



CORRIGENDUM-I

Ref: Tender Enquiry No.: **TPWODL/PJ/O/SU/014/CORRIGENDUM/001**, Date: 29.06.2021.

Sub: - Extension of due date for payment of Tender Fee towards purchase of Tender Documents, Revised Calendar events and Revised Technical Specification.

All interested prospective bidders may kindly note the following modification to the calendar of events of the open Tender No. **TPWODL/PJ/O/SU/014 for supply of 250KVA & 500KVA, 33/0.433KV, BIS Energy Efficiency Level-II Rating, BEE Star-I rated Distribution Transformer.**

Sr No	Calendar of Events	Existing Schedule	Revised schedule
1	Date by which interested and eligible vendors to pay tender fee and confirm participation in accordance with "Procedure /for participating in tender"	28 th . June. 2021; 15:00 Hrs.	8 th . July 2021; 15:00 Hrs.
2	Last Date of receipt of pre-bid queries, if any	05 th .July. 2021; 15:00 Hours	15 th . July. 2021; 15:00 Hours
3	Last Date of Posting Consolidated replies to all the pre-bid queries as received	13 th .July. 2021; 15:00 Hours	23 th . July.2021; 15:00 Hours
4	Last date and time of receipt of Bids	19 th .July. 2021; 15:00 Hours	26 th .July. 2021; 15:00 Hours

ANNEXURE II

Revised Technical Specifications attached separately with the tender.

All other terms and conditions of the above tender will remain same.

By Order

Chief (Contracts & Store), TPWODL

DOCUMENT TITLE	STANDARD TECHNICAL SPECIFICATION FOR TWO WINDING OUTDOOR STATION TRANSFORMER OF 33/.433 KV ONAN TRANSFORMER 100KVA, 250 KVA, 500 KVA,630 KVA	EFFECTIVE DATE 29/06/2021
DOCUMENT NO	TPWODL/ENGG/SPEC/016/2021	REVISION NO: R1

STANDARD TECHNICAL SPECIFICATION

For

**TWO WINDING OUTDOOR 33/.433KV ONAN TRANSFORMER
100KVA, 250 KVA, 500 KVA, 630 KVA**

PREPARED BY	REVIEWED BY	APPROVED BY
PRATYUSH K RATH	M S ANWAR	S B KUNDARGI

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1. SCOPE

- a. This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding, supply and unloading at site/store of TP Western Odisha Distribution Limited of below rating outdoor type, oil immersed Two Winding Power Transformer complete with all accessories for trouble free and efficient performance.
- i. 100 KVA, 33/.433 KV
 - ii. 250 KVA, 33/.433KV
 - iii. 500 KVA, 33/.433 KV
 - iv. 630 KVA, 33/.433 KV
- b. The transformer shall be complete with all components and accessories, which are necessary or usual for their efficient performance and trouble-free operation under the various operating and atmospheric conditions specified in clause no. 3
- c. Such of the parts that may have not been specifically included, but otherwise form part of the transformer as per standard trade and/or professional practice and/or are necessary for proper operation of transformer, will be deemed to be also included in this specification. The successful bidder shall not be eligible for any extra charges for such accessories etc. notwithstanding the fact that at the time of an initial offer bidder had segregated such items and quoted for them separately.

2. APPLICABLE STANDARDS

The equipment (and the materials used) covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian standards & other relevant standards for components, BEE & CEA guidelines with latest amendment from time to time, thereof, some of which are listed below:

S.No.	IS/IEC	Description of Items covered
i.	IS 5: 2007	Specification for Colors for Ready Mixed Paints and Enamels
ii.	IS 104: 1979 (REAFFIRMED 2004)	Specification for ready mixed paint, brushing, zinc chrome, priming
iii.	IS 335: 2018 / IEC60296	Specification for New insulating oils

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S.No.	IS/IEC	Description of Items covered
iv.	IS 649: 1997 (REAFFIRMED 2001)	Methods for testing steel sheets for magnetic circuits of power Electrical apparatus.
v.	IS 1576: 1992 (Reaffirmed 2004)	Solid Pressboard for Electrical Purposes -Specification
vi.	IS 2026: 2011 / IEC 60076 -2011	Specification for Power Transformers
vii.	IS 2099: 1986 (REAFFIRMED 2003) / IEC-61037	Specification for Bushings for Alternating Voltages Above 1000 Volt
viii.	IS 2362: 1993 (REAFFIRMED 2004)	Determination of Water content in oil by Karl Fischer Method- Test Method
ix.	IS 2544: 1973 (Reaffirmed 2001)	Specification for Porcelain post insulators for systems with nominal Voltage Greater than 1000V
x.	IS 2705: 1992 (Reaffirmed 2002)	Specification for Current Transformers
xi.	IS 3401: 1992 (REAFFIRMED 2003)	Specification of Silica Gel
xii.	IS 3637: 1966 (Reaffirmed 2001) / IEC-364	Specification for gas operated relay (Buchholz relay).
xiii.	IS 4253: Part II: 1980 (Reaffirmed 2004)	Specification for cork composition sheets - Part II: Cork and Rubber
xiv.	IS 4257 (Part I): 1981 (Reaffirmed 2004)	Dimensions for Clamping Arrangements for Porcelain Transformer Bushings - Part I : For 12 kV to 36 kV Bushings
xv.	IS 4257 (Part II): 1986 (Reaffirmed 2004)	Dimensions for Clamping Arrangements for Porcelain Transformer Bushings for 72 kV to 123 kV Bushings
xvi.	IS 5082: 1998 (REAFFIRMED 2003)	Specification for Wrought Aluminum and Aluminum Alloy Bars, Rods, Tubes, Selection, Plates and Sheets for Electrical purposes

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S.No.	IS/IEC	Description of Items covered
xvii.	IS 5561: 1970 (REAFFIRMED 2002)	Specification for Electric Power Connectors.
xviii.	IS 6103: 1971 (REAFFIRMED 2001)	Specification for Method of Testing of specific resistance (Resistivity) of electrical insulating liquids
xix.	IS 6262: 1971 (Reaffirmed 2001)	Method of test for power factor and dielectric constant of electrical Insulating liquids
xx.	IS 6600: 1972 (Reaffirmed 2001)	Guide for Loading of Oil-immersed Transformer.
xxi.	IS 6792: 1992 (Reaffirmed 2003)/IEC-156	Method for Determination of Electric Strength of Insulating Oil
xxii.	IS 8468: 1977 (REAFFIRMED 2006)	On-load tap changers
xxiii.	IS 8603 (PART-1)2008 (REAFFIRMED 2006)	Dimensions for Porcelain Transformer Bushings for Use in Heavily Polluted Atmospheres - Part I: 12 kV, 17.5 kV, 24 kV and 36 kV Bushing
xxiv.	IS 9335 (Reaffirmed 2001)	Specification for Cellulosic Papers for Electrical Purposes
xxv.	IS 10028: 1981 (Reaffirmed 2001)	Code of Practice for Selection, Installation and Maintenance of Transformers
xxvi.	IS 12444: 1988	Specification for Continuously Cast and Rolled Electrolytic Copper Wire Rods for Electrical Conductors.
xxvii.	IS 13964: 1994 (Reaffirmed 2004)	Methods of Measurement of Transformer and Reactor Sound level
xxviii.	IS 3639: 1966	Specification for fitting & accessories of Power Transformer
xxix.	IS 1866: 2000	Code of practice for maintenance of transformer oil
xxx.	IEC 60156: 1995	Insulating liquids - Determination of the breakdown voltage at Power frequency - Test method

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S.No.	IS/IEC	Description of Items covered
xxxi.	IEC 60296: 2003	Specification for unused mineral insulating oils for transformers and switchgear
xxxii.	IEC 60529: 2001 IS 2147	Degrees of protection provided by enclosures (IP Code)
xxxiii.	IEC 60437	Radial Interference test on high-voltage insulator
Xxxiv	IS 1180 (PART 1) : 2014	Version for Outdoor type Oil immersed Distribution Transformers up to and including 2500 kVA, 33 kV
Xxxv	IS 3347(PART I): 1979	Dimensions for porcelain Transformer Bushings for use in normal and lightly polluted atmospheres - Part 1: up to and including 1 KV.
Xxxvi	IS 2099: 1986	Specification for Bushings for Alternating Voltages Above 1000 Volts
Xxxvii	IS 7421: 1988	Specification for porcelain bushings for alternating voltages up to and including 1000kV.
Xxxviii	IS: 1271	Electrical Insulation classified by Thermal stability.

3. CLIMATIC CONDITIONS OF THE INSTALLATION

The material shall be suitable for following climatic conditions,

[a] Maximum altitude above sea level	: 1000 m
[b] Maximum ambient temperature	: 50 ° C
[c] Maximum daily average ambient air temperature	: 40 ° C
[d] Minimum ambient air temperature	: -5° C
[e] Maximum temperature attainable by an object exposed to the sun	: 60 ° C
[f] Maximum yearly weighted average ambient temperature	: 32° C
[g] Maximum relative humidity	: 100%
[h] Average no. of rainy days in a year	: 120 days
[i] Average annual rainfall	: 150 cm
[j] Maximum wind pressure	: 260 Kg/Sq.Mtr
[k] Average number of thunderstorm days per annum	: 70

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Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation.

Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

4. GENERAL TECHNICAL REQUIREMENTS

S. No.	Description	Particulars			
		100 KVA	250KVA	500 KVA	630 KVA
1	Rating	100 KVA	250KVA	500 KVA	630 KVA
2	Type	Two Winding Transformer	Two Winding Transformer	Two Winding Transformer	Two Winding Transformer
3	Type of winding	Copper Wound	Copper Wound	Copper Wound	Copper Wound
4	Application	Outdoor	Outdoor	Outdoor	Outdoor
5	Cooling Medium	ONAN	ONAN	ONAN	ONAN
6	Number of Phases	Three (3)	Three (3)	Three (3)	Three (3)
7	Voltage Ratio	33/.433 kV	33/.433 kV	33/.433 kV	33/.433 kV
8	Connection	Delta/Star	Delta/Star	Delta/Star	Delta/Star
9	Vector Group	DYn11	DYn11	DYn11	DYn11
10	System Voltage				
	a) HV side Nominal/ Highest	33/36 kV	33/36 kV	33/36 kV	33/36 kV
	b) LV side Nominal/ Highest	0.433/0.458 kV (433V +6%)	0.433/0.458 kV (433V +6%)	0.433/0.458 kV (433V +6%)	0.433/0.458 kV (433V +6%)
11	Line Current				
	a) HV side Nominal/ Highest	1.74	4.37	8.75	11.02

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S. No.	Description	Particulars																			
	b) LV side Nominal/ Highest	133.34	333.35	666.71	840.05																
12	Short Circuit Impedance (at Base KVA)	4.50%	4.50%	4.50%	4.5%																
13	HV Taps	Off Circuit Tap changer shall be provided in equal steps of 2.5% with + 5% to -10% on HV winding.																			
		There should be 7 Tap Position and standard position at no 3.																			
		<table border="1"> <thead> <tr> <th>Tap Position</th> <th>Primary Voltage (KV)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>34.65</td> </tr> <tr> <td>2</td> <td>33.825</td> </tr> <tr> <td>3</td> <td>33</td> </tr> <tr> <td>4</td> <td>32.175</td> </tr> <tr> <td>5</td> <td>31.35</td> </tr> <tr> <td>6</td> <td>30.525</td> </tr> <tr> <td>7</td> <td>29.7</td> </tr> </tbody> </table>		Tap Position	Primary Voltage (KV)	1	34.65	2	33.825	3	33	4	32.175	5	31.35	6	30.525	7	29.7		
		Tap Position	Primary Voltage (KV)																		
		1	34.65																		
		2	33.825																		
3	33																				
4	32.175																				
5	31.35																				
6	30.525																				
7	29.7																				
Transformer shall be suitable for continuous operation at a voltage of 110% of each operating tap and 120% of the rated current on each tap.																					
Transformer shall be capable of delivering the rated current at a voltage equal to 105% of rated voltage, without exceeding the temperature rise specified.																					
14	Type of Earthing																				
	a) HV Side	Without Neutral Point	Without Neutral Point	Without Neutral Point	Without Neutral Point																
	b) LV Side	Neutral Point Solidly Earthed	Neutral Point Solidly Earthed	Neutral Point Solidly Earthed	Neutral Point Solidly Earthed																
15	Voltage fluctuation	HV Side $\pm 10\%$ LV Side +6%-9%	HV Side $\pm 10\%$ LV Side +6%-9%	HV Side $\pm 10\%$ LV Side +6%-9%	HV Side $\pm 10\%$ LV Side +6%-9%																
16	Frequency	50 Hz $\pm 3\%$	50 Hz $\pm 3\%$	50 Hz $\pm 3\%$	50 Hz $\pm 3\%$																
17	Basic Insulation Level: (neutral should not be graded)																				

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S. No.	Description	Particulars			
	a) For 33kv	170 kVp rms	170 kVp rms	170 kVp rms	170 kVp rms
18	One (1) minute power frequency withstand voltage:				
	a) For 33kv	70 kV rms	70 kV rms	70 kV rms	70 kV rms
	b) For .433kv & Neutral	3 kV rms	3 kV rms	3 kV rms	3 kV rms
19	Phase arrangement	Phase markings U-V-W from left to right when viewed from HV side.			
20	Direction of Power Flow	Bidirectional	Bidirectional	Bidirectional	Bidirectional
21	Maximum Flux Density	1.9T	1.9T	1.9T	1.9T
22	Magnetic material used for core	CRGO Silicon Steel: Grade M3 or Better	CRGO Silicon Steel: Grade M3 or Better	CRGO Silicon Steel: Grade M3 or Better	CRGO Silicon Steel: Grade M3 or Better
23	Winding				
	a) Maximum Current Density	2.6 Amps/sq mm	2.6 Amps/sq mm	2.6 Amps/sq mm	2.6 Amps/sq mm
	b) Nature of insulation HV/LV	A/A	A/A	A/A	A/A
24	Temperature rise limit:				
	a) Winding by Resistance	a)55 deg. C	a)55 deg. C	a)55 deg. C	a)55 deg. C
	b) Oil by Resistance	b)45 deg. C	b)45 deg. C	b)45 deg. C	b)45 deg. C
	c) Maximum temperature gradient between oil and winding	c)10 deg. C	c)10 deg. C	c)10 deg. C	c)10 deg. C
25	Noise Level	56 dB	56 dB	56 dB	56 dB
26	Fault levels	The anticipated fault levels on the 33 kV and .433 kV sides are 600 MVA and 25 MVA respectively.			
27	Over fluxing capability	Transformers shall be designed for continuous over fluxing withstands capability due to -10% to +5% voltage variation on HV side and frequency variation of $\pm 3\%$. Combined variation of voltage and frequency shall be within $\pm 10\%$.			

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S. No.	Description	Particulars
28	Auxiliary Supply	
	a) AC	a) 415 Volts 3 phase 4 wire, ungrounded (Provision to connect neutral to be made in the terminal block). Two 415 V sources shall be made available by purchaser.
	b) DC	b) 24V & 48V
29	No Load Current	Tolerance for No-Load Current shall be +30% of the declared value. NLC shall be 2 % of full load current.
30	Core Grounding	The core and frame grounding connection shall be brought out through a suitable bushing for provision of external grounding. The bidder shall submit the drawing clearly showing the details of core grounding.
31	Transformer Dimension	To be submitted as per design & will be finalized during evaluation
32	Wheels	The transformer shall be provided with four flanged bi-directional rollers suitable for rail gauges in both the axis for movement of the transformer in either direction.
33	Terminal Connector	HV bushing stems shall be provided with suitable Al. lug for termination of 3C X 300sq mm cable. Transformers, on LV side suitable Al lugs shall be provided for connection of cable with Al bus bar inside the cable box. Transformers shall be fitted with cable box without disconnecting chambers on HV side. Provision for disconnecting LT cables to be made for testing purpose. Detachable flexible Cu links to be provided between LV bus bar & all bushings; also a window above these links should be provided on LV terminal box for accessibility to these links. Terminal connectors shall be type tested as per IS 5561. Bottom plate of Cable box should be of Aluminium, if single core cables are used. The terminal connector Drawings shall be provided by the bidder and shall be submitted for Purchaser's approval
34	Cable Boxes	For HV side, bare bushings shall be provided on top for all ratings of transformers. The LV cable boxes shall be made of Mild Steel (M.S.) Sheet. The LV cable box front cover & bottom cable gland plate shall be removable for cable termination purpose. Suitable handle shall be provided on front cover of cable box. Size of the cable cover should be moderate so that only 2 people is enough to lift it). Suitable canopy shall be provided over the connection of LV & HV Box to the Transformer Tank. HV cable box should have proper anti-moisture arrangement (provision of louvers for cross ventilation). The LV cable box shall be provided with tinned brass palm connector with aluminium Busbar and suitable Al lugs to be provided for cable termination of Cable Size 4C x 300 sq.mm, 1.1kV XLPE cables (No. of

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35		<p>Cables- one for 100KVA, one for 250KVA, two for 500KVA & 3 for 630 KVA). The gland plate shall be of non-magnetic material with suitable brass gland (It can be MS with suitable cut to prevent flux). The LV busbar shall be supported using epoxy insulators from the top side inside the LV dividing box. Permanent connection of wire mesh installed inside louvers of HT and LT boxes and doors by (sliding into special channels and fixed thereafter) permanent bolting arrangement or welding is required.</p> <p>The neutral of the star connected winding shall be brought out to a separate bushing terminal of 1.1KV class. Neutral CT should be installed before bifurcation. The neutral bushing shall be provided outside body of transformer to facilitate lead the earth conductor down to ground level. Insulators shall be provided for supporting the neutral earthing bar of specified section, along its run from the neutral bushing to ground level. The Neutral Should be mounted with FRP/Bakelite sheets, firmly, so that LV neutral bus should not touch the CT. Provision shall be provided to enable the transformer to be removed without cutting the termination of the cables from the gland plates. Breathers are to be provided in HV and LV cable box in order to avoid moisture ingress on cable terminations.</p> <p>Suitable gasket of no deteriorating rubber cork or similar material shall be provided at all joints to ensure tightness. Suitable clamping arrangement for supporting HV/LV cable shall be provided. The canopy shall be provided on all gasket joints. The complete cable box shall be removable with the nuts and bolts</p>
	Off Circuit Tap changer (OCTC) on HV Side	
	a) Type	Rotary type, off load control tap changing gear
	b) Range	+5% to -10% in steps of 2.5 %
	d) Principal Tap Position	3 rd Position
	e) Manual / Automatic	Yes (Both)
	f) Remote / Local	Yes (Both)
	g) Indian Standard	8468-2006
	h) All contacts should be SCADA compatible and suitable for connection to TMU	Yes

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S. No.	Description	Particulars
	i) Separate Conservator, OSR, PRV & MOG	Yes
	j) Potential free contacts for SCADA Provided	Yes
	k) Flow of Power	Bidirectional
	l) Surge Relay	Yes

4.2 Minimum clearance (In Air) between live parts shall be as follows or as per IS/IEC/CBIP:

Location	33 kV (Bare Bushing)	LV & Neutral (Bare Bushing)
Phase to phase	350 mm	75 mm
Phase to Ground	320 mm	40 mm

WTI CT for HV Side

Purpose	CTR	Class	Burden	Knee Point Volt	I mag at Vk/2	ISF	Rct
100 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	≤ 10	As per OEM design
250 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	≤ 10	As per OEM design
500 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	≤ 10	As per OEM design
630 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	≤ 10	As per OEM design

WTI CT for LV Side

Purpose	CTR	Class	Burden	Knee Point Volt	I mag at Vk/2	ISF	Rct
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100 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	<=10	As per OEM design
250 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	<=10	As per OEM design
500 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	<=10	As per OEM design
630 KVA	As per OEM design	0.2	As per OEM design	As per OEM design	As per OEM design	<=10	As per OEM design

CTs shall not limited to the below mentioned points. All CTs shall be as per IS: 2705.

- a) All cabling from equipment to terminal boxes shall be of FRLS copper of size not less than 4 sq.mm and shall have insulated sleeve throughout the length and shall be laid in covered cable conduits. Wire terminals shall be hard core copper using round lugs. Wiring of all the cores shall be brought up to the terminal block and disconnecting type terminals shall be used. The CTs shall be shorted at CT terminals from the bidder's end only.
- b) Brass nuts along with lock-nuts, brass washers and spring washers shall be provided for all CT connections.
- c) All CTs shall have polarity marking and terminals shall have well defined marking for the purpose of usage, which shall be clearly written on CT terminal plates.
- d) CT specifications along with winding diagrams shall be provided in the transformer nameplate.
- e) Neutral & WTI CT test certificates shall be provided along with Transformer test certificates.
- f) In marshalling box protection CT and WTI CT shall be separately marked for wiring purpose. Also provide marking plate on WTI and neutral bushing CT on top of tank.
- g) Location of WTI and Neutral CT shall be such that easily wiring can be accessible at the time of commissioning and maintenance.

4.5 Insulating Oil:

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PRATYUSH K RATH	M S ANWAR	S B KUNDARGI

DOCUMENT TITLE	STANDARD TECHNICAL SPECIFICATION FOR TWO WINDING OUTDOOR STATION TRANSFORMER OF 33/.433 KV ONAN TRANSFORMER 100KVA, 250 KVA, 500 KVA,630 KVA	EFFECTIVE DATE 29/06/2021
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- a. Oil for first filling together with 10% extra shall be supplied with each transformer. The oil shall comply in all respects with the provisions of IS 335, IEC No.60296. Particular attention shall be paid to deliver the oil free from moisture having uniform quality throughout in non-returnable steel drums.
- b. The oil shall be of EHV grade and shall have the following main characteristics or equivalent (the requirements indicated are determined in accordance with the test methods as per IS: 335). The oil in the transformer shall be filled up to 'Transport filled level' before dispatch of the transformer.
- c. The maker of the oil shall be subject to approval by the Purchaser.
- d. Also refer below GTP table for insulating oil

Sr. No.	Characteristics	Requirement as per IS:335	Method of Test
1.	Appearance	The oil shall be clear and transparent and free from suspended matter or sediment temperature.	A sample of Oil shall be examined in 100mm thick layer at 27deg C
2.	Density at 29.5° C (max)	0.89 g/cm ³	IS 1448 (P:16):1990
3.	Kinematic Viscosity @ 27° C. (Max.)	27 cSt.	IS 1448 (P:25):1976
4.	Interfacial tension Min.	0.04 N/m	IS:6104:1971
5.	Flash Point (Closed CUP)	140° C	IS 1448 [P : 21] : 1992
6	Pour Point (max)	-6° C	IS 1448 [P : 10] : 1970
7	Neutralization Value (total acidity) max.	0.03 mg/KOH/g	IS 1448 [P : 2] : 1967
8	Corrosive sulphur (In terms of classification of copper strip)	Non Corrosive	IS 1448 (Part-I)/Annex B of IS :335
9	Electric Strength (Breakdown voltage)	The sampling shall be done in accordance with the procedure laid down in IS 6855: 1973.	IS 6792 : 1992
	i) New untreated oil	30 kV (r.m.s.)	
	If the above value is not attained, the oil shall be filtered		
	ii) After Filtration Min	60 kV (r.m.s.)	

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10	Dielectric Dissipation Factor (tan-delta) at 90°C, max.	0.002	IS:6262-1971
11	Specific resistance (resistivity) ohm/cm/min		IS:6103-1971
	a) At 90° C, Min	35 X 10 ¹² ohm-cm	
	b) At 27° C, Min	1500X 10 ¹² ohm-cm	
12	Water content, max. per million	30 (avg. 20 ppm)	Karl Fischer Method
13	Oxidation Stability		
	(i) Neutralization value after oxidation Max.	0.40 mg. KOH/g	Appendix C of IS:335
	(ii) Total sludge, after oxidation, max.	0.1 percent by weight	
14	Tan delta at 90° C after ageing test (max)	0.20	IS 6262:1971
15	Saponification Value	Max. 1.0 mg. KOH/g	Appendix E IS-335
16	Presence of oxidation inhibitor	The oil shall contain anti-oxidant additives.	IS 13631: 1992

4.6 Maximum Acceptable Losses:

The transformer losses should be as defined below:

- “Maximum Total Loss at 50% Loading” (50% LLmax) at rated voltage on principal tapping at 75°C and at rated frequency.
- “Maximum Load loss” (LLmax) at rated current for the principal tapping at 75°C excluding auxiliary losses.

The losses shall not exceed the value given below,

Description	Losses Type	100KVA	250 KVA	500 KVA	630 KVA
Max. Total Losses at 50% loading at 75°C (watts) As defined above at point no 4.6 (A)above	50% LL max	510	1054	1623	2000
Max. Total Losses at 100% loading) at 75°C (Watts). As defined above at point no 4.6 (B)above	LL max	1650	3150	4623	5630

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However, bidder can offer loss values lower than as mentioned above, but no financial advantage is available for the same.

4.7 Performance:

- a. The transformer shall be capable of being operated, without danger, on any tapping at the rated KVA with voltage variation of $\pm 10\%$ corresponding to the voltage of the tapping.
- b. Transformer shall be capable of operating under natural cooled condition up to specified load.
- c. The transformer 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.
- d. The transformer shall be able to withstand thermal and mechanical stresses caused by symmetrical or asymmetrical fault on any winding.
- e. The transformer and all its accessories including CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs.
- f. Loading of the transformer shall be as per IS: 6600.

4.8 FREQUENCY

The transformer shall be suitable for continuous operation with a frequency variation of $\pm 3\%$ from normal of 50 Hz without exceeding the specified temperature rise.

4.9 PARALLEL OPERATION

The similar ratio transformers shall operate satisfactorily in parallel with each other if connected between high voltage and low voltage conductor.

4.10 SHORT CIRCUIT WITHSTAND CAPACITY

The transformer shall withstand the short circuit at its terminals for the specified fault levels for minimum duration of 3 seconds.

4.11 EARTHQUAKE

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As the Transformers will be installed in areas prone to earthquakes, they shall be designed to withstand seismic forces equivalent to 0.1 g acceleration. Necessary devices for clamping the wheels to the rails shall also be provided along with any other suitable anti earthquake clamping arrangement.

5.0	GENERAL CONSTRUCTIONS :	
5.1	GENERAL	<ol style="list-style-type: none"> 1. All transformers shall be provided with detachable, flanged, bi-directional wheels for movement and mounting on rail gauge. Purchaser shall provide rail tracks grouted in concrete foundation. Bidder shall provide means for locking the wheels in positions parallel to and at right angles to the longitudinal axis of the tank. 2. Transformer shall be two winding type, with cold rolled grain oriented, silicon-steel laminations having excellent magnetic properties, insulated and clamped to minimize vibration and noise. Laminations shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property All covers and seals shall be oil and airtight and shall not be affected by mineral or synthetic oil action. 3. All fasteners of M10 and below size should be of stainless steel. All fasteners of M12 and above size should be hot dip galvanized. To achieve a good quality corrosion free painting, supplier should provide epoxy plus polyurethane paint with minimum total paint thickness of 120 microns. 4. The framework, clamping arrangement and general structure of the cores of each transformer shall be of robust construction and shall be capable of withstanding any shock to which they may be subjected during transport, installation and service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the eddy-currents to a minimum. 5. The limbs and the yokes of the core shall have similar sections to minimize heating and noise arising from transverse flux. The joints in the laminated magnetic circuit shall be interleaved. Necessary cooling ducts shall be provided for heat dissipation from the core so that the anticipated maximum hot spot temperature in the core shall not be injurious to any material used in the core assembly. 6. The core clamping frame shall be provided with lifting eyes having ample strength to lift the complete core and winding assembly. The core assembly of oil immersed transformers shall be electrically connected to the transformer tank for effective core earthing. 7. The neutral terminal shall be brought out through neutral bushing from the tank and the same shall be brought upto the skid level, duly insulated by means of suitably rated epoxy insulators. The neutral conductor lead shall be of copper conductor designed to carry the maximum E/F current with solidly earthed neutral. The bidder shall justify the voltage/current rating of the neutral bushing chosen during

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		<p>detailed engineering. The voltage rating of the neutral bushing shall be chosen considering the probable voltage rise for neutral floating conditions. The current rating shall be chosen considering solidly earthed neutral. The neutral shall be formed at the bottom of the winding and brought to LVN bushing through a separate path.</p> <ol style="list-style-type: none"> 8. The neutral CT shall be mounted in an enclosure (IP 55) outside the main transformer tank. Both primary and secondary terminals of the NCTs shall be accessible for testing. The NCTs shall be mounted in the Neutral to Earth path. 9. Top sampling valve shall be internally/externally piped and brought out of the tank sideways at skid level. 10. Transformer with all accessories shall be of free-standing type. Transformer accessories shall be designed in such a way that no supporting posts/structures are necessary other than the rail. 11. The sets of radiator banks shall be connected to the main tank through a header pipe welded to the tank. Design wherein individual radiator is connected to main tank is not acceptable. Individual radiator tubes shall be connected to main tank thru butterfly valves at both ends of radiator tubes. Arrangement shall be made for suitable gap between main tank and radiator tubes. 12. Transformer conservator breather shall be of conventional breather type with silica gel filled. 13. The oil level shall be higher than HV bushing terminal. 14. The part of the HV bushing terminal, to which overhead conductor/UG cable is connected should not be involved either in the oil sealing arrangement or air release arrangement. This is to be specifically confirmed by the bidder at the time of offer. 15. Two separate parts shall perform the two functions of receiving the jumper and oil sealing. 16. Air seals are not acceptable at HV bushing terminals. 17. The oil shall be supplied in non-returnable drums. The quantity shall be of 10% excess over the requirement of transformer at 30°C. 18. Magnetic oil level indicator shall comprise with 2 nos. mercury contact/switch (for High / Low oil level alarm). 19. Conventional breather or equivalent shall be used for main tank & silica gel breather with clear sight glass and oil sealing arrangement shall be used for OCTC purpose. 20. The transformer shall be suitable for operation at full rated power on all tapings without exceeding the applicable temperature rise. The transformer shall be designed to suppress harmonic content, especially the third and fifth, so as to eliminate distortion in the waveform and consequent additional insulation stress, noise on communication system and undesirable circulating currents between the neutrals at different transformer stations. 21. The design of each transformer shall be such that the risk of accidental short-circuits due to birds or vermin are obviated.
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		<p>22. All outdoor apparatus, including bushing insulators and fittings shall be so designed that they do not collect water at any point.</p> <p>23. All electrical connections and contacts shall be of ample cross sections for carrying the rated current without excessive heating.</p> <p>24. Each transformer shall be designed for minimum no-load and load losses within the economic limit and as per the Indian Standards.</p> <p>25. Ground terminals shall also be provided on marshalling box, OCTC local control panel and cable end box to ensure effective earthing.</p> <p>26. For continuity of earth connection, all gasketed joints shall be provided with minimum two numbers copper strip jumpers of adequate size.</p> <p>27. Rain Guard shall provided for LV compartment, OSR, PRV, SPR, Cooler Control Box and Marshalling Box so that rain water can enter to the junction box of these relays/ cubicles. Wiring shall be bottom entry.</p>
5.2	CORE	<p>1. The core shall be of high grade cold rolled, non-ageing, grain oriented, annealed silicon steel lamination (CRGO), having low loss & good grain properties, coated with hot oil proof insulation, bolted together to the frames firmly to prevent vibration or noise.</p> <p>2. The grade of core shall be M3 or better. The core shall be stress relived by annealing under inert atmosphere if required, especially suitable for transformer.</p> <p>3. All core clamping bolts (If any) shall be effectively insulated. Only one grade and one thickness of core shall be accepted and no mixing of different grades shall be allowed.</p> <p>4. The complete design of the core must ensure permanency of the core losses with continuous working of the transformers.</p> <p>5. The value of the maximum flux density allowed in the design & grade of laminations used shall be clearly stated in the offer.</p> <p>6. The successful bidder is required to submit the following documents with regard to the procurement of core material:</p> <p>a) Invoice of supplier</p> <p>b) Mill's test certificate</p> <p>c) Packing list</p> <p>d) Bill of landing</p> <p>e) Bill of entry certificate by custom</p> <p>f) Description of material, electrical analysis, physical inspection certificate for surface defects, thickness and width of the material</p> <p>g) Subjecting to at least 10% of the transformer to routine tests and no load and load loss measurement</p> <p>7. Purchaser shall impose heavy penalty or black list bidders using seconds/ defective CRGO sheets or load losses found to be more than stipulated limit.</p> <p>8. After being sheared the laminations shall be treated to remove all burrs. Both sides of steel laminations shall be so constructed that eddy currents will be minimum.</p>

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		<p>9. The core frame shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.</p> <p>10. The core and the coil shall be so fixed in the tank that shifting will not occur when the transformer is moved or during a short circuit.</p> <p>11. All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling and welding. Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.</p> <p>12. The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling. Adequate lifting lugs shall be provided to enable the core and windings to be lifted.</p> <p>13. Core Grounding:</p> <ul style="list-style-type: none"> i. The grounding lead from the core shall be brought out of the tank through a 11 kV class bushing and grounded externally. ii. A protective cover shall be provided for the bushing. iii. The core grounding rod (stem) through the bushing shall be solid rod (stem). iv. The design of core grounding arrangement shall be such that the grounding links shall not come out of core during installation as well service conditions. v. The supplier shall submit a drawing clearly showing the details of core grounding. vi. The core / frame grounding's both connections shall be brought out through a suitable bushing for provision of external grounding. vii. The bidder shall submit the drawing clearly showing the details of core grounding.
5.3	WINDING	<p>1. The windings shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable, and field repairs to the windings can be made readily, without special equipment.</p> <p>2. The coils shall be supported between adjacent sections by insulating spacers, and the barriers bracings and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings.</p> <p>3. Coils should be transposed to minimize magnetic forces and extra supports shall provide for inter-disc connection.</p> <p>4. All materials used in the insulation and assembly of the winding shall be new, insoluble, non-catalytic, and chemically inactive in the hot transformer oil, and shall not soften or otherwise be adversely affected under the operating conditions.</p> <p>5. The current density of coil shall not exceed 2.6 Amps/ sq mm at min tap of respective PTR's higher rating.</p> <p>6. All threaded connections shall be provided with locking facilities. All leads from the winding to the terminal board and bushings shall be</p>

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		<p>rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.</p> <ol style="list-style-type: none"> 7. The winding shall be brought out through bushing and provided with suitable terminal connectors, the details of which will be forwarded later. 8. The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core and windings shall be vacuum-dried and suitably impregnated before removal from the treating tank. The copper conductors used in the coil structure shall be best suited to the requirements, and all permanent current carrying joints in the windings and the leads shall be brazed. 9. Sharp bends should be avoided in the windings as far as possible, where unavoidable such bends should be reinforced with extra insulation tapes. 10. The tolerance for the winding resistance measurement for different phases but at same taps shall be limited to 1%. 11. The change in impedance values between the winding (HV/LV) shall not exceed $\pm 10\%$ of nominal impedance value as specified at all taps on HV/LV side. 12. The windings shall be brought out through bushing. The windings shall be designed to withstand the specified thermal and dynamic short-circuit stresses. 13. The end turns of the high voltage windings shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal condition. 14. Winding shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching. All the windings shall be capable of withstanding stresses that may be caused by such switching. 15. Primary and secondary windings shall be constructed from high-conductivity (copper conductors), Double Paper Covered (DPC) copper conductor. 16. The insulation between core and bolts and core and clamps shall withstand 2.5 kV for one minute. 17. Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted as per standards. 18. All turns of windings shall be adequately supported (by which material) to prevent movement. The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions. 19. The joints in the winding shall be avoided but if it is necessary then, these shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. Crimping is not allowed at any joints.
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5.3 INSULATING PAPER AND INSULATING PRESS BOARD

1. The bidder shall submit characteristics along with make for all the type of insulation papers and Pressboards to be used with the offer.
2. Inter layer insulation both for HV and LV windings shall be Epoxy diamond dotted Thermally Upgraded Kraft Paper (TUKP) and compressed pressboard of make (refer Clause no.5.21) subject to approval of TPWODL.
3. For Winding insulation, only Double Paper Covered insulation is acceptable with laying in opposite direction to each other and each paper must have overlapping more than 25% of its width.
4. Thermally Upgraded Kraft Paper (TUKP) and Pressboard should be made of pure Cellulose from soft wood pulp manufactured from sulphate process. No additive, adhesive or coloring matter shall be present.
5. Thermally Upgraded Kraft Paper (TUKP) and Pressboard should be of class A (105°C) insulation material.
6. All spacers, axial wedges / runners used in windings shall be made of pre-compressed solid pressboard.
7. All axial wedges/runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely.
8. Insulation shearing, milling and punching operations shall be carried out in such a way, that there should not be any burr, sharp edges and dimensional variations.
9. Thermally Upgraded Kraft Paper (TUKP) self-adhesive tape to be used for bonding of insulating paper layer, spanner and paperboards that are immersed in the oil filled transformer.

Below required values could be verified if required at any stage of the inspection and it should fulfil the requirement as per below table:

Characteristics	Thermally Upgraded Kraft Paper (TUKP)	Pressboard (all Sizes)
1. Dimension	As specified by bidder with $\pm 5\%$ tolerance.	As specified by bidder with tolerance as per IS1576.
2. Apparent Density	$>0.80 \text{ g/cm}^3$	as per IS1576 w.r.t Thickness
3. pH of Aqueous extract	6-8%	6-8%
4. Electrical strength i) in air ii) In Oil	7KV/mm -----	12KV/mm 35KV/mm
5. Ash content	Maximum 1%	Maximum 0.7
6. Moisture content	Maximum 8%	Maximum 8%
7. Oil absorption	-----	Minimum 9%

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		<p>Bidder has to submit the test certificates as per IS-9335, IS-1576 for all type of insulating materials covering above stated parameters along with below parameters during stage inspection :</p> <ol style="list-style-type: none"> 1. Substance (Grammage) (g/m³) 2. Compressibility 3. Tensile strength 4. Conductivity of water extract 5. Shrinkage in air 6. Flexibility 7. Cohesion between plies1. 8. Elongation 9. Air permeability 10. Tear index 11. Heat stability
5.4	TANK	<ol style="list-style-type: none"> 1. The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and shall be of adequate thickness. 2. The tank and the cover shall be of welded construction. All seams shall be welded and where practicable they shall be double welded. 3. The tank shall have sufficient strength to withstand without permanent distortion (i) filling by vacuum and (ii) continuous internal gas pressure of 0.35 atmp. with oil and operating level. 4. The tank material shall be as per IS: 2026 or equivalent with ultrasonic testing done for elimination of defects in rolled plates. 5. The welding shall be as per prior approved WPS (Welding Procedure Specs) by trained and tested welders. 6. The welding plan shall be shown in general i.e. Category-wise or for each type of weld in the mechanical fabrication drawing, which shall be submitted to Purchaser. 7. All fittings like elbows, bends etc. shall be seamless as per applicable American or Indian Standards. 8. No resistance welding of fasteners shall be done anywhere on the transformer. 9. The tank shall have an oil tight bolted flanged joint near the base of the transformer so that the tank can be lifted off to provide access to the core and coils. 10. To ensure oil tightness, recessed neoprene or equivalent gaskets shall be used. 11. Inspection covers on elevation (on vertical plane) shall be provided for all HV bushing turrets. 12. Suitable guides shall be provided for positioning the various parts during assembly or dismantling. 13. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment. 14. All joints including bolted as well as flanged, shall have machined matching surfaces/inner edges with smooth finish, to ensure leak proof joints.

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		<p>15. Lifting eyes or lugs shall be provided on all parts of the transformer requiring independent handling during assembly or dismantling. In addition, the transformer tank shall be provided with lifting lugs and bosses properly secured to the sides of the tank, for lifting the transformer either by crane or by jacks.</p> <p>16. The design of the tank, the lifting lugs and bosses shall be such that the complete transformer assembly filled with oil can be lifted with the use of these lugs without any damage or distortions.</p> <p>17. The tank shall be provided with two nos. of suitable copper alloy lugs for the purpose of grounding.</p> <p>18. The grounding pads should be mirror finished. Two grounding pads, located on opposite sides of the tank shall be provided with two tapped holes for connecting it with station ground mat. Necessary hardware like M10 GS bolts and spring washers shall also be provided for connections.</p> <p>19. Each tank shall be equipped with the following valves with standard flange connection for external piping:</p> <p>a) One drain valve located on the low voltage side of the transformer and placed to completely drain the tank. At the option of the Purchaser's a large valve may be furnished with an eccentric reducer. This valve shall be equipped with a small sampling cock.</p> <p>b) One filter valve located at the top of the tank on the high-voltage side. The opening of this valve shall be baffled to prevent aeration of the oil.</p> <p>c) One filter valve, located slightly above the bottom of the tank.</p> <p>d) One relief valve to operate at a pressure below the test pressure for the tank.</p> <p>e) Other two nos. valves shall also be provided, as required for proper functioning of the transformer.</p> <p>f) A suitable locking arrangement shall be provided for locking these valves in close/open position.</p> <p>20. All valves should be provided with clear open/close position indications. Wherever rising spindle type valves are provided the valves should be clockwise rotating for closing operations.</p> <p>21. Transformer tank shall be of welded sheet steel construction and provided with gaskets steel cover plates.</p> <p>22. Base shall be suitably reinforced to prevent any distortion during lifting. Base channels shall be provided with skids and pulling eyes to facilitate handling.</p> <p>23. All seams shall be electrically double welded for absolute oil tightness.</p> <p>24. Suitable arrangement shall be made for mounting HV and LV lightning arrestors of the transformer.</p> <p>25. Guards shall be provided for drain, bottom sampling and filter valves to prevent oil pilferage.</p> <p>26. Minimum Thickness for the transformer shall be as follows:</p>
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		<p>Tank Side wall (mm) 05 Tank Top Cover (mm) 06 Tank Bottom Plate (mm) 06 Conservator (mm) 06</p>
	OIL-PRESERVING EQUIPMENT	<ol style="list-style-type: none"> Oil preserving equipment shall be conventional conservator type. The conservator shall have two filter valves, one at the bottom at one end, the other at the top, opposite end, in addition to the valve specified in the Accessories for the main tank. The conservator or expansion tank shall also have a shutoff valve and a small drain valve and sampling cock, the latter so arranged as not to interfere with oil lines. The oil level gauges (prismatic and magnetic) shall be mounted on the conservator or expansion tank. The top of the conservator shall have contact with atmosphere through two silica gel breathers to facilitate replacement of breather without having to keep Buchholz relay inoperative. The silica gel breathers shall have Polyurethane Type body & it should be transparent and UV protected. Proper valve arrangement (Two top valve & one bottom valve on conservator) is to be provided for proper oil filling. Prismatic oil level indicators with red color float shall be provided on main tank.
5.6	TAP CHANGING MECHANISM off Circuit Tap changer	<ol style="list-style-type: none"> Rotary/Ring type tap changing mechanism to be mounted on side of the transformer in such way that could be easily operated in smooth way. Tap changing shall be carried out by means of an externally operated self-position switch and when the transformer is in de-energised condition. The taps shall be provided in HV winding and each tap change shall result in voltage variation of 2.5%. Switch position no.1 shall correspond to the maximum plus tapping (i.e.+5%) and position no.7 shall correspond to minimum tapping (i.e.-10%). Tap no. 3 to be considered as principal tap position. Provision shall be made for locking the tapping switch handle in position. Suitable plate shall be fixed for tap changing switch to know the position.
5.7	BUSHINGS	<ol style="list-style-type: none"> Bushings provided by the bidder shall be as per IS2099-1986. The bushings shall have high factors of safety against leakage to ground and shall be so located as to provide adequate electrical clearance between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size and all external current carrying contact surfaces shall be plated, adequately. The insulation class of the high voltage neutral bushing shall be properly co-ordinate with the insulation class of the neutral of the high voltage winding.

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		<ol style="list-style-type: none"> 2. All main winding leads shall be brought out through outdoor type bushings as specified which shall be so located that the full flashover strength will be utilized and the adequate phase clearance shall be realized. 3. Each bushing shall be so coordinated with the transformer insulation that all flash-over will occur outside the tank. 4. All porcelain used in bushings shall be of the wet process, homogeneous and free from cavities or other flaws. The insulation (porcelain) shall be without any joint up to 145kV class. The glazing shall be uniform in colour and free from blisters, burns and other defects. Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration. 5. Bushings rated for 72.5 kV and above shall be of the oil filled condenser type with a central tube and draw-in conductor which shall be connected to the connector housed in the helmet of the bushings. The pull through lead shall be fitted with a gas bubble deflector. Condenser type bushings shall be equipped with following : <ol style="list-style-type: none"> a) Provision for power factor, dissipation factor and tan delta testing without disconnecting main leads. b) Stress rings and lower end shields. c) Current transformers shall be provided, if specified and the bushing shall be so arranged that it can be removed without disturbing the current transformers and secondary terminals. d) Bushing turrets shall be provided with vent pipes which shall be connected to route any gas collection through the Buchholz relay. 6. All oil filled bushing shall be provided with prismatic type oil gauge with red colored float inside the gauge for oil level indication. The oil gauge glass shall be so designed that it shall give satisfactory service (without melting/cracking or bulging) at specified site conditions, throughout the life of transformer/bushing. It shall not turn opaque during the service. 7. In case of oil communicating type bushing (for 33 KV & 11 KV), venting screw of the hollow stud, shall be provided with Teflon gaskets, to avoid oil leakage problem through the same. Angle of inclination to vertical for any bushing shall not exceed 30 deg. All bushings shall have puncture strength greater than the dry flash-over value. 8. Main terminals shall be solder less terminals, and shall be of the type and size specified in the drawings. The spacing between the bushings must be adequate to prevent flashover between phases under all conditions of operation. 9. The Bidder shall give the guaranteed withstand voltages for the above and also furnish a calibration curve with different settings of the co-ordination gap, to the purchaser to decide the actual gap setting. Bidder's recommendations are also invited in this respect.
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		<p>10. The following routine tests shall be carried out on all bushings in the presence of purchaser’s representative, in addition to any other specified in the IS:</p> <ul style="list-style-type: none"> a) Visual examination b) One minute dry withstand test c) Oil tightness test d) Partial discharge test (Applicable on 66 kV only) e) Test for capacitance and power factor, dispassion factor and tan delta (on CT only) measurement. <p>11. The bushings shall have a link type isolating facility for tap for maintenance tests viz. power factor measurement etc. (Terminal shall be provided for the measurement of power factor and tan delta).</p>
5.8	NEUTRAL CURRENT TRANSFORMERS	<p>1. The current transformers shall conform to Indian Standards and shall have the class of accuracy, burden and other details as per IS. The design and construction shall be sufficiently robust to withstand the thermal and mechanical stresses resulting from maximum short circuit current. The core laminations shall be of high grade silicon steel or other equivalent alloy. The exciting current shall be as low as possible. Characteristics of the CTs shall be furnished by the bidder.</p> <p>2. Bidder shall forward following information for CTs along with the offer.</p> <ul style="list-style-type: none"> a) Winding dimensional drawing of CT including mounting details. b) Total weight of each CT. c) Quantity of oil/CT (if applicable) d) Rating and diagram plate drawing. e) CT characteristic curves with excitation current Vs secondary voltage for each core as measured in the case of protection CTs. f) CT secondary resistance as measured in ohms. g) Maximum shipping weight and volume. h) CT mounting drawing. I) All type test report as per IS
5.9	GASKETS	<p>1. All bolted connection to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions. Gaskets shall be of rubber/Nitrate.</p> <p>2. Special attention shall be given to the methods of making the oil-tight joints between the tank and the cover as also between the cover and the bushings and all other outlets to ensure that the joints can be remade satisfactorily and with ease, with the help of semi-skilled labor.</p> <p>3. Where compressible gaskets are used, steps shall be provided to prevent over compression.</p> <p>4. All the bolts provided shall be of hot dip galvanized.</p> <p>5. All bolts shall be provided with one spring washer and two numbers of flat washers and with locking bolts.</p>

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		6. All gasket joints shall be provided with equalizing links to extend earth connections.
5.1 0	RADIATORS	<ol style="list-style-type: none"> 1. Radiators of pressed steel type conforming to the design requirement suitable for mineral oil and Ester oil (all type) type transformer. 2. The Pressed Steel type should be used in vertical formation without any bending and should be individually tested for leakage and pressure test etc. before welding with the main tank. 3. Thickness of sheet for radiators shall be 1.20 mm (min). 4. The mounting of the radiators shall be non-detachable (i.e., they should be welded permanently with the tank). 5. The number / cross section / length / fixing arrangement of radiators shall be indicated in the general assembly drawing. 6. Radiator thickness must be uniform without any dent or damage and also no bulging or concave should occur even after performing pressure/ vacuum test and temperature rise test. 7. Corrugated designs are not accepted 8. The radiators of cooler units shall be epoxy painted the entire surface including edges should be cleaned properly before painting to avoid peeling of paint at the edges. 9. Radiators shall be metal spray painted. 10. The colour shade for the radiator shall be shade 631 as per IS: 5.
5.1 1.1	CONTROL WIRING	<ol style="list-style-type: none"> 1. TTB links in Marshalling box shall be of droppable type. 2. Ring type lugs must be used for connecting CT control wiring at all places. 3. Anodized aluminum plate showing details of all terminals nos.& drawing shall be provided along with marshalling box. 4. Wiring from the current transformers and other control and alarm equipment shall be carried out in conduits or alternatively in concealed trays and terminated in marshalling box. 5. All terminal blocks for WTI, OTI etc shall be of disconnecting type. Terminal blocks for short circuiting the current transformer shall be provided separate from the terminal blocks accommodating the control and indicating circuits. The direct and alternating current terminals shall be isolated from each other. 6. All tapings of all CTs shall be brought to terminals in the marshalling box. The terminals for the current transformer leads shall be suitable for accommodating , 6 sq.mm cable leads, with disconnecting type links, while the terminals for the control and other circuits shall be suitable for accommodating 4 sq.mm. cable leads. All wires shall be stranded copper, 1.1kV grade insulation, fire resistant and shall be of reputed make. A minimum of ten spare terminals for control wiring shall be provided. 7. Suitably rated switches shall be provided to enable the control supply to the transformer to be cut off from the cabinet. 8. Enough Space shall be provided at the bottom of the operating cabinet to mount the Purchaser's control cables double compression

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		<p>type glands. The number and size of the cable glands shall be intimated later. All terminal blocks for control shall be rated for 10 Amps.</p> <ol style="list-style-type: none"> 9. Wire and cable bunching rods shall be provided on all terminal blocks on either side. The wire terminals shall be engraved or otherwise indelibly marked ferrules and the wires shall be color coded. 10. All terminal blocks shall have terminal nos. on either side of terminals. 11. Stud type fuse mounts shall be provided with an insulating cover as protection against accidental contact with live terminals. 12. Acrylic name plates shall be provided on doors of marshalling box cabinet, CT junction box and thermo junction box. Name plates shall also be provided for all the components inside the marshalling box. 13. Additional 230V, 15 Amps, 3 pin plug point shall be provided for testing purposes inside the marshalling box. 14. A suitably rated light point with its associated control switches shall be provided inside the housing for use in emergency. 15. All alarm and control devices shall be ungrounded. 16. Bidder shall furnish a list of the relays, control switches, timers, and other accessories like Bidder, bushing, MOG etc. indicating the make, type, auxiliary supply requirements, contact rating etc. along with quotation. 17. The make of devices shall be subject to approval by purchaser, after finalization of order. The bidder shall furnish O & M manual for all the auxiliary equipment's. 18. A single metal-enclosed main isolating switch, with HRC fuses, shall be provided for the cooling plant. 19. The contactors, starters and relays provided in the marshalling box shall be reputed make such as Siemens, L&T, ABB or equivalent make as per purchaser's approval. 20. The switching in or out of the cooling equipment shall be controlled by winding/oil temperature and there shall be provided for automatic switching in or out at predetermined temperature levels which should be capable of adjustment in settings. 21. The local mechanical indication scheme for all annunciation shall be provided in the marshalling box with mechanical target relays/contactors. 22. The following alarm indication shall be provided each with 2No contacts (wherever applicable). <ol style="list-style-type: none"> i. Failure of power supply/control supply. ii. Conservator oil level low (MOG)/ Oil Level High iii. PRD Trip./PRV TRIP iv. Buchholz relay trip/alarm. v. Winding Temperature high. vi. Winding Temperature high-high. vii. Oil Temperature high. viii. Oil Temperature high-high.
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		<ul style="list-style-type: none"> ix. Bucholz/OSR of OCTC trip x. OCTC oil level low / OCTC oil level high xi. SPR Trip 						
5.1 1.2	Valves	<ol style="list-style-type: none"> 1. All valves upto and including 100 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. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel. 2. Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves. 3. Each valve shall be provided with the indicator to show clearly the position of the valve. 4. All valves flanges shall have machined faces. 5. All valves in oil line shall be suitable be suitable for continuous operation with transformer oil at 100°C. 6. The oil sampling point for main tank shall have two identical valves to be put in series. Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling. 7. A valve or other suitable means shall be provided to fix the on-line dissolved gas monitoring system to facilitate continuous dissolved gas analysis. The location & size of the same shall be finalized during detail engineering stage. 8. After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint conforming to IS:2932 and of a shade (preferably red or yellow) distinct and different from that of main tank surface. 9. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate conforming to IS:2074 followed by two coats of fully glossy finishing paint. 10. All hardware used shall be cadmium plated/electro galvanized. 						
5.1 2	INSULATION	<ol style="list-style-type: none"> 1. The dielectric strength of the winding insulation and of the bushings shall conform to the values given in IS 2026 (latest version). 2. For rated system voltage, the following impulse test voltage shall be offered. System voltage: 1.1 KV, 36KV. Impulse Test Voltage: 3 kV, 170KV. 3. The transformer shall be capable of operating continuously at its normal rating without exceeding temperature limits as specified below: <table border="1" style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 35%;">Type of cooling</th> <th style="width: 35%;">Temperature rise</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>		Type of cooling	Temperature rise			
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	Winding	ONAN cooled	55 deg.C
	Oil	All types	45 deg.C

5.1 3	ACCESSORIES	<p>Each transformer shall be provided with the following accessories:</p> <ol style="list-style-type: none"> 1. Dial Type Thermometers for Oil (OTI) A dial-type indicating thermometer of robust pattern mounted on the side of the transformer at a convenient height to read the temperature in the hottest part of the oil and fitted with alarm and trip contacts and contacts for switching in and switching out the cooling system at predetermined temperatures. 2. Winding Temperature Indicator (WTI) in one winding of each phase as described below: <ol style="list-style-type: none"> a) It shall be indicating type, responsive to the combination of top oil temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding. b) The winding temperature detector shall operate a remote alarm in the event the hottest spot temperature approaches a dangerous level and in the case of ONAN (Oil Natural and Air Natural) Thus WTI shall have 4 independent NO contacts for alarm and trip and cooler control. 3. Equipment for remote winding and oil temperature Indicators including these to be installed in the Purchaser's control room shall be provided. Pocket with heater coil and CT for RTD for winding hot spots shall be provided. 4. For purpose of remote recording and data acquisition system Top oil temperature detector along with suitable transducer and other necessary devices to provide two sets of 4-20 mA signals with PT-100 type of sensors. 5. Tap changer indicator of OCTC along with suitable transducer and other necessary devices to provide two sets of 4-20 mA signals along with one set of 1-16K resistance output shall be provided. 6. All digital outputs for remote annunciation/control/DAS shall be provided with two changeover (NO) contacts for alarm condition and two changeover (NO) contacts for trip condition. The OTI & WTI shall be provided with micro switches, instead of mercury switches for alarm and trip purpose. All the interconnected wiring between TJB, Marshalling box and OCTC etc shall be done by the bidder and schematics drawings of the same shall be supplied. 7. One magnetic-type oil-level gauge each in Main Tank and OCTC Tank with low and high level alarm contacts for main tank MOG and low level alarm for OCTC tank MOG and a dial showing minimum, maximum and normal oil levels. The gauge shall be readable from the transformer base level. It should have cable disconnecting facility at top of MOG, to facilitate testing of MOG. Along with MOG, prismatic type oil level indicator (glass window) shall also be provided on conservator.
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MOG technical parameters should be according to the below mentioned specifications.			
General Technical Requirements for MOG:			
S N o	DESCR PTION	UNI TS	
1	Mountin g Pad Diamete r	Mm	150
2	Electric Switch		Two no's Micro Switches/ mercury switch
3	Contact Rating		5 Amps 240V AC, 0.25 Amp 220V DC
4	Switch Operatio n		Normally open, closes when oil level drops to near empty condition. Switch recovers automatically on rising of oil level
5	Mountin g of indicator		Vertical
6	Dial Marking		Maximum, Minimum, 1/4, 1/2 & 3/4
7	Moveme nt of float arm		In the plane perpendicular to seating face
8	Conserv ator Dia	mm	The capacity of the conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain 10% quantity of the oil used in transformer . Normally, at least 30% volume of conservator shall be filled with Oil.
9	Air cell in conserv ator		Yes

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	10	Switches for		Low Oil level Alarm, High oil level Alarm.
	11	Color		Black marking with white/yellow background.
	12	Readable from transformer base level		Yes
	13	Cable disconnecting facility at top of MOG to facilitate testing of MOG		Yes
	14	Mechanical Protection degree		IP55
	15	Suitable for transformer rating	KVA	
	16	Packing		Supplier shall ensure that the equipment covered by this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner so as to protect the equipment from damage in transit.
	17	Marking		The unit shall be appropriately marked as "PROPERTY OF TPWODL, ODISHA" and with the name of the vendor, Manufacturer type/serial no., and year of manufacturing at suitable location.

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		18 Warranty	2 years from the date of purchase. In case any defects are found, the vendor shall replace the product free of cost.
		19 Test Reports	Test certificates to be provided : 1) Specified levels. 2) Switch operation 3) HV Test 4) Leakage Test 5) Insulation Test
		20 Acceptance test	Following tests shall be carried out: 1) Specified levels 2) Switch operation 3) HV Test 4) Leakage Test 5) Insulation Test
<p>8. One oil filling valve (inlet) 9. One oil drain valve 10. One filter valve located at the top of the tank on the HV side. 11. Oil sampling valves. 12. Pressure relief device a). Spring-loaded Pressure Relief Device (PRV) with mechanical flag indicator shall be provided on the main tank top of the transformer. b). Oil splashguard along with draining arrangement (with wire net on both side) up to ground level to be provided for prevention of oil splashing. c). Arrangement for air-release through a gate valve should be provided at the base of the PRV. d). The PRV shall not be located in the vicinity of the Marshalling Box or OCTC Box for safety of operating personnel. e). A pair of potential free contacts shall be provided to trip the transformer on action of the pressure relief device. f). It shall have the limit switch with 2NO and 2NC contacts, flag, switch operated rod etc. g). PRV shall be tested for all the applicable test such as Leakage Test, Switch operation, break down test.</p>			

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13. **Oil Surge Relay** should be according to the following general technical parameters as mentioned in below table.

S. No.	Description	Unit	Requirements
1	Type of relay		Magnetic reed switch type OSR suitable for 25 mm nominal pipe bore with 1 set of potential free contact to be used for 48V to 220V DC
2	No. of Switching systems		1
3	Suitable for		OCTC
4	Nominal Pipe Bore	mm	25
5	Type of Flange		Square
6	Diameter of flange	mm	78 square
7	Diameter of bolt circle	mm	72
8	Number of the bolts		4
9	Size of the bolts		M10
10	Flange Thickness	mm	6 mm
11	Surge Test (TRIP)	cm/s	70 to 130
12	Velocity Test	cm/s	70 to 130
13	Relay operating range: Oil Temperature		10°C to 100°C
14	Relay operating range: Oil Viscosity		66 to 75 centistokes at 10°C, 2 to 3.5 centistokes at 100°C
15	Element Test		With oil, at 1.75Kg/cm ² for 15 minutes,
16	High Voltage Test		Shall be able to withstand 2000 V at 50 Hz for 1 minute

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	17	Insulation Resistance Test	Shall be Greater than 10 Mega ohms with 500 V megger
	18	Porosity Test	With oil, at 1.5 kg/cm ² for 4 hours - There shall not be any leakage or mechanical damage
	19	Mechanical Strength Test	With oil at 8 kg/cm ² for 1 minute
	20	Resistance of the Switch	Not to exceed 0.1 ohm across the electrodes of magnetic switch
	22	Cable entry in terminal box	From bottom side

14. Radiators shall be complete with motors, fans etc as described in clause 5.10.
 15. Oil Preserving Equipment.
 16. Eye bolts and lugs on all parts for ease of handling.
 17. Two grounding terminals.
 18. Diagram and rating plate.
 19. One set of equipment for control, protection, indication and annunciation for each transformer comprising motor contactors, detecting elements or devices, indicating apparatus instruments, relay, annunciators, etc.
 20. Separate tank mounted marshalling box for terminal blocks for current transformer secondary only with Cable conduits for cables from devices to marshalling box.
 21. Provision shall be made for installing resistance temperature detectors for temperature recording instruments arranged separately for the following:
 - a) Hot oil
 - b) Winding hot spot
 22. Two silica gel breathers (more than 5kg) each of 100% capacity for main tank.
 23. Inspection covers for transformer inspections on all phases (on vertical plane)
 24. Provide separate contacts for OSR relay in marshalling box.
- The equipment and accessories furnished with the transformer shall be suitably mounted on the transformer for ease of operation, inspection and maintenance, and the mounting details shall be subject to the approval of the purchaser. All valves shall be provided either with blind companion flanges or with pipe plugs, for protection. All valves shall have open/close position clearly marked.

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		Indication, alarm and relay equipment shall have contacts suitable for operation with 220/50V Volts DC supply. Any other accessories or appliances recommended by the Bidder for the satisfactory operation of the transformers shall be supplied.
5.1 5.5	Following Tests shall be carried out on the Marshallin g Box	<ul style="list-style-type: none"> a) Functional tests / 2KV withstand. b) Dimensional checks. c) Make and operation of contactors, relays. d) Factory test report attached for bought out items. e) Test for Enclosure Protection.
5.1 6	ANTI RUSTING/ CORROSION TREATMENT	<ul style="list-style-type: none"> 1. The bidder shall ensure that all fabrication i.e. transformer tank, radiators, marshalling boxes and other accessories are treated for highest quality performance for the entire life of the transformer. The Bidder shall submit plan for extra measures he is taking for prevention of corrosion, along with the offer. 2. Finishes on transformer and appurtenant parts, edges (exposed to atmosphere) 3. NO GAS CUT EDGE OR SURFACE shall be acceptable unless smoothly ground to plane surface without irregular projections and corners (which cannot be blasted to the required roughness). 4. For all radiators the following painting procedure shall be followed. The metal spray (99.95% assay zinc) to a thickness about 100 microns with surface roughening and two coats of paints with proper supervision and quality checks. Bidder shall indicate separate price for metal spray of radiators. 5. In this corrosion prevention measure it is imperative that the job is fully monitored for optimizing the proper conduct of the procedure as given in the various national standards. The coating shall be as per BS: 2569 (latest revision). The coating requirement shall be to BS: 5493 Gr. SC10Z. 6. The Bidder shall submit a Quality Plan, giving the parameters and checking methods, (major, critical, minor). 7. The paint shade used shall be shade 631 as per IS:5. The following shall be the check points for the metal spray of Radiators:- <ul style="list-style-type: none"> a) Metal Spray b) Surface preparation c) Chemical analysis of actual material used for spray (batch wise identification). d) Coating Process (the first trial job will be witnessed to see if the written procedure is followed). e) Coating thickness test, adhesion test as per BS. f) Repair area classification major or minor and accordingly the repair from blasting onwards otherwise. 8. Bidder may quote for galvanized radiators instead of metal spray radiators as an alternative.

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DOCUMENT TITLE	STANDARD TECHNICAL SPECIFICATION FOR TWO WINDING OUTDOOR STATION TRANSFORMER OF 33/.433 KV ONAN TRANSFORMER 100KVA, 250 KVA, 500 KVA,630 KVA	EFFECTIVE DATE 29/06/2021
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5.1 7	CENTRE OF GRAVITY	The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric relative to track either with or without oil, its location shall be shown on the outline drawing.						
5.1 8	CENTRAL LINE MARKING	Central line of the transformer, tank, cooler bank, cable box etc shall be marked properly with indication to avoid any confusion during installation of the transformer.						
5.1 9	PAINTING	<ol style="list-style-type: none"> 1. Before painting, surface preparation shall be done by sand blasting and procedure for sand blasting has to be submitted by the Vendor along with the bid. The surface preparation for all external surface prior to painting or coating shall be witnessed by customer or shall be treated as customer hold points. After sand blasting at all edges Belzona E metal to be applied. 2. Before shipment all steelwork not under oil shall be painted with a primary coat of anti-corrosive paint of durable nature and two coats of battleship grey paint (Shade 631 of IS:5). Paint shall be epoxy type. The interior surfaces shall be painted as per bidder's standard practice. All the paint including primer shall be applied after testing such as air test, hydraulic test etc. Bidder shall submit their procedure for painting for Purchaser's approval, along with the offer. 3. Painting of Marshalling box: Two coats of red oxide primer & two coats of synthetic enameled paint after chemical treatment. 4. Metal parts not accessible for painting shall be made of corrosion resistant material. 5. Paint shall be as per Indian Standard/International Standard for quality, surface preparation, application method, thickness check and any other test. 6. Additional paint shall be supplied along with the transformer for applying touch up paint at site during installation. The shade of the paint used shall be shade 631 as per IS: 5. 						
5.2 0.	NITROGEN INJECTION DRAIN AND STIR SYSTEM	This system is not to be given along with Transformer.						
5.2 1	MAKE OF MAJOR COMPONENTS & RAW MATERIALS	<p>The BA shall procure the following constituent items from the designated vendors as follows:</p> <table border="1"> <thead> <tr> <th>S.no</th> <th>RAW MATERIAL/EQUIPMENT</th> <th>MAKE</th> </tr> </thead> <tbody> <tr> <td>a)</td> <td>Copper</td> <td>M/S Sterlite, M/S Hindustan Copper, M/S Hindalco</td> </tr> </tbody> </table>	S.no	RAW MATERIAL/EQUIPMENT	MAKE	a)	Copper	M/S Sterlite, M/S Hindustan Copper, M/S Hindalco
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5.22 SURFACE PREPARATION AND PAINTING

- The paint shall be applied by airless spray.
- Steel surfaces shall be prepared by **shot blast cleaning** (IS-9954) to grade Sq.2.5 of ISO 8501-1 or **chemical cleaning** including phosphating of the appropriate quality (IS 3618).
- Heat resistant (Hot oil proof) paint** shall be used for the **inside surface** and whereas for **external surface one coat of thermosetting powder paint or one coat of epoxy primer (zinc chromate) followed by two coats of polyurethane (P.U.) base paint.** as per table given below:

S. No.	Paint type (should be UV restraint, non-fading)	Area to be painted	No of coats	Total dry film thickness (min); micron
1.	Thermosetting powder paint	Inside	01	30
		Outside	01	60
2.	Liquid Paint			
a.	Epoxy (primer)	Outside	01	30
b.	P.U. Paint (finish paint)	Outside	02	25 (each)
c.	Hot oil resistant paint	Inside	01	35

- The two coats shall be of oil and weather-resistant nature with final coat as glossy and non-fading paint of shade 631 as per IS 5 or RAL 7032.
- The dry film thickness shall not exceed the specified minimum dry film thickness by more than 25%.
 - Any damaged part shall be cleaned to bare metal with an area extending 25 mm around its boundary. A priming coat shall be immediately applied

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		<p>followed by full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage. The repainted surface shall present a smooth surface which shall be obtained by carefully chamfering the paint edges before and after priming.</p> <p>6. Painting shall not affect by weather changes & performance against pilling out or fading etc. to be guaranteed for 5 Years.</p>
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6.0 NAME PLATE AND MARKING

6.1	RATING PLATE	<ol style="list-style-type: none"> 1. A stainless-steel rating plate, of at least 1 mm thickness, shall be fitted to each transformer in a visible position and shall carry all the information as specified in the standards. 2. The letters on the rating plate shall be engraved black on the white/silver back ground. 3. Fixing screws for outdoor use shall be of stainless steel or any other corrosion resistant metals. 4. The Name plate shall be embossed with "PO no. with date" & "PROPERTY OF TPWODL". 5. Danger notice shall have red lettering on a white background or they may be pictorial as approved by the Purchaser. 6. The name plate shall contain following information: <ol style="list-style-type: none"> a) Type of transformer (Two Winding Transformer) b) Relevant standard. c) Manufacturer's Name d) Manufacturer's Serial No. e) Year of Manufacture f) No. of phases g) Rated kVA h) Rated frequency i) Rated Voltage j) Rated current k) Connection symbol l) Percentage impedance voltage at rated current. m) Type of cooling (ONAN). n) Total Mass. o) Mass and Volume of insulating Oil. p) Connection diagram showing the internal connections. q) Temperature rise r) Insulation levels of the windings, including neutral end of windings with non-uniform insulation. s) Transportation weight t) Untanking weight. u) Core and windings weight v) Table giving the tapping voltage, tapping current and tapping power for each tapping. w) Values of short circuit impedance on the extreme tapings and on the principal tapping and indication of the winding to which the impedance is related.
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		<p>x) A table of all guaranteed particulars. y) Quantity of oil required for normal filling. z) HV and LV phase to phase clearances. aa) Vector diagram bb) Indication of the winding which is fitted with tapping. cc) Table giving the tapping voltage, the tapping current and the tapping power of each winding, for each tap. dd) Value of short circuit impedance on the extreme tapping and on the principal tapping and indication of the winding to which the impedance is related. ee) Information of the ability of the transformer to operate at a voltage exceeding 110 % of the tapping voltage or, for the principal tapping, 110 % of the rated voltage. ff) provide tan delta value of insulating oil, transformer and bushing.</p>
6.2	Valve Schedule Plate	The name plate shall contain information of all the valves, their locations, quantities and schematic for the valves.
6.3	Marshalling Box	<p>a) Manufacture's Name. b) Manufacture's Serial No. c) Year of Manufacturing. d) Purchase Order No.</p> <p>The following shall be clearly mentioned / Engraved on the Plate: "Property of TPWODL, Odisha" Engraved drawing of control circuit, CT / PT circuit and TB shall be available on Marshalling Box and OCTC Box</p>
6.4	BEE Certification Label	<p>Star Rating as per IS 1180 part (1) shall be specified. BEE Label for Power Savings shall be marked on the transformer. The format for the BEE label shall be as follows: 1) Detailed label Specification (Size, Color scheme, Font size, security Features, if any) shall be specified as below. 2) The label shall be applied near the nameplate details of the transformer and shall be clearly visible on the equipment</p>

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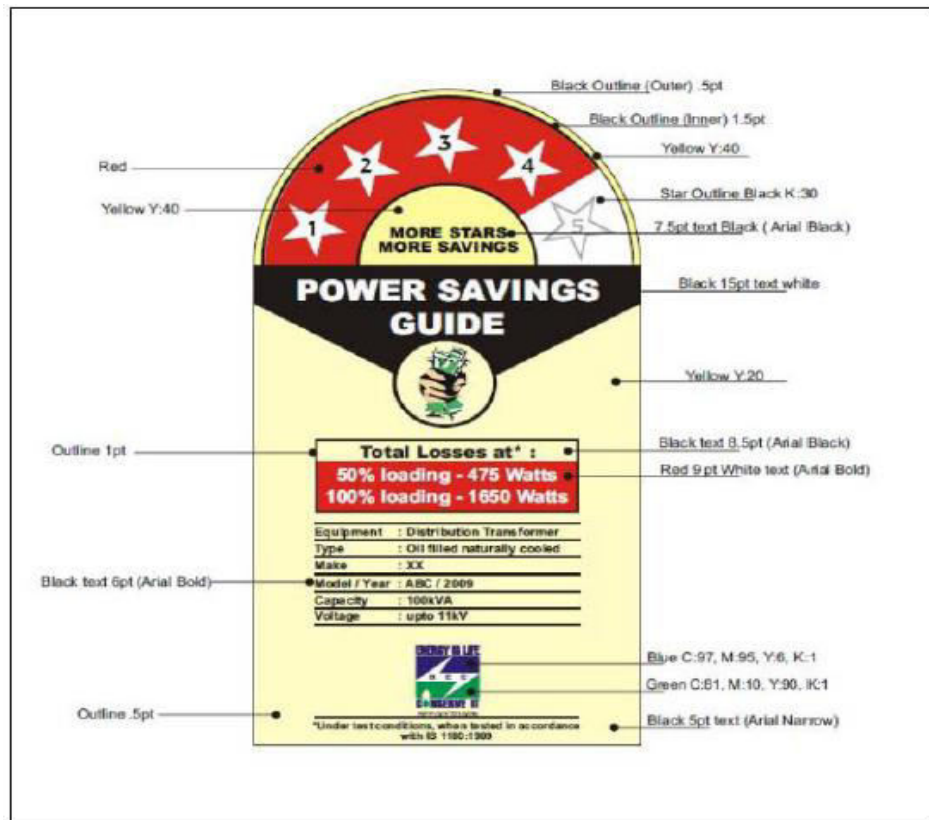
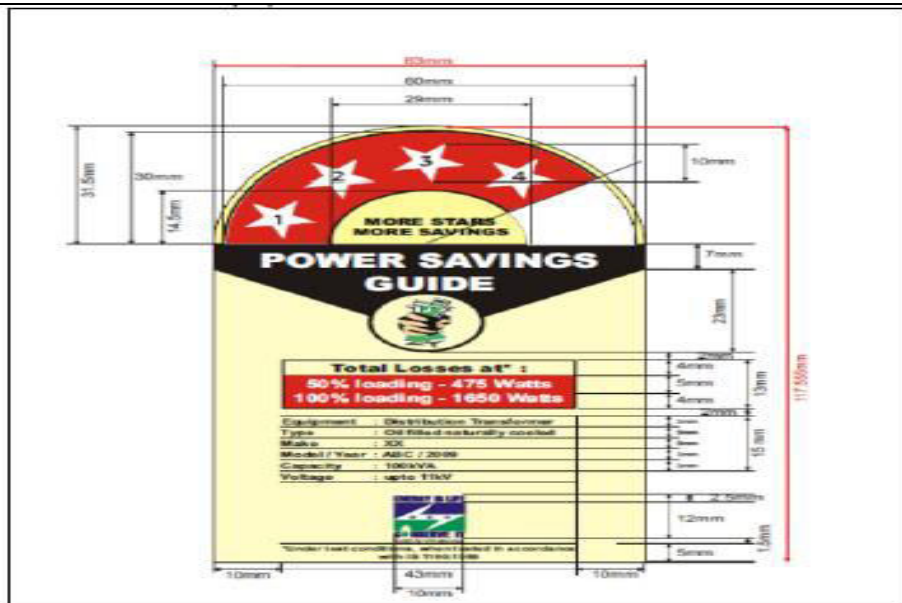
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6.5 **Oil filling instruction** The name plate shall contain
a) step wise process for filling oil in conservator

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	plate for conservator	b) Table of fittings with functions c) Conservator diagram with oil filling process d) Precautions in detail																																																				
7.0	TESTS	All routine, acceptance & type tests shall be carried out in accordance with the relevant IS/IEC. All routine/acceptance tests shall be witnessed by the purchaser/his authorized representative. All the components and fittings shall also be type tested as per the relevant standards. Following tests shall be necessarily conducted on the Power Transformers in addition to others specified in IS/IEC standards. Test for the OCTC shall be done as per the IS 8468																																																				
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	13	Measurement of Magnetizing current at low voltage.		
	14	Vacuum withstand test on tanks and radiators.		
	15	The total Losses shall comprise of the No Load Losses, Load Losses (I^2R loss + stray loss) and Auxiliary Losses at rated output duly converted at 75 °C average winding temperature and shall also be indicated in the test report. Load losses shall be that corresponding to rated load on HV, LV windings.		
	16	Physical Verification of complete Transformer with all assembly including test rollers, radiators, cable boxes etc.		
	17	Voltage Regulation at rated load and at unit, 0.9, 0.8 lagging power factor.		
	18	Measurement of Acoustic Noise Level.		
	19	Measurement of the power taken by the fans		
	20	Functional tests on auxiliary equipment:- i. Test on OTI and WTI ii. High Voltage test on insulation test for Auxiliary Wiring. iii. High Voltage test on insulation test for Auxiliary Wiring		
	21	Test on Oil filled in Transformer: i. Dielectric Strength of Oil ii. Water Content. iii. Dielectric Dissipation factor (tan delta at 90° C. iv. Resistivity		
	22	Induced over voltage withstand test	IS 2026 (Part 3)	11
	23	Separate Source voltage withstand test	IS 2026 (Part 3)	10
	24	Oil Pressure test on completely assembled transformer at 0.35kg/sq.cm for 8 hrs	IS 1180 (Part 1)	21.5.1.2 & 21.5.1.3
	25	BDV and moisture content of oil in transformer (Type-2 oil)	For mineral oil : IS 335 (2018)	For mineral oil : IS 335Table 2

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7.2	Acceptance tests	<ol style="list-style-type: none"> At least 10% transformer of the offered lot (minimum of one) shall be subjected to all the tests mentioned under the section 'ROUTINE Test' in presence of TPWODL representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS: 2026. Oil Leakage test for acceptance shall be conducted at pressure of 0.35kg/sq.cm for one hour as per IS2026. Temperature Rise Test (on one unit of first lot against every release order / PO for each rating, for further lots, TPWODL reserves the right to perform Temperature rise if required) [As per IS 2026 (Part 2) Clause no.4] The painted surface shall pass the Cross Adhesion Test (IS1180 part 1 clause no. 21.4.d). At stage inspection -Checking of weight, dimensions, fitting and accessories, tank sheet thickness, oil quantity, material finish and workmanship, physical verification of core coil assembly and measurement of flux density on one unit of each rating of the offered lot with reference to the GTP and contract drawings. At Final inspection, the incoming raw material and its movement/consumption record in the related jobs of TPWODL will be verified by inspecting officer. In case of any deviation or non-availability of such records, the offered lot may get rejected. The format of final inspection as per annexure.
7.3	Type Tests	<p>The type tests to be carried out by the Bidder shall include but not limited to the following:</p> <ol style="list-style-type: none"> Measurement of winding resistance. Measurement of voltage ratio and check of voltage vector relationship. Measurement of impedance voltage / short-circuit impedance (Principal tapping) and load loss. Measurement of no load loss and current. Measurement of insulation resistance. Dielectric Test. Temperature rise for determining the maximum temperature rise after continuous full load run. The ambient temperature and time should be stated in the test certificate. Tests on on-load tap-changer. Short Circuit withstand test. Test to verify IP55 of Marshalling and cable boxes. Lightning Impulse voltage test with chopped wave. <p>Note: The bidder shall submit the test report from CPRI or ERDA for g, i and k of the above mentioned.</p>
7.4	Special Tests	<p>Following type tests shall be carried out on one transformer of each rating, at the works of the bidder, in presence of Purchaser's representative.</p> <ol style="list-style-type: none"> Temperature rise test including DGA (DGA shall be done before & after the heat run test).

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		2. Impulse Test (Including chopped wave on all the three limbs of HV & LV).
7.5	Type Test on Nitrogen Injection Drain and Stir System (NIDS)	NA
7.6	Special Test	<p>The following tests shall be carried out by mutual agreement between the purchaser and the bidder. All Tests shall be done as per the relevant standard. Test certificates shall be submitted for bought out items. High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.</p> <p>a) Measurement of the harmonics of the No-Load Current. b) Determination of transient voltage transformer characteristics. c) Measurement of insulation resistance to earth of the windings, and / or measurement of Dissipation factor ($\tan \delta$) of the insulation system capacitances.(These are reference values for comparison with later measurement in the field. No limitation for the values are given here.). d) Lightning impulse test on Neutral terminals. e) Long duration induced AC voltage test (ACLD) transformer winding $72.5 < U_m \leq 170kV$. f) Magnetic circuit (isolation) test. g) SFRA Test.</p>
7.7	TESTS AT SITE	<p>After erection at site, the transformers shall be subjected to the following tests and the bidder shall guarantee results of test certificates under service conditions.</p> <p>a) Measurement of winding resistance. b) Measurement of voltage ratio and check of voltage vector relationship. c) Measurement of magnetizing current. d) Magnetic balance test on three phase transformer. e) Magnetic circuit (isolation) test. f) Measurement of short circuit Impedance at low voltage. g) Insulation resistance measurement. h) Dielectric Test on oil. i) Determination of Capacitances and dissipation factor winding-to-earth and between windings. j) Bushing Capacitance and $\tan \delta$. k) Test on other Auxiliaries. l) No-Load and Excitation current.</p> <p>This is for bidder's information that tests at site may be in bidder's scope based on mutual agreement between bidder and purchaser's. However, in any case bidder shall be required to send their engineer to confirm that the erection & commissioning is done in a satisfactory manner.</p>

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7.8	FURTHER TESTS	The purchaser reserves the right of having any other reasonable tests carried out at his own expense either before shipment, or at site to ensure that the transformer complies with the requirements of this specification.
8.0	TYPE TEST CERTIFICATES	The Bidder shall furnish the type test certificates of the Two Winding Power Transformer for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI / ERDA as per the relevant standards. Type tests should have been conducted in certified Test laboratories during the period not exceeding 5 years from the date of opening the bid. In the event of any discrepancy in the test reports, i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to the Purchaser.
9.0	PRE-DESPATCH INSPECTION	<ol style="list-style-type: none"> Equipment shall be subject to inspection by a duly authorized representative of the Purchaser. Inspection may be made at any stage of manufacture at the option of the purchaser and the equipment if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to Purchaser's representatives at all times when the work is in progress. Inspection by the Purchaser or its authorized representatives shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by Purchaser. <p>Following documents shall be sent along with material:</p> <ol style="list-style-type: none"> Test reports MDCC issued by TPWODL Invoice in duplicate Packing list Drawings & catalogue Guarantee / Warranty card Delivery Challan Other Documents (as applicable) <ol style="list-style-type: none"> In respect of raw material such as core stampings, winding conductors, insulating paper and oil, bidder shall use materials manufactured/supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the purchaser. The bidder shall furnish following documents along with their offer in respect of the raw materials: <ol style="list-style-type: none"> Invoice of supplier. Mill's certificate Packing List. Bill of Landing Bill of entry certificate by custom

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		<p>6. After the main raw-material i.e. core and coil material and tanks are arranged and transformers are taken for production on the shop floor, to ensure the quality of transformers, the inspection shall be carried out by the purchaser’s representative at following stages:</p> <ul style="list-style-type: none"> i. Stage Inspection I – Bidder has to facilitate for stage inspection of Tank, HV and LV windings and Core of the offered transformers. Bidder has to facilitate for stage inspection of Tank, HV and LV windings in one inspection call without any extra charges. Multiple inspections calls for stage inspection-I will not be considered and the delay will be accountable at bidder end. At this stage checking of weights, dimensions, tank sheet thickness, Pressure and vacuum test and quality of material, finish & workmanship as per GTP/QA plan and approved drawings. During stage inspection TPWODL reserves the rights to dismantle the assembled core to ensure that the CRGO laminations used are of good quality. ii. Stage inspection II – Bidder has to facilitate for stage inspection -II for Core coil assembly of the offered transformers in without any extra charges. The testing shall be carried out in accordance with IS : 2026 and as per GTP/QA plan/Drawing. <p>Note: For Stage inspection, Annexure –II will be referred.</p> <ul style="list-style-type: none"> iii. Final Inspection - Bidder has to facilitate for final inspection once the offered transformer is ready for dispatch. Inspection will be done as per w.r.t tests mentioned in Clause 7.2 and inspection test plan format in Annexure-III. <p>7. To ascertain the quality of the transformer oil, the original manufacturer’s tests report shall be submitted at the time of inspection. Arrangements shall also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of purchaser’s representative.</p> <p>8. The Bidder shall intimate the purchaser in advance for inspection, so that an officer for carrying out inspection could be deputed, as far as possible within 07days (Within Odisha)/ 12Days (outside Odisha) from the date of intimation.</p> <p>9. Further, about the readiness of the transformers, for final inspection for carrying out tests as per relevant IS/IECs shall be sent by the Bidder along with routine test certificates. The inspection shall</p>
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		<p>normally be arranged by the purchaser at the earliest after receipt of offer for pre-delivery inspection.</p> <p>10. In case of any defect/ defective workmanship observed at any stage by the purchaser’s Inspecting officer, the same shall be pointed out to the Bidder in writing for taking remedial measures. Further processing shall only be done after clearance from the inspecting officer / purchaser.</p> <p>11. All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase/tender.</p> <p>12. The manufacturer shall offer the inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include Stage Inspection during manufacturing stage as well as during Acceptance Tests.</p> <p>13. The bidder shall provide all services to establish and maintain quality of workmanship in his works and to ensure the mechanical / electrical performance of components, compliance with drawings, identification and acceptability of all materials, parts and equipment as per latest quality standards of ISO 9000.</p> <p>14. The Purchaser has the right to have the test carried out at his own by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation purchaser have every right to reject the entire lot or penalize the bidder, which may lead to blacklisting, among other things.</p>
10.0.	INSPECTI ON AFTER RECEIPT AT STORES	<p>1. The material received at Purchaser’s store shall be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.</p> <p>2. In case the transformers proposed for supply against the order are not exactly as per the tested design, the Bidder shall be required to carry out the short circuit test and impulse voltage withstand test at its own cost in the presence of the representative of the Purchaser. The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test. Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.</p> <p>3. The Purchaser reserves the right to conduct all tests on Transformer after arrival at site / stores and the manufacturer shall guarantee test certificate figures under actual service conditions.</p> <p>4. The Purchaser reserves the right to conduct short circuit test and impulse voltage withstand test in accordance to IS, afresh on each ordered rating at purchaser cost, even if the transformer of the same</p>

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		<p>rating and similar design are already tested. This test shall be carried out on a transformer to be selected by the purchaser either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the bidder.</p> <p>5. Test at TPWODL store/Site: after receipt of transformers at TPWODL stores/Site, following minimum tests will be carried out.</p> <p>a) Total weight of the transformer. (It should be as per the offer, subjected to tolerance as per approved drawings & GTPs).</p> <p>b) Oil level in the transformer</p> <p>c) Verifications of all the fittings.</p> <p>d) Physical verification of all the transformers for any damages, oil leakage, quality of painting etc.</p> <p>6. Test at site: The purchaser reserves the right to conduct all tests on Transformer after arrival at site/stores and the manufacturer shall guarantee test certificate figures under actual service conditions.</p> <p>7. Shock/impact recorder data analysis to be submitted by bidder to ascertain the concealed damage.</p>
11.0.	GUARANT EE	<p>1. Bidder shall stand guarantee towards design, materials, workmanship & quality of process/ manufacturing of items under the contract for due and intended performance of the same, as an integrated product delivered under this contract.</p> <p>2. In the event any defect is found by the Purchaser up to a period of 48 months from the date of commissioning or 60 months from the date of last supplies made under the contract, whichever is earlier.</p> <p>3. Bidder shall be liable to undertake to replace/rectify such defects at his own costs, within mutually agreed timeframe, and to the entire satisfaction of the Purchaser, failing which the Purchaser will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@ 20% of expenses incurred), from the Bidder or from the "Security cum Performance Deposit" as the case may be.</p> <p>4. In case of Two Winding Power Transformer fails within the guarantee period the purchaser will immediately inform the Bidder who shall take back the failed Two Winding Power Transformer within 15 days from the date of intimation at his own cost and replace / repair the transformer within forty five days of date of intimation with a roll over guarantee.</p> <p>5. The outage period i.e. period from the date of failure till unit is repaired / replaced shall not be counted for arriving at the guarantee period.</p> <p>Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.</p>
12.0.	PACKING	<p>1. Bidder shall ensure that all the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit.</p>

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		<ol style="list-style-type: none"> 2. The packing may be in accordance with the bidder's standard practice but he should give full particulars of packing for the approval of the purchaser. Special arrangement should be made to facilitate handling and to protect the projecting connections from damage in transit. 3. Bidder shall ensure that all the equipment covered under this specification shall be prepared for rail/road transport in a manner so as to protect the equipment from damage in transit. 4. Transformers shall be delivered filled with oil and supplied with all accessories mounted. Screws and bolts shall be thoroughly tightened to ensure no leakage of oil. 5. A shock recorder also shall be provided during transport. <p>Note: One use plastic not to be used for packing of the material.</p>
13.0.	TENDER SAMPLE	N.A.
14.0.	TRAINING	1. Not Applicable.
15.0.	QUALITY CONTROL	<ol style="list-style-type: none"> 1. The bidder shall submit with the offer Quality assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. 2. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. 3. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections. 4. The Bidder shall invariably furnish following information along with his bid, failing which the bid shall be liable for rejection. Information shall be separately given for individual type of equipment offered. <ol style="list-style-type: none"> i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested. ii. List of tests normally carried out on raw materials in the presence of Bidder's representative, copies of test certificates. iii. Information and copies of test certificates as in (I) above in respect of bought out accessories. iv. List of manufacturing facilities available. v. Level of automation achieved and list of areas where manual processing exists. vi. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection. vii. List of testing equipment available with the bidder for final testing of equipment along with valid calibration reports shall

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		<p>be furnished with the bid. Manufacturer shall possess 0.1 class instruments for measurement of losses.</p> <p>viii. Quality Assurance Plan (QAP) withholds points for purchaser's inspection.</p> <p>5. The successful Bidder shall within 30 days of placement of order, submit following information to the purchaser.</p> <p>i. List of raw materials as well as bought out accessories and the names of sub-Suppliers selected from those furnished along with offer.</p> <p>ii. Type test certificates of the raw materials and bought out accessories.</p> <p>6. The successful Bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing.</p>
16.0.	MINIMUM TESTING FACILITIES	Bidder shall have adequate in house testing facilities for carrying out all routine tests, acceptance tests and pre-dispatch inspection as per relevant International / Indian standards
17.0	MANUFACTURING ACTIVITIES	<ol style="list-style-type: none"> The successful bidder will have to submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer. This bar chart will have to be submitted within 15 days from the release of the order.
18.0.	SPARES, ACCESSORIES AND TOOLS	<ol style="list-style-type: none"> Bidder shall provide a list of recommended spares with quantity and unit prices for 5 years of operation after commissioning. The Purchaser may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Purchaser may order additional spares at any time during the contract period at the rates stated in the Contract Document. Bidder shall give an assurance that spare parts and consumable items will continue to be available through the life of the equipment which shall be 25 years minimum. However, the Purchaser shall be given a minimum of 12 months' notice in the event that the Bidder or any sub-vendor plans to discontinue manufacture of any component used in this equipment. Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the equipment and must be suitably marked and numbered for identification.
19.0.	DRAWINGS AND DOCUMENTS	<p>a. Following drawings and documents shall be prepared based on TP WESTERN ODISHA DISTRIBUTION LIMITED specifications and statutory requirements and shall be submitted with the bid:</p>

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	<p>b. Completely filled in Technical Particulars and compliance to each clause of the specification General Technical Requirements to Additional Details.</p> <p>c. Description of the transformer and all components including brochures.</p> <p>d. General arrangement for Transformer.</p> <p>e. Bill of material.</p> <p>f. Design calculation details of transformer losses, cooling, efficiency and current density, weight of coils and components</p> <p>g. Experience Certificate and list</p> <p>h. Type test certificates.</p> <p>i. List of makes of major components as listed above.</p> <p>2. Drawings / documents to be submitted after the award of the contract are as under:</p>																																																																	
	<table border="1"> <thead> <tr> <th>Sr. No</th> <th>Description</th> <th>For Approval</th> <th>For Review Information</th> <th>Final Submission</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Technical Parameters</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>2.</td> <td>GA Drawing of Transformer</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>3.</td> <td>HV and LV bushing internal view with terminal connector</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>4.</td> <td>Internal coil arrangement with dimensions</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>5.</td> <td>Breather Drawing</td> <td></td> <td>√</td> <td>√</td> </tr> <tr> <td>6.</td> <td>Rating Plate</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>7.</td> <td>Cooling calculation with no. of radiators and fins mentioned specifically</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>8.</td> <td>Prismatic oil level gauge drawing</td> <td></td> <td></td> <td>√</td> </tr> <tr> <td>9.</td> <td>Installation Instruction</td> <td></td> <td>√</td> <td>√</td> </tr> <tr> <td>10.</td> <td>QA & QC Plan</td> <td></td> <td>√</td> <td>√</td> </tr> <tr> <td>11.</td> <td>Test Certificates</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>12.</td> <td>Shipping drawings showing dimensions and weights of each package.</td> <td>√</td> <td>√</td> <td>√</td> </tr> </tbody> </table>	Sr. No	Description	For Approval	For Review Information	Final Submission	1.	Technical Parameters	√	√	√	2.	GA Drawing of Transformer	√	√	√	3.	HV and LV bushing internal view with terminal connector	√	√	√	4.	Internal coil arrangement with dimensions	√	√	√	5.	Breather Drawing		√	√	6.	Rating Plate	√	√	√	7.	Cooling calculation with no. of radiators and fins mentioned specifically	√	√	√	8.	Prismatic oil level gauge drawing			√	9.	Installation Instruction		√	√	10.	QA & QC Plan		√	√	11.	Test Certificates	√	√	√	12.	Shipping drawings showing dimensions and weights of each package.	√	√	√
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		13.	Assembly drawings and weight of main component parts.	√	√	√	
		14.	Drawings giving Weights for foundations	√	√	√	
		15.	Tap changing and name plate diagram.		√	√	
		16.	Schematic control along with logic block diagram and wiring diagram for all auxiliary equipment.		√	√	
		17.	Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross-sectional views showing the duct sizes, cooling pipes etc.	√	√	√	
		18.	Large scale drawings of high- and low-tension windings of the transformers showing the nature and arrangement of insulation and terminal connections.	√	√	√	
		19.	Bushing drawing and specifications.	√	√	√	
		20.	Crane requirement for assembly and dismantling.		√	√	
		21.	Overhead Conductor Connections.		√	√	
		22.	Foundation drawing of transformer.	√	√	√	
		23.	Valve Schedule details	√	√	√	

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24.	Marshlling junction box details	√	√	√	
25.	Thermo junction box details.	√	√	√	
26.	Neutral arrangement	√	√	√	
27.	Drawing showing conservator with air bag and oil filling instructions	√	√	√	
	In addition to the above, the following drawing / information for each item pertaining to marshalling box and OCTC shall also be supplied.				
28.	General arrangement drawing of the marshaling box	√	√	√	
29.	Shipping drawings showing dimensions and weight of each package	√	√	√	
30.	Drawing giving the weight for its foundation.	√	√	√	
31.	Schematic control drawing and TB schedule / wiring diagram for all elements	√	√	√	
32.	Valve Schedule	√	√	√	
33.	Test report of all bought out elements.	√	√	√	
34.	Cooler Control drawing	√	√	√	
35.	The tightening torque chart	√	√	√	

3. **List of Calculations to be submitted:**

All the calculations shall be step by step showing the use of formulas and other practical considerations. **Concise calculations in table or excel sheet shall not be accepted.** Also, the reference (only standard sources as IS, IEC or any such standard is acceptable) of the formulas shall be mentioned.

1. Resistance Calculation (75 deg. C)
2. Load Losses Calculation (at 75 deg. C)

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		<ol style="list-style-type: none"> 3. No load Loss Calculation. 4. Auxiliary & Stray Loss Calculation. 5. Weight of Copper (Bare and with Insulation also). 6. Weight of Core. 7. BH curve & Loss/Kg graph of core material offered. 8. Flux Density calculations. 9. Efficiency vs Load curve of the offered design. 10. Current Density Calculations. 11. Short Circuit withstand. 12. Temperature Rise Calculations. 13. Cooling Calculations. 14. Calculation sheet for Lifting lug design and mounting lug design to be submitted by Bidder. <p>4. <u>Additional Documents to be submitted :</u></p> <ol style="list-style-type: none"> 1. List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer. 2. Type test certificates of the raw materials and bought out accessories. 3. The successful Bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing. <p>All the documents & drawings shall be in English language. After the receipt of the order, the successful bidder will be required to furnish all relevant drawings/parameters/ calculation to TPWODL for approval.</p> <p>5. <u>Instruction Manuals:</u> Bidder shall furnish two softcopies (CD) and four (4) hard copies of nicely bound manuals (In English language) covering erection and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices.</p>
20.0	CAPITALIZATION OF LOSSES AND LIQUIDATED DAMAGES	Capitalisation of losses will be as per Annexure B which is attached herewith. No (+)ve tolerance shall be allowed at any point of time, on the quoted losses after the award. In case, the losses during type testing ,routine testing etc are found above the quoted losses, the award shall stand cancelled. In such a case, the CPG money shall also be forfeited.
21.0	GUARANTEED TECHNICAL PARTICULARS	
21.1	All clauses and points in the Specification to be complied for along with GTR.	
21.2	<u>ADDDITIONAL DETAILS:</u>	

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Sl. No.	Description	Unit	As furnished by Bidder
1.	Tapings on HV winding a) Range b) Number of steps c) Principal tap		
2.1	Maximum current density in winding	Amps/mm2	
2.2	Use of continuously transposed conductor (CTC) in LV winding. (YES)	Yes/No	
2.3	Area of cross section of winding conductor (HV/LV/Reg).	mm ² (Minimum)	
2.4	Description of winding insulation		
2.5	Nature of insulation	Class	
2.6	Bare weight of copper in windings without paper insulation and leads.	Kg (Minimum)	
2.7	Details of winding and winding conductor		
3	Tank :		
3.1	Approximate thickness		
	I. Sides II. Bottom III. Cover	mm mm mm	
3.2	Material of tank		
4	Maximum temperature-rise above an ambient of (deg.C) a)Top oil b)Windings c) Temperature Gradient between Oil and Winding	°C °C °C	

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5.	Total loss at rated voltage at principal tapping and rated frequency.	KW		
6.	Component losses: at 90%, at 100%, and 110% :			
6.1	Maximum Guaranteed No load loss at rated voltage on principal tapping and at rated frequency:	KW		
6.2	Calculated No load loss at rated principal tapping & rated frequency. Submit necessary calculations	KW		
6.3	Maximum guaranteed I ² R loss at rated current for the principal tapping at 75°C.	KW		
6.4	Calculated I ² R loss at rated current for the principal tapping at 75°C. Submit necessary calculations.	KW		
6.5	Calculated additional losses (Eddy + stray losses) at rated current for the principal tapping at 75°C. Submit necessary calculations.	KW		
6.6	Maximum guaranteed additional losses (Eddy + stray losses) at rated current for the principal tapping at 75°C.	KW		
6.7	Maximum Guaranteed auxiliary losses	KW		
6.8	Auxiliary losses at rated current for principal tripping: (KW)	KW		
6.9	Maximum Calculated total Losses (sum of sr. no. 19.2+19.4+19.5+19.7) submit necessary Calculation.	KW		

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6.10	Guaranteed total Losses (sum of sr. no. 19.1+19.3+19.6+19.7) submit necessary Calculation.	KW		
7	Impedance voltage at rated current for the principal tapping HV – LV (Percent) Note: (The above impedance values shall be on full MVA rating of transformer i.e. For 2 winding transformer on 31.5 MVA base)	%		
8	Reactance at rated current and rated frequency (On full MVA rating of transformer i.e. For 2 winding transformer on 31.5 MVA base) i) HV – LV ii) No load current at rated voltage and rated frequency	%		
9	a)Partial discharge level : b)Noise level : c)Harmonic content in charging current :			
10	Insulation level			
10.1	Separate source power-frequency voltage withstand : i)HV winding ii)LV winding iii)LV neutral	kV rms kV rms kV rms		
10.2	Induced over voltage withstand i)HV winding ii)LV winding	kV rms kV rms		

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	iii)LV neutral	kV rms		
10.3	Full wave lightning impulse withstand voltage i)HV winding ii)LV winding iii)LV neutral	kV peak kV peak kV peak		
10.4	Uniform/Graded Insulation i)HV winding ii)LV winding iii)LV neutral	kV peak kV peak kV peak		
11	a)External short circuit withstand capacity b)External short circuit withstand capacity i) for HV side ii) for LV side c)Duration of external short withstand capacity	MVA kA kA In Sec		
12	Efficiencies at 75 deg.C at unity power factor : a) At full load b) At 3/4 full load c) At 1/2 full load d) At 1/4 full load	% % % %		
13	Efficiencies at 75 deg.C at 0.8 power factor : a) At full load b) At 3/4 full load c) At 1/2 full load d) At 1/4 full load	% % % %		

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14	a)415 V single phase short circuit impedance b)Percentage variation between phases.			
15	Regulation at full load at 75 deg.C a)At unity power factor b)At 0.8 power factor lagging	% %		
16	Number of coolers or cooler banks per transformer	Not Applicable		
16.1	Cooling fans a) Type b) Quantity c) Rating	Not Applicable		
17	a) Rating of each cooler or cooler bank in percent. b) Whether Radiators can be placed on either side of transformers and whether mounted separately c) Whether Reverse flow blocking device and flow indicators provided	Not Applicable		
18.1	<u>Terminal arrangement: for Without HV Box</u> a) High voltage b) Low voltage c) Neutral (LV) d) HV terminal phase spacing e) LV terminal phase spacing f) Any other information			
18.2	<u>Terminal arrangement: For With HV Box</u> a) High voltage b) Low voltage c) Neutral (LV)			

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	d) HV terminal phase spacing e) LV terminal phase spacing f) Any other information			
19	Approximate masses: a)Core b) Winding c) Bare weight of copper in windings without paper insulation and leads d)Tanks, fittings and accessories. e)Oil f)Total mass	Kg Kg Kg Kg Kg kg		
20	Untanking height Reference standards			
21	Details of HV Bushings line (HV line end) a)Voltage class, b)Current rating, c)1.2/50 μ s impulse withstand d)Make e)Type f)Creepage distance, total g)Creepage distance, protected. h)Year of manufacture. i)Qty. of oil in oil filled bushing	kV A kV (rms) mm mm		
22	Details of LV Bushings line (LV line end) a)Voltage class, b)Current rating, c)1.2/50 μ s impulse withstand	kV		

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		d)Make	A		
		e)Type	kV (rms)		
		f)Creepage distance, total	mm		
		g)Creepage distance, protected.	mm		
		h)Year of manufacture.			
		i)Qty. of oil in oil filled bushing			
	23	Details of HV Bushings			
		a)Voltage class,	kV		
		b)Current rating,	A		
		c)1.2/50 μ s impulse withstand	kV (rms)		
		d)Make			
		e)Type			
		f)Creepage distance, total	mm		
		g)Creepage distance, protected.	mm		
		h)Year of manufacture.			
		i)Qty. of oil in oil filled bushing			
	24	Details of Neutral Bushings			
		a)Voltage class,	kV		
		b)Current rating,	A		
		c)1.2/50 μ s impulse withstand	kV (rms)		
		d)Make			
		e)Type			
		f)Creepage distance, total	mm		
		g)Creepage distance, protected.	mm		
		h)Year of manufacture.			
		i)Qty. of oil in oil filled bushing			
	25	Details of Core Grounding Bushings			

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	a)Voltage class, b)Current rating, c)1.2/50 μ s impulse withstand d)Make e)Type f)Creepage distance, total g)Creepage distance, protected. h)Year of manufacture. i)Qty. of oil in oil filled bushing	kV A kV (rms) mm mm		
26	Details of Core Grounding Bushings Neutral a)Voltage class, b)Current rating, c)1.2/50 μ s impulse withstand d)Make e)Type f)Creepage distance, total g) Creepage distance, protected. h) Year of manufacture. i)Qty. of oil in oil filled bushing	kV A kV (rms) mm mm		
27	Details of LV Cable Connection a)Clearances i)Phase to Phase ii)Phase to Earth b)Drawing enclosed c)Length Of Each phase Bus Bars			

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		d) The Bus bars are suitable for how many numbers of 1Cx 1000 sq mm, 11 kV, XLPE cable.			
	28	Designed Fault Levels: a) HV b) LV	MVA MVA		
	29	Core a)Material & Grade b) thickness in mm c)Type of core d)Operating flux density e)Maximum flux density f)Over fluxing capability for $\pm 10\%$ voltage & $\pm 3\%$ frequency variation g) Specific No load loss for the grade of core chosen at the specified flux density. h) Net weight of CRGO lamination in core. (Kg minimum). Please submit copy of graph in support of this)	Yes / No Watts/Kg		
	30	Details of CTs on HV Bushings.(Line) a)No. of cores b)Ratio for each core c)VA burden - for each core. (along with I_{mag} and V_K wherever necessary) d)Accuracy class of each core. e)Year of manufacture. f)Short time thermal current rating i)Current ii)Rated time	Not Applicable		

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31	Details of CTs on LV Bushings.(Line) a)No. of cores b)Ratio for each core c)VA burden - for each core. (along with Imag and VK wherever necessary) d)Accuracy class of each core. e) Year of manufacture. f)Short time thermal current rating i)Current ii)Rated time	Not Applicable			
32	Rail gauge (along both axis)				
33	Overload capacity of transformer for 100% ONA coolers working simultaneously				
34	Whether Neutral end surge diverter recommended by bidder				
35	If yes details of surge diverter a) Type b) Make c) KV class d) kV rating				
36	Tertiary winding if any kept isolated then the bidder to state whether one terminal to be earthed or any other precautions required during service conditions				
37	Marshalling Box a)Derived control supply Voltage b)415 V control supply provided. c)Local OTI/WIT provided.	V			

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	<p>d)Remote OTI/WIT provided.</p> <p>e)Two sets of 0/4-20 mA signals for OTI/WIT provided.</p> <p>f) List of annunciations.</p> <p>g) Two sets of potential free contacts for annunciations provided.</p>			
38	Whether Marshalling boxes (ground as well as tank) provided as per specifications i.e			
39	<p><u>Surface Preparation/Painting</u></p> <p>1) Material used fir Adequate rust proofing done on transformer and radiator (Details of measures to be enclosed)</p> <p>2) Type of paint (epoxy/enamel)</p> <p>3) Whether galvanized radiator offered as alternative.</p>			
40	<p>Conservator Oil preservation system Details (Air bag)</p> <p>a) Material of separator/Air bag</p> <p>b) Details of air pressure for the separator</p> <p>i. Design pressure</p> <p>ii. Working pressure</p> <p>iii. Bursting pressure (Puncture strength)</p> <p>c) Procedure of oil filling with air bag to be enclosed.</p> <p>d) Any precautions to be taken during maintenance of transformer with air bag to be mentioned here.</p>			
41	<p>General arrangement drawing of the transform indicating details of HV/MV/LV terminals and over all dimensions enclosed</p>	Yes / No		

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	42	Neutral Bushing Calculation to be submit.	Yes							
21.0	SCHEDULE OF DEVIATIONS :	<p><u>(TO BE ENCLOSED WITH THE BID)</u></p> <p>All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's</p> <table border="1"> <thead> <tr> <th>S.No.</th> <th>Clause No.</th> <th>Details of deviation with justifications</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table> <p>We confirm that there are no deviations apart from those detailed above. Seal of the Company:</p> <p>Signature</p> <p>Designation</p>			S.No.	Clause No.	Details of deviation with justifications			
		S.No.	Clause No.	Details of deviation with justifications						

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ANNEXURE-I**A) INSPECTION TEST PLAN FOR STAGE INSPECTION-I OF POWER TRANSFORMER**

S No.	Particulars	Details
(A)	GENERAL INFORMATION:	
1	Name of firm	
2	Order No. and Date	
3	Details of offer	
a)	Rating	
b)	Quantity	
c)	Serial Numbers	
4	Details of last stage inspected lot:	
a)	Total quantity inspected	
b)	Serial Numbers	
c)	Date of stage inspection	
d)	Quantity offered for final inspection of (a) above with date	
(B)	Position of manufacturing for the offered quantity:	
a)	Complete tanked assembly	
b)	Core and coil assembly ready	
c)	Core assembled	
d)	Coils ready for assembly	
	i) HV coils	
	ii) LV coils	

Note: i) The stage inspection-I shall be carried out in case:-

- a) 100% quantity of core and coil shall be ready for inspection.

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- b) 100% Quantity of Tank and its mountings i.e Marshalling box, conservator etc. shall be ready for inspection.
- ii) Quantity offered for stage inspection should be offered for next level of Inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

S No.	Particulars	As offered	As observed	Deviation and Remarks
(C)	<u>Inspection of Core :</u>			
	(I) Core Material			
	1) Manufacturer's characteristic certificate in respect of grade of lamination used. (Please furnish test certificate)			
	2) Thickness of core lamination			
	3) Remarks regarding Rusting and smoothness of core.			
	(II) Core Construction :			
	(1) Core Diameter (mm)			
	(2) Total cross sectional area of core			
	(3) Effective cross sectional area of core			
	(4) Whether top yoke is cut for LV connection.			
	(5) If yes, at 4 above, whether Reinforcement is done.			
	(6) Core length (leg center to leg center)			
	(7) Window height.			
	(8) Core height			
	(9) Core weight only			
(D)	INSPECTION OF WINDING			
	(I) Winding material			
	(1) Material used for			
	a) HV winding			
	b) LV winding			
	(2) Grade of material for			

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	a) HV winding			
	b) LV winding			
	(3) Test certificate of manufacturer (enclosed copy) for winding material of:			
	a) HV			
	b) LV			
	(II) Construction Details			
	1) Size of Cross sectional area of conductor for :			
	a) HV winding			
	a) LV winding			
	2) Type of insulation for conductor of :			
	a) HV winding			
	b) LV winding			
	3) Diameter of coils in:			
	a) LV winding			
	a) Internal Diameter (mm)			
	ii) Outer diameter (mm)			
	b) HV winding			
	a) Internal diameter (mm)			
	ii) Outer diameter (mm)			
	4) Current density of winding material used for:			
	a) HV			
	b) LV			
	5) Total No. of turns			
	a) HV coils			
	b) LV coils			
	6) Total weight of coils of			
	a) LV winding (Kg)			
	b) HV winding (Kg)			
(E)	INSULATION MATERIALS			

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	(I) DPC Paper Insulation			
	a) Type of Paper (Dotted Kraft or Diamond Dotted Kraft)			
	b) Make			
	c) Thickness (mm)			
	d) DPC laying direction			
	e) Percentage Overlapping			
	II) Interlayer Insulation			
	a) Type of Paper			
	b) Make			
	c) Thickness (mm)			
	III) Between HV and LV winding			
	a) Type of Paper			
	i. Make			
	ii. Thickness (mm) (all size)			
	b) Type of Pressboards			
	i. Make			
	ii. Thickness (mm) (all size)			
	IV) Between core and LV			
	Type of Paper			
	i. Make			
	ii. Thickness (mm) (all size)			
	Type of Pressboards			
	i. Make			
	ii. Thickness (mm) (all size)			
	V) Material used for top and bottom yoke and insulation			
	a) Type of Material			
	i. Make			
	ii. Thickness (mm) (all size)			

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	VI) Material used for Spanner, wedge and Axial for insulation			
	a) Type of Material			
	i. Make			
	ii. Thickness (mm) (all size)			
	iii. Visual condition(i.e free from dust, burr, damage and sharp edges)			
	VII) Test certificate of manufacturer (enclose copy for all type of papers and pressboard used)			
(F)	CLEARANCES: (mm)			
	(I) Related to core and winding			
	1) LV to core (radial)			
	2) Between HV and LV (Radial)			
	3) Thickness of duct between HV and LV coil mm			
	(II) Between core – coil assembly and tank:			
	1) Between winding and body			
	a) Tank height wise			
	b) Tank side wise			
(G)	TANK :			
	(I) Construction Details:			
	1) Circular shape			
	2) Thickness of side wall (mm)			
	3) Thickness of top and bottom plate (mm)			
	4) Provision of sloping top cover			
	5) Tank internal dimensions (mm)			
	a) Diameter			
	b) Height			
	(II) General Details :			

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	1) Inside painted by oil corrosion resistant paint (please specify which type of coating done)			
	2) Provision of lifting lugs.			
	a) Numbers			
	b) Whether reinforcement done by welding all side of Lug			
	3) Provision of air release plug			
	4) Provision of hot dip galvanized GI Nuts Bolts with 1no. plain and 1no. spring washer.			
	5) Deformation of side wall of tank when subject to:			
	a) Vacuum of (-) 0.7 Kg/sq.cm for 30 minutes.			
	b) Pressure of 0.8 Kg/sq.cm. for 30 minutes.			
(K)	TERMINALS:			
	1) Material whether of Brass Rods			
	a) HV			
	b) LV			
	2) Size (dia. In mm)			
	a) HV			
	b) LV			
(L)	BUSHINGS – Two part			
	1) Whether HV & LV bushings mounted as per drawing.			
	a) HV- Top Inclined			
	b) LV – Side			
	2) Bushing Clearance: (mm)			
	a) LV to Earth			
	b) HV to Earth			
	3) Bushing are two part and inner part shall be sealed and external part is replaceable without affecting sealing and need of opening of top cover.			
(M)	TANK BASE:			
	1) Whether tank base is welded folded upwards, as Specified in specification.			

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(N)	OIL:			
	1) Name of supplier			
	2) Breakdown voltage of oil: (kV)			
	a) Filled in tanked transformer			
	b) In storage tank (to be tested by Inspecting officer).			
	3) Supplier's test certificate (enclose copy)			
(O)	ENGRAVING:			
	1) Engraving of Sl. No. and name of firm and YoM.			
	a) On bottom of clamping channel of core-coil assembly.			
	b) On Body of tank (on Yellow base with black paint)			
(P)	MS Plate of size 125× 125 mm welded on width side of stiffener.			
	i) Following details engraved (as per approved GTP):			
	a) Serial Number			
	b) Name of firm			
	c) Order No. and date			
	d) Rating			
	e) Date of dispatch			
(Q)	NAME PLATE DETAILS:			
	Whether Name Plate is as per approved drawing			
(R)	COLOUR OF TRANSFORMER			
	1) Tank body (Inner side)			
	2) Tank body (Outer side)			

PURCHASER'S OFFICER

BIDDER'S REPRESENTATIVE

DATE OF INSPECTION

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B) INSPECTION TEST PLAN FOR STAGE INSPECTION- II OF POWER TRANSFORMER

S No.	Particulars	Details
(A)	GENERAL INFORMATION:	
1	Name of firm	
2	Order No. and Date	
3	Details of offer	
a)	Rating	
b)	Quantity	
c)	Serial Numbers	
4	Details of last stage inspected lot:	
a)	Total quantity inspected	
b)	Serial Numbers	
c)	Date of stage inspection	
d)	Quantity offered for final inspection of (a) above with date	
(B)	Position of manufacturing for the offered quantity:	
a)	Complete tanked assembly	
b)	Core and coil assembly ready	
c)	Core assembled	
d)	Coils ready for assembly	
	i) HV coils	
	ii) LV coils	

Note: i) The stage inspection-II shall be carried out in case:-

100% quantity of core coil assembly shall be ready for inspection.

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- ii) Quantity offered for stage inspection should be offered for next level of Inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

ANNEXURE-II

INSPECTION TEST PLAN FOR POWER TRANSFORMERS

1	Name of the firm / BA	
2	Date of inspection	
3	Details of offer made	
	(i) Order No. and date	
	(ii) Rating	
	(iii) Quantity	
	(iv) Sl. No. of transformers	
4	Date of stage inspection of the lot	
5	Reference of stage inspection clearance	
6	Sample Quantity (10% of the offered lot, min. one)	Sr. No.----- ---

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S. No.	Name of test	Specified value(Range)	Reference documents	Test Result	Pass/Fail
1	Visual inspection for material, finish and workmanship	Free from cracks, nicks, protrusion and other visible defects.	TPWODL specification		
2	Physical Verification of complete Transformer with all assembly including test rollers, radiators, cable boxes etc. and Checking of weights, Dimensions.	GTP Values	TPWODL specification		
3	Measurement of Winding Resistance	GTP Values	IS : 2026-2011 (Part I) cl. 10.2		
4	Measurement of voltage ratio and phase displacement	GTP Values	IS : 2026-2011 (Part I) cl. 10.3		
5	Verification of vector group relationship	DYn11	IS : 2026-2011 (Part I) cl. 8.6, 8.7		
6	Measurement of short-circuit impedance and Load Loss.	GTP Values	IS : 2026-2011 (Part I) cl. 10.4		
7	Measurement of No-Load Loss and Current (Losses at 90, 100 and 110% of rated voltage).	GTP Values	IS : 2026-2011 (Part I) cl. 10.5		
8	Measurement of insulation resistance.	GTP Values	IS : 2026-2011 (Part I) cl. 10.1.3		
9	Dielectric Test	GTP Values/TPWODL Specification	IS : 2026 (Part III)-2009		
10	Test on Off Circuit Tap Changer	GTP Values/TPWODL Specification	IS : 2026-2011 (Part I) cl. 10.8		

PREPARED BY	REVIEWED BY	APPROVED BY
PRATYUSH K RATH	M S ANWAR	S B KUNDARGI

DOCUMENT TITLE	STANDARD TECHNICAL SPECIFICATION FOR TWO WINDING OUTDOOR STATION TRANSFORMER OF 33/.433 KV ONAN TRANSFORMER 100KVA, 250 KVA, 500 KVA,630 KVA	EFFECTIVE DATE 29/06/2021
DOCUMENT NO	TPWODL/ENGG/SPEC/016/2021	REVISION NO: R1

11	Zero-Phase sequence Measurement	GTP Values	IS : 2026-2011 (Part I) cl. 10.7		
12	Oil Pressure/leakage test on completely assembled transformer at 0.35kg/sq.cm for 8 hrs.	Should withstand	TPWODL Specification		
13	Bushing shall be tested for Capacitance and Power factor and shall meet the manufacture's requirement.	GTP / TPWODL Specification	IS : 2026 (Part III) cl. 10		
14	All CTs and resistance of image coil for winding temperature indicator shall be checked for ratio test, polarity and knee point voltage test	GTP / TPWODL Specification	TPWODL Specification		
15	Determination of Capacitances and dissipation factor winding-to-earth and between windings.	GTP / TPWODL Specification	IS : 2026 (Part I) cl.10.1.3		
16	Magnetic balance test	GTP / TPWODL Specification			
17	Measurement of Magnetizing current at low voltage		IS : 2026-2011 (Part I) cl. 10.1.3		
18	Voltage Regulation at rated load and at unit, 0.9, 0.8 lagging power factor	GTP/TPWODL specification	GTP/TPWODL specification		
19	Measurement of Acoustic Noise Level	GTP/TPWODL specification	GTP/TPWODL specification		
20	Measurement of the power taken by the fans	GTP/TPWODL specification	TPWODL specification		
21	Functional tests on auxiliary equipment: i. Test on OTI and WTI ii. High Voltage test on insulation test for Auxiliary Wiring.	GTP/TPWODL specification	TPWODL specification		

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22	Test on Oil filled in Transformer i. Dielectric Strength of Oil ii. Water Content. iii. Dielectric Dissipation factor (tan delta at 90° C. iv. Resistivity	GTP/TPWODL specification	TPWODL specification,		
23	Temperature rise test	GTP/TPWODL specification	IS : 2026 (Part II)		
24	Short Circuit withstand test	Should withstand	IS : 2026 (Part V)		
25	Test to verify IP55 of Marshalling and cable boxes.	Should Confirm IP55	TPWODL Specification		
26	Lightning Impulse voltage test with chopped wave.	GTP/TPWODL Specification	IS : 2026 (Part III) cl. 13		

PURCHASER'S OFFICER
REPRESENTATIVE

BIDDER'S

DATE OF INSPECTION

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ANNEXURE – III

SOURCE OF MATERIAL/PLACES OF MANUFACTURE, TESTING AND INSPECTION

S No.	Item	Source of Material	Place of Manufacture	Place of testing and Inspection
1.	Core Laminations			
2.	Copper Conductor			
3.	Insulating winding wires			
4.	Transformer Oil			
5.	Press Boards			
6.	Thermally Upgraded Kraft Paper (TUKP)			
7.	Tank material			
8.	Gaskets			
9.	Bushing HV/LV			
10.	Paint			
11.	OCTC			
12.	NIDS			
13.	CTs			
14.	WTI			
15.	OTI			

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ANNEXURE – IV

Methodology for computing total owning cost for Power Transformer

TOC	= IC + (A xWi) + (B xWc);	Losses in KW
TOC	= Total Owning Cost	
IC	= Initial cost taxes of transformer as quote by the manufacturer	
A Factor	= Cost of load losses in Rs/Kw	(A = 334447)
B Factor	= Cost of load losses in Rs/KW	(B = 151616)
Wi	= No load losses quoted by the manufacturer	
Wc	= Load losses quoted by the manufacturer in KW	

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