SHEET
12	PE-V0-409-302-E803	SERVICE TRANSFORMER PAINTING PROCEDURE
13	PE-V0-409-302-E143	1600 KVA SERVICE TRANSFORMER (6.6/0.433KV) RATING & DIAGRAM PLATE
14	PE-V0-409-302-E148	1600KVA TRANSFORMER (6.6/0.433KV) H.V. BUSHING
15	PE-V0-409-302-E146	1600KVA TRANSFORMER (6.6/0.433KV) HV CABLE BOX ARRANGEMENT DRAWING
16	PE-V0-409-302-E801	SERVICE TRANSFORMER FIELD QUALITY PLAN
17	PE-V0-409-302-E901	QUALITY PLAN FOR SERVICE TRANSFORMERS
18	PE-V0-409-302-E155	1600KVA TRANSFORMER (6.6/0.433KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY
19	PE-V0-409-302-E153	1600KVA TRANSFORMER (6.6/0.433KV) TRANSPORTATION DETAILS


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20	PE-V0-409-302-E175	2000KVA TRANSFORMER (6.6/0.433KV) DESIGN CALCULATIONS FOR SHORT CIRCUIT CAPABILITY
21	PE-V0-409-302-E168	2000KVA TRANSFORMER (6.6/0.433KV) H.V. BUSHING
22	PE-V0-409-302-E170	2000KVA TRANSFORMER (6.6/0.433KV) LVN BUSHING
23	PE-V0-409-302-E165	2000KVA TRANSFORMER (6.6/0.433KV) GENERAL ARRANGEMENT OF MARSHALLING BOX
24	PE-V0-409-302-E166	2000KVA TRANSFORMER (6.6/0.433KV) HV CABLE BOX ARRANGEMENT DRAWING
25	PE-V0-409-302-E173	2000KVA TRANSFORMER (6.6/0.433KV) TRANSPORTATION DETAILS
26	PE-V0-409-302-E172	2000KVA TRANSFORMER (6.6/0.433KV) WIRING DIAGRAM FOR MARSHALLING BOX
27	PE-V0-409-302-E164	2000KVA TRANSFORMER (6.6/0.433KV) FOUNDATION PLAN
28	PE-V0-409-302-E171	2000KVA TRANSFORMER (6.6/0.433KV) VALVE SCHEDULE PLATE
29	PE-V0-409-302-E169	2000KVA TRANSFORMER (6.6/0.433KV) L.V. BUSHING
30	PE-V0-409-302-E167	2000KVA TRANSFORMER (6.6/0.433KV) LV BUS DUCT TRUNKING DRAWING

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ANNEXURE – III
LIST OF TYPE TESTS

SI No	TYPE TEST
1	TANK PRESSURE TEST
2	TANK VACUUM TEST
3	MEASUREMENT OF ACOUSTIC NOISE LEVEL AS PER NEMA TR-1
4	TEMPERATURE RISE TEST
5	DIELECTRIC TYPE TEST (INCLUDING CHOPPED WAVE IMPULSE TEST)
6	SHORT CIRCUIT TEST **

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ANNEXURE IV

SPECIAL TOOLS AND TACKLES REQUIRED FOR ERECTION, COMMISSIONING AND MAINTENANCE OF EQUIPMENT

S. NO.	DESCRIPTION	QTY.

Note

Bidder shall furnish the list of special tools & tackles and quantity along with the offer. Price shall be included in the total bid price.

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ANNEXURE -V

COMMISSIONING SPARES FOR EACH TRANSFORMER

S. NO.	DESCRIPTION	QTY.		REMARKS
		1600 kVA	2000 kVA	

Note


Bidder shall furnish the list of commissioning spares and quantity for each type of transformer along with the offer. Price shall be included in the transformer price.

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DATA SHEET -A

6.6/0.433kV SERVICE TRANSFORMER


<u>S. No.</u>	<u>Description</u>	<u>Unit</u>	<u>Particulars</u>
1.0	Quantity	Nos. & kVA	12 & 1600 kVA 2 & 2000 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	6.6
	b) LV Winding	kV	0.433
8.0	No Load transformation ratio		6.6/0.433
9.0	Vector group		Dyn1
10.0	Impedance voltage at rated current and frequency	%	1600 kVA : 8% 2000 kVA : 10%
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	7.2 kV
	b) LV Winding	V	415V + 10%
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	20 (6.6kV)
	b) LV Winding	kV	3
16.2	Impulse withstand voltage		
	a) HV Winding	kVp	60 (6.6kV)
	b) LV Winding	kVp	-
17.0	Terminal details		
	a) HV Line		Cable box (XLPE cables)
	b) HV Neutral		N.A.
	c) LV Line		Flange throat for TPN non-segregated Al Busduct
	d) LV Neutral		One neutral as part of LV busduct throat and second neutral with copper earthing bar for system earthing brought near the base of the transformer.
18.0	System Fault Level		
	a) HV Winding	kA	40 kA RMS
	b) LV Winding	kA	50 kA RMS

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- 19.0 Method of System Earthing
- a) HV System low resistance earthed to limit earth fault current to 300A
Solidly grounded
2 Sec.
- b) LV System
- c) Through fault withstand time
- 20.0 Details of Cooling Equipment Detachable tank mounted radiators
- 21.0 Provision/ accommodation of CTs
LV Neutral 2 Core PS CLASS or 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 6.6kV Unearthed
- iii) Conductor material & size Stranded Aluminium,
after award of contract
- iv) No. of cores & runs Three core, one run

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- b) LV side
- | | | |
|--------------------------------|----|-----|
| 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 IS-1180
[Mention Thermo Setting powder/ Epoxy paint]

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DATA SHEET –B

TECHNICAL PARTICULARS

[TO BE SUBMITTED A LOG WITH TECHNICAL OFFER]

FOR 6.6kV/0.433V

S. No	Description	1.6MVA
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 tappings (+/-)	%	
	b) Size of tapping step	%	


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c) For HV/LV variation


13.0	Impulse voltage withstand level	
	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

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	b) Rated current	A
33.0	Maximum flux density	
	a) At rated voltage	Wb/M ²
	b) At 110% rated voltage	Wb/M ²
34.0	Maximum current density for	
	a) HV Winding	Amp/mm ²
	b) LV Winding	Amp/mm ²
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/M ²
	b) Radiator and other fittings	Kg/M ²
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	

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42.1	Tank dimensions	
	a) Length	mm
	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)	:

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- 51.0 Material of Winding
a) HV/LV :
- 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.

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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			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :		
					BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-302-E001, REV. 0			SPECIFICATION TITLE:		
		SHEET 1 OF 10			SYSTEM			ITEM :OIL FILLED TRANSFORMER			DOC. NO. :		
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% - - -			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 TEST MEASURE	10% - 10% 10% 10% - - - - - -	DRG/DATA SHEET/ MANUF. STD / IS:3024 / IS:649	DRG/DATA SHEET/ MANUF. 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%	MANUF. STD / IS:13730-P-27/IEC 60554	MANUF. 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% - - - - - - - - - - -	MANUF. STD / IS:9335-P-2/IS:9335- P-III/IEC 60554	MANUF. 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			CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
					BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE:			
		SHEET 2 OF 10		SYSTEM			ITEM :OIL FILLED TRANSFORMER		DOC. NO. :			
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	Major	Measure	10%	'MANUF. STD / IS:1576	'MANUF. STD / IS:1576	QC Record.	2		1	
		b) Compressibility	Major	Test	-			Supplier's TC	3/2		2	
		c) Density	Major	Test	-			Supplier's TC	3/2		2	
		d) Tensile strength	Major	Test	-			Supplier's TC	3/2		2	
		e) pH value/Conductivity of water extract	Major	Test	-			Supplier's TC	3/2		2	
		f) Electrical strength in air & oil	Major	Test	-			Supplier's TC	3/2		2	
		g) Shrinkage in air	Major	Test	-			Supplier's TC	3/2		2	
		h) Flexibility	Major	Test	-			Supplier's TC	3/2		2	
		i) Ash content	Major	Test	-			Supplier's TC	3/2		2	
		j) Moisture content	Major	Test	-			Supplier's TC	3/2		2	
		k) Cohesion between plies	Major	Test	-			Supplier's TC	3/2		2	
l) Elongation	Major	Test	-	Supplier's TC	3/2		2					
m) Oil absorption	Major	Test	-	Supplier's TC	3/2		2					
1.6	Densified wood	a) Dimension	Major	Measure	10%	'MANUF. STD / IS:3513	'MANUF. STD / IS:3513	QC Record.	2		1	
		b) Surface finish	Major	Visual	10%			QC Record.	2		-	
		c) Electrical strength in oil	Major	Test	-			Supplier's TC	3/2		1	
		d) Oil absorption	Major	Test	-			Supplier's TC	3/2		-	
		e) Moisture content	Major	Test	-			Supplier's TC	3/2		-	
		f) Compression strength	Major	Test	-			Supplier's TC	3/2		-	
		g) Crossbreaking strength	Major	Test	-			Supplier's TC	3/2		-	
		h) Tensile strength	Major	Test	-			Supplier's TC	3/2		-	
		i) Specific gravity/ Density	Major	Test	-			Supplier's TC	3/2		-	
		1.7	Gasket(Rubber Bonded Cork sheet (if applicable)	a) Dimension	Major			Measure	10%	'MANUF. STD / IS:4253	'MANUF. STD / IS:4253	
b) Hardness	Major			Test	-	Supplier's TC	3/2		1			
c) Tensile strength	Major			Test	-	Supplier's TC	3/2		-			
d) Compressibility	Major			Test	-	Supplier's TC	3/2		1			
e) Recovery	Major			Test	-	Supplier's TC	3/2		-			
f) Compression set	Major			Test	-	Supplier's TC	3/2		-			
g) Flexibility	Major			Test	-	Supplier's TC	3/2		-			
h) Fluid resistance test	Major			Test	-	Supplier's TC	3/2		-			
i) Chloride/Sulphate content of water extract	Major			Test	-	Supplier's TC	3/2		-			
j) Density	Major			Test	-	Supplier's TC	3/2		-			
1.8	Nitrile Rubber Cord and "O" Ring (if applicable)	a) Dimension	Major	MEASURE	10%	'MANUF. STD / IS:4253	'MANUF. STD / IS:4253	Supplier's TC	2		-	
		b) Shore Hardness	Major	Test	-			Supplier's TC	3/2		-	
		c) Tensile strength	Major	Test	-			Supplier's TC	3/2		-	
		d) Elongation at break	Major	Test	-			Supplier's TC	3/2		-	
		e) Compression set	Major	Test	-			Supplier's TC	3/2		-	
		f) Accelerated Ageing in oil	Major	Test	-			Supplier's TC	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 :			PROJECT TITLE :			SPECIFICATION NO. :		
					BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-302-E001, REV. 0			SPECIFICATION TITLE:		
		SHEET 4 OF 10			SYSTEM			ITEM :OIL FILLED TRANSFORMER			DOC. NO. :		
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	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	 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	 2,1 2,1 2			
2.5	Magnetic Oil Level Gauge (MOG)	a) Type, size & make b) Dial marking c) Switch continuity d) HV test e) Operation test	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	 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	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	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	 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 SHEET 5 OF 10			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :		
					BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-302-E001, REV. 0			SPECIFICATION TITLE:		
					SYSTEM			ITEM :OIL FILLED TRANSFORMER			DOC. NO. :		
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	Measure Visual 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	Test Measure/Test Measure/Test Measure/Test Measure/Test	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	3/2 3/2 3/2 3/2 3/2	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	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	Visual Measure Measure/test Test Test Visual/ DPTest	100% 100% 100% 100% 100%	Drg./Manf. Std./IS:101	Drg./Manf. Std./IS:101	QC records QC records QC records Supplier's TC Supplier's TC	3/2 3/2 3/2 3/2 3/2	2 2 2	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 :		PROJECT TITLE :		SPECIFICATION NO. :			
					BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE:			
					SHEET 6 OF 10		SYSTEM		ITEM :OIL FILLED TRANSFORMER		DOC. NO. :	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	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	Visual Measure 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	2 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		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :				
				BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE:				
		SHEET 7 OF 10		SYSTEM		ITEM :OIL FILLED TRANSFORMER		DOC. NO. :				
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
3 IN-PROCESS												
3.1	Fabrication of Tank, Conservator, Radiator, HV&LV CABLE BOX and welding requirement	a) Welding procedure specification	Major	Verify/Review	100%			QC Records	3/2		2	
		b) Process qualification record	Major	Verify/Review	100%			QC Records	3/2		2	
		c) Weider qualification	Major	Verify/Review	100%			QC Records	3/2		2	
		d) Welding electrodes-Mechanical Properties	Major	Verify/Review	100%			QC Records	3/2		2	
		e) Fitup for butt weld joints of tank and cover	Major	Visual	100%			QC Records	3/2		2	
		f) Visual check on weldment & any foregin particle in the entire tank with conservator, pipes etc.and blanking of ends with bolted plates	Major	Visual	100%			QC Records	3/2		2	
		g) Dimensional check after final welding incl.foundation dimension-HV & LV cable box/ Radiator/ Cooler/ Pipes	Major	Measure	100%	Manf. Drg./stand.	Manf. Drg./stand.	QC Records	3/2		2	
		h) DP test on welded joints	Major	Test	100%			QC Records	3/2		2,1	
		i) Check for flatness gasket surface	Major	Visual	100%			QC Records	3/2		2,1	
		J) Rim flatness	Major	Measure	100%			QC Records	3/2		2,1	
		k) Surface cleaning by sand/ shot blasting	Major	Visual	100%			QC Records	3/2		2,1	
		l) Primer coating, paint shade thickness inside & outside	Major	Measure	100%			QC Records	3/2		2,1	
		m) Paint film adhesion test	Major	Test	100%			QC Records	3/2		2,1	
n) Vacuum Test (Tank)	CR	Vacuum test		1 unit each type	Appd. Doc./BHEL SPEC./CBIP	Appd. Doc./BHEL SPEC./CBIP	QC formate	3/2	1			
o) Pressure test (Tank)	CR	Pressure test		1 unit each type			QC formate	3/2	1			
3.2	Core Stamping	a) Burr & Bow	Major	Visual	100%			QC Records	2		-	
		b) Dimensional check	Major	Measure	100%	Manf. Drg./stand.	Manf. Drg./stand.	QC Records	2		-	
3.3	Core Building	a) Dimensional check	Major	Measure	100%			QC Records	2		-	
		b) Assembly of limb insulation and limb plates.	Major	Visual	100%			QC Records	2		-	
		c) Rectangularity of core assembly	Major	Visual	100%			QC Records	2		-	
		d) Freedom from overlaps & air gap at joints	Major	Visual	100%		Manf. Drg./stand.	Manf. Drg./stand.	QC Records	2		-
		e) Leaning of cor(i.e core verticality)	Major	Visual	100%			QC Records	2		-	
		f) Limb & stack thickness	Major	Visual	100%			QC Records	2		-	
		g) Limb clamping & binding	Major	Visual	100%			QC Records	2		-	
		h) Core diameter	Major	Visual	100%			QC Records	2		1	
		i) Earthing of core	Major	Visual	100%			QC Records	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												



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	BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE:	
	SHEET 8 OF 10		SYSTEM		ITEM :OIL FILLED TRANSFORMER	
						DOC. NO. :

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

3.4	Test on Core	a) Dimensional check	Major	Measure	100%	Manf. Drg./stand.	Manf. Drg./stand.	QC Records	2		-	
		b) Flux density measurement	Major	Measure	100%			QC Records	2		-	
		c) Isolation test between(core to core clamps)	Major	Test	100%			QC Records	2		-	
		d)Torque Tightness	Major	Measure	100%			QC Records	2		-	
		e) Core Insulation	Major	Electrical	100%			QC Records	2		-	
		f) Core Loss	Major	Electrical with dummy coil	100%			QC Records	2		1	
		g)Visual checks of core verticality	Major	Visual	100%			QC Records	2		-	
3.5	Winding	a) Brazing procedure & Brazer qualification	Major	Review	100%	Manf. Drg./Relevant stand.	Manf. Drg./Relevant stand.	QC Records	2		-	
		b) Conductor size.	Major	Measure	100%			QC Records	2		-	
		c) Radial depth of winding	Major	Measure	100%			QC Records	2		-	
		d) Anchoring & binding at start & finish	Major	Measure	100%			QC Records	2		-	
		e) No. of turns	Major	Measure	100%			QC Records	2		-	
		f) Transposition of cross-overs	Major	Measure	100%			QC Records	2		-	
		g) Dimensional check (OD,ID & axial length)	Major	Measure	100%			QC Records	2		-	
		h) Insulation arrangement & alignmt.	Major	Measure	100%			QC Records	2		-	
		i) Winding length	Major	Measure	100%			QC Records	2		-	
		j) Brazed joints	Major	Measure	100%			QC Records	2		-	
		k) Lead & coil identification and marking	Major	Measure	100%			QC Records	2		-	
		l) Free from damages	Major	Measure	100%			QC Records	2		-	
		m) Continuity test for leads	Major	Measure	100%			QC Records	2		-	
		n) Turn to Turn Insulation	Major	Measure	100%			QC Records	2		1	
		o) Measure. Of Resistance	Major	Measure	100%	QC Records	2		1			
3.6	Core coil assembly	a) Cleanliness of core	Major	Visual	100%	Manf. Drg./Relevant stand.	Manf. Drg./Relevant stand.	QC Records	2		-	
		b) Alignment of spacers/blocks	Major	Visual	100%			QC Records	2		-	
		c) Elect. Clearance & Insp. Of core & coil assly after completion of terminal gear	Major	Visual/measure	100%			QC Records	2		-	
		d) Check provision of core frame earthing	Major	Visual	100%			QC Records	2		-	
3.7	Connection and Tap switch assembly	a) Ratio test on all taps	Major	Test	100%	Manf. Drg./Relevant stand.	Manf. Drg./Relevant stand.	QC Records	2		1	
		b) Lead disposition.	Major	Visual	100%			QC Records	2		-	
		c) Brazing of joints	Major	Visual	100%			QC Records	2		-	
		d) Crimping of joints	Major	Visual	100%			QC Records	2		-	
		e) Insulation over joints	Major	Visual	100%			QC Records	2		-	
		f) Vector group	Major	Test	100%			QC Records	2		1	
3.8	Ovening and Tanking	a) Cleanliness of tank	Major	Visual	100%	Manf. Drg./Relevant stand.	Manf. Drg./Relevant stand.	QC Records	2		-	
		b) Drawing	Major	Physical	100%			QC Records	2		1	
		c) Check tightness of clamped blocks and measurements of winding height	Major	Measure	100%			QC Records	2		1	
		d) Electrical clearances	Major	Measure	100%			QC Records	2		1	
		e) Oil filling and air release	Major	Physical	100%			QC Records	2		-	
		f) Dryness (Tan-delta & I.R)	Major	Measure	100%			QC Records	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 :		PROJECT TITLE :		SPECIFICATION NO. :	
	BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-302-E001, REV. 0		SPECIFICATION TITLE:	
	SHEET 10 OF 10		SYSTEM		ITEM :OIL FILLED TRANSFORMER	
				DOC. NO. :		


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.	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		
		q) Jacking Test followed by D.P. Test	Major	Measure	100%				2	1		
		r) Paint shade & adhesion test	Major	Measure	100%				2	1		
		s) Protection on M. Box by paper insertion	Major	Measure	100%				2	1		
		t) 2 KV test on M.Box wiring & functional check for component of MB	Major	Measure	100%				2	1		
		u) Slope and alignment of Buchholz relay	Major	visual	100%				2	1		
		v) DFT of paint	Major	Measure	100%				2	1		

6	Pre Shipment check & Despatch	a) Transformer- verification of final transportation.							2			
		b) Dew points measurement of N2/Dry gas tightness/ Pr reading (Only applicable for transformers dispatched with Gas Filling)							2			
		c) Packing of loose items							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

	TITLE :	SPECIFICATION NO.
	STANDARD TECHNICAL SPECIFICATION FOR	PE-SS-999-302-E001
	OIL FILLED SERVICE TRANSFORMERS	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**

SECTION : **II**

REV NO. : **00** DATE : 30/06/2016


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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		
Dummy	Buchholz Relay Trip	
T-08		
T-09	PRV-1 Alarm	
T-10		
T-11	PRV-1 Trip	
Dummy		
T-12		if applicable
T-13	PRV-2 Alarm	
T-14		
T-15	PRV-2 Trip	
Dummy		
T-16		
T-17	OTI Alarm	
T-18		
T-19	OTI Trip	
Dummy		
T-20		
T-21	WTI-1 Alarm	
T-22		
T-23	WTI-1 Trip	
Dummy		
T-24		
T-25 to T-28	SPARE	if applicable
T-29		
T-30	4-20 mA for OTI (DDCMIS)	
T-31	4-20 mA for OTI (SCADA)	
T-32		
T-33	4-20 mA for WTI-HV (DDCMIS)	
T-34	4-20 mA for WTI-HV (SCADA)	if applicable
T-35		
T-36		
T-37 to T-50	SPARE	
T-51	WTI 1-CT	
T-52	CT Shorting Terminal	
T-53		
T-54	WTI 2-CT	if applicable
T-55	CT Shorting Terminal	
T-56		
T-57	LV Neutral CT (REF Protection)	
T-58	CT Shorting Terminal	
T-59		
T-60	LV Neutral CT (EF Protection)	
T-61	CT Shorting Terminal	
T-62		
T-63	HV Neutral CT (REF Protection)	
T-64	CT Shorting Terminal	
T-65		
T-66	HV U-PHASE CT	if applicable
T-67	CT Shorting Terminal	
T-68		
T-69	HV V-PHASE CT	
T-70	CT Shorting Terminal	
T-71		
T-72	HV W-PHASE CT	
T-73	CT Shorting Terminal	
T-74		
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-35 to T-40 shall be left as spare terminals.
- 3). Provide 20% spare TBs.

	TITLE :	SPECIFICATION NO.
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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.