

**NTPC LTD**

**CC-OS**

**EOC NOIDA**

**Sub: Qualifying Requirement for Vendor Enlistment for supply of LT Transformers**

A)	MEG DETAILS		
	1.0	MEG NO.	87MEC-02
	2.0	MEG DESCRIPTION	LT Transformers (Outdoor Transformer)
	3.0	RESPONSIBILITY CENTRE	CC
B)	<p><b>Technical Criteria of QR:</b></p> <p>(i) The Vendor should have manufactured &amp; supplied at least two numbers (one each at two different installations) of 16MVA, 11kV or higher rating Oil Filled Transformers which should have been in successful operation for a period of at least two (2) years prior to date of application for enlistment.</p> <p style="text-align: center;">And</p> <p>(ii) Vendor should have its own facilities for conducting all routine and type tests as per IS: 2026 (except short circuit test).</p> <p style="text-align: center;">And</p> <p>(iii) 16MVA, 11kV or higher rated Oil Filled Transformer manufactured by Vendor should have been successfully short circuit tested.</p> <p>NOTE -: Two different installations means two different project sites or two different contracts.</p>		
C)	<p><b>Other Documents to be submitted:</b> In addition to the documents required in support of meeting technical requirements as stated above, following documents are required to be submitted by the Applicants applying for enlistment:-</p> <ol style="list-style-type: none"> <li>1. Three POs of the highest executed values of similar work during previous five years from the date of application. Copy of Invoice / Completion certificate from the concerned buyer/s in support of successful execution of supply against the POs to be submitted.</li> <li>2. Audited balance sheet including Profit &amp; Loss statement for the previous three completed financial years reckoned from the date of application. In case the audited documents are not ready / available, then certified copy by a registered practicing Chartered accountant may be submitted.</li> <li>3. Latest annual report OR NSIC / SSI / MSME registration certificate / BIS license / ISO certificate / Certificate of registration from the concerned excise department / any other statutory document as a proof of being manufacturer of the required material.</li> <li>4. Any other documents in addition to the above which the applicant wants to submit.</li> </ol>		
D)	NOTE-1	Similar works means: Supply of 16MVA, 11kV or higher rating Transformer.	
	NOTE-2	The executed value means basic value of quantity of similar works executed/supplied against the reference PO(also applicable to partly executed POs as on date of application).Where PO value is composite(i.e. including Taxes etc.),the applicant to give item-wise break-up of Composite PO value mentioning Basic Value, Taxes etc.	

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**Sub: Technical Specifications for Vendor Enlistment for supply of LT Transformers.**

A)	MEG DETAILS		
	1.0	MEG NO.	87MEC-02
	2.0	MEG DESCRIPTION	LT Transformers (Outdoor Transformer)
	3.0	RESPONSIBILITY CENTRE	CC
B)	<b>Technical Specifications:</b>  As per attached annexure below		

**GENERAL INFORMATION TO BIDDER**

The offered transformer should be suitable for replacing both the existing Transformers.

The bidder is advised to visit site and get detail information /drawings and make comparative study of HV & LV side connection, existing fire water connection(if any), orientation of marshalling box & conservator, existing foundation plan and location of fire wall & sprinkler system.

The bidder shall offer the Transformer for one to one replacement of existing transformer i.e. there will be no need to change the existing foundation, LV side busduct connection and external cable connection etc. The cooler & conservator shall be tank mounted.

The bidder shall also furnish necessary drawings such as busduct adopter pieces, flexible for connecting busduct & LV bushing, foundation etc. required for replacement of existing transformer. NTPC intends to use these drawings for procurement of necessary hard wares if required for replacing existing with offered one.

**NOTE: NECESSARY MODIFICATION TO BE DONE AS PER SITE REQUIREMENTS BEFORE TENDERING**

1.00.00

**TECHNICAL PARAMETERS**

1.01.00

**Outdoor Transformers**

(a)	Rated output	As per Site Requirement
(b)	Cooling	ONAN
(c)	Type	Two winding
(d)	Voltage Ratio	As per Site Requirement
(e)	Frequency	50 Hz
(f)	Phase	Three (3)
(g)	Service	Outdoor
(h)	Duty	Continuous
(i)	Overload capacity	As per IS: 6600 and specified elsewhere in the specification.
(j)	Permissible Temperature rise over an ambient temp. of 50 deg. C	

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**TECHNICAL REQUIREMENTS**

(1.)	Winding (by resistance method)	55 deg. C
(2.)	Top oil (by thermometer)	50 deg. C
(k)	Impedance at 75 deg.C	As per Site Requirement
(l)	Noise Level	As per NEMA TR-1
(m)	System fault level	As per Site Requirement

(n) **Winding**

1.	Highest System Voltage(kV)	<b>36</b>	<b>12</b>	<b>7.2</b>	<b>3.6</b>	<b>0.433</b>
2.	Lightning impulse withstand voltage, kVp	170	75	60	40	-
3.	One min power frequency withstand voltage, kVrms	70	28	20	10	3
4.	Insulation	uniform	uniform	uniform	uniform	uniform

5. Method of neutral earthing and Vector group: As per Site Requirement

(o) **Tap changer details:**

i) Tap range	As per Site Requirement
ii) Tap Control	As per Site Requirement

(p) **Bushing CT Parameters:**

SI NO.	Transformer Rating	CT Parameters	
		Earth fault CT Class: 5P20	R.E.F.CT Class: PS
1.	Site to fill	As per Site Requirement	As per Site Requirement

(q) **Bushing Parameters**



	Parameters	36 KV	12 KV	7.2KV	3.6kV	433 V
( 1 . )	Rated Voltage(kV)	36	12	7.2	3.6	1.1
( 2 . )	Lightning impulse withstand voltage, kVp	170	75	60	40	-
( 3 . )	One min power frequency withstand voltage , kV (rms)	77	30	22	11	3.0
( 4 . )	Minimum total creepage distances (mm)	25mm/kV x Rated Voltage of Bushing <u>OR</u> 31mm/kV x Rated Voltage of Bushing (As per Site Requirement)				
( 5 . )	Mounting	Tank / Transformer body				
( 6 . )	Rated Current	As per details of Transformers under (r) Subsection.				

**(r) Bushing Rated Current (in Amperes)**

SR. No.	KVA RATING	HV RATING (kV)	LV RATING (kV)	HV-Line	LV-Line	Neutral
(1.)	As per Site Requirement	As per Site Requirement	As per Site Requirement	As per Site Requirement	As per Site Requirement	As per Site Requirement

**(s) Termination Details**

(1.)	HV Phase Terminal	As per Site Requirement
(2.)	LV Phase Terminal	As per Site Requirement
(3.)	LV Neutral Terminal	As per Site Requirement

**(t) XLPE Cable size**

SR. No.	KVA RATING	HV RATING (kV)	LV RATING (kV)	HV side	LV side
(1.)	Site to fill	Site to fill	Site to fill	Cable (As per Site Requirement)	Cable/Busduct (As per Site Requirement)

**(u) Minimum Clearance in air (mm)**

System voltage	33 kV	11 kV	6.6 kV	3.3 KV	433 V
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**TECHNICAL REQUIREMENTS**

Phase to Phase	350	130	100	70	25
Phase to Earth	320	120	90	60	25

1.02.00

**Neutral Grounding Resistors (If applicable)**

1.02.01

**3.6 kV & 11 KV NGR**

Sr. No	Parameters	3.6 kV	11 kV
i)	Resistance Value at 50 deg. C.	(As per Site Requirement)	(As per Site Requirement)
ii)	Rated current	(As per Site Requirement)	(As per Site Requirement)
iii)	Service	Outdoor	Outdoor
iv)	Resistor material & connection	Punched stainless steel grid element type	Punched stainless steel grid element type
v)	Maximum allowable temperature rise over ambient 50 oC	350 deg. C	350 deg. C
vi)	Mounting	3.6 KV grade insulators.	12 KV grade insulators.
vii)	Power frequency test level	10 KV (rms)	28 KV (rms)
viii)	Application	(As per Site Requirement)	

1.02.00

**Details of Transformers**

Sr. no.	Transformer Name	Transformer Rating
1.	(As per Site Requirement)	(As per Site Requirement)

1.03.00

**GENERAL**

1.04.00

**STANDARDS**

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

Indian Standards No.	Title	International & internationally recognized standards
IS: 2026	Power transformers	IEC: 60076
IS: 3639	Fittings & accessories for power transformers	

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	Indian Standards No.	Title	International & internationally recognized standards
		Insulating oils for transformer and switchgear	IEC: 60296, BS:148
	IS: 2099	Bushing for alternating voltages above 1000 V	IEC: 60137, BS: 223
	IS: 2705	Current transformers	IEC: 60185
	IS: 325	Three phase induction motors	IEC: 60034
	IS: 3637	Gas operated relays	
	IS: 10028	Code of practice for selection installation & maintenance of transformers	
	IS: 4691	Degree of protection provided by enclosure for rotating electrical machinery	
	IS: 13947	Specification for low voltage switchgear & control gear Part - I	IEC: 144
	IS : 5	Colours for ready mix paints	
	IS: 1866	Code of practice for maintenance & Supervision of mineral insulating oil in equipment	
	IS: 6272	Industrial cooling fans	
	IS: 6600	Guide for Loading of oil immersed transformers	IEC: 60076-7
	IS: 3347	Specification for dimensions of porcelain bushing	
	IS:8603		
	IS: 8468	Tap changers	IEC: 214
		High voltage test technique	IEC: 60
		Insulation co-ordination	IEC: 71
		NEMA standard publication for Power transformers	NEMA-TR-1
	IS: 10596	Code of practice for selection, Installation operation & maintenance of pumps for Industrial applications	
	IS: 9434	Guide for sampling & analysis of free & dissolved gas & oil from oil filled electrical equipment	IEC: 567
	IS: 2544	Porcelain post insulators for systems with nominal voltage greater than 1000 V	
	IS: 5561	Specification for electric power connectors	
	IS: 5621	Hollow insulators for use in electrical equipment	
	IS: 2633	Methods for testing uniformity of coating of Zinc coated articles	
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CLAUSE NO.	TECHNICAL REQUIREMENTS													
	Indian Standards No.	Title	International & internationally recognized standards											
	IS: 12676	Dimensions for OIP insulated condenser bushings												
	BEE Guideline & CEA notification													
1.05.00	The electrical installation shall meet the requirements of Indian Electricity act 2003.													
2.00.00	<b>PERFORMANCE</b>													
(a)	The maximum flux density in any part of the core & yoke at the rated MVA, voltage & frequency shall be such that under 110% continuous voltage condition it does not exceed 1.9 Tesla.													
(b)	The transformer & all its accessories including CT's etc, shall be designed to withstand without injury the thermal & mechanical effects of any external short circuit to earth & of short circuits at the terminal of any winding for a period of 2 sec.													
(c)	Transformers shall withstand, without injurious heating, combined voltage & frequency fluctuations, which produce the following over fluxing condition:													
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%; text-align: center;">1)</td> <td style="width: 95%;">110 %- continuous</td> </tr> <tr> <td></td> <td>125%- for one minute</td> </tr> <tr> <td></td> <td>140%- for five seconds</td> </tr> <tr> <td style="text-align: center;">2)</td> <td>Bidder shall indicate 150% &amp; 170% over voltage withstand time.</td> </tr> <tr> <td style="text-align: center;">3)</td> <td>Over fluxing characteristics up to 170 % shall be submitted.</td> </tr> </table>				1)	110 %- continuous		125%- for one minute		140%- for five seconds	2)	Bidder shall indicate 150% & 170% over voltage withstand time.	3)	Over fluxing characteristics up to 170 % shall be submitted.
1)	110 %- continuous													
	125%- for one minute													
	140%- for five seconds													
2)	Bidder shall indicate 150% & 170% over voltage withstand time.													
3)	Over fluxing characteristics up to 170 % shall be submitted.													
(d)	The transformers shall be capable of being operated continuously without danger on any tapping at the rated MVA with voltage variation of $\pm 10\%$ corresponding to the voltage of tapping.													
(e)	The transformers shall be capable of being loaded in accordance with IS: 6600 / IEC: 60076-7 up to load of 150 %. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.													
3.00.00	<b>CONSTRUCTION</b>													
	The features & construction details of each transformer shall be in accordance with the requirement stated hereunder.													
3.01.00	TANK AND TANK ACCESSORIES													
(a)	Tank shall be of welded construction & fabricated from tested quality low carbon steel of adequate thickness. The welding procedure specification (WPS), procedure qualification record (PQR), shop welding schedule, welder's													
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	<p>qualification shall be subject to Employer's approval. After completion of welding, all joints shall be subjected to visual examination. In case of doubt particular weld shall be checked by D.P. Test. However weld joints of load bearing member shall be left unpainted till carrying out of jacking test followed by DP Test during final inspection of transformer. Details of acceptance norms of welding shall be submitted for Employer's approval which shall include permissible undercut, overlap, surface crack, porosity, out of alignment of plate surface in butt joints, maximum gap due to incorrect fit up of fillet joint etc.</p> <p>(b) Each tank shall be provided with :</p> <p>(i.) Lifting lug suitable for lifting the equipment complete with oil.</p> <p>(ii.) A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic or mechanical screw jacks.</p> <p>(iii.) Suitable haulage holes shall be provided for transformer wheeling in all four directions.</p> <p>(c) For all transformers, suitable bi-directional skids with pre-drilled holes shall be provided integral with the tank body for fixing the transformer tank on foundation. These skids shall be such that the bottom of the tank body is at a sufficient height above foundation for cleaning purposes.</p> <p>The transformers (except transformers upto and including 2 MVA) are to be provided with four no. of bi - directional flat rollers of detachable type &amp; shall be mounted on wheels on foundation. Suitable locking arrangement shall be provided for the wheels to prevent accidental movement of transformer.</p> <p>(d) At least two adequately sized inspection openings one at each end of the tank shall be provided for easy access to bushing &amp; earth connections. The inspection covers shall not weight more than 25 Kg. Handles shall be provided on the inspection cover to facilitate lifting.</p> <p>(e) All bolted connections shall be fitted with weather proof, hot oil resistant, rubberized cork gasket in between for complete oil tightness. If gasket is compressible, metallic stops shall be provided to prevent over compression.</p> <p>(f) The tank shall be designed in such a way that it can be mounted on the plinth directly.</p> <p>(g) Wherever possible the transformer tank &amp; its accessories shall be designed without pockets wherein gas may collect. Where pockets can not be avoided, pipes shall be provided to vent the gas into the main expansion pipe.</p> <p>(h) The main tank body shall be capable of withstanding full vacuum.</p> <p><b>3.02.00 Core</b></p> <p>(a) The core shall be constructed from cold rolled, super grain oriented (CRGO), silicon steel laminations of equivalent to M4 or better grade.</p> <p>(b) The core isolation level shall be 2 kV (rms.) for 1 minute in air.</p> <p>(c) Adequate lifting lugs will be provided to enable the core &amp; windings to be lifted.</p> <p><b>3.03.00 Windings</b></p>

- (a) The contractor shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere. The bidder shall furnish details of the facilities available at his works along with the Techno- Commercial bid.
- (b) The conductors shall be of electrolytic grade copper free from scales & burrs.
- (c) All windings of the transformers having voltage less than 66 kV shall be fully insulated.
- (d) Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

**3.04.00****Insulating Oil**

No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.

S.No.	Property	Permissible values
1.	Kinematic Viscosity, mm <sup>2</sup> /s	≤ 12 at 40 ° C ≤ 1800.0 at (-)30 ° C
2.	Flash Point, ° C	≥ 140° C
3.	Pour point, ° C	≤ (-)40 ° C
4.	Appearance	Clear , free from sediment and suspended matter
5.	Density kg/dm <sup>3</sup> at 20 ° C	≤ 0.895
6.	Interfacial Tension N/m at 25° C	≥ 0.04
7.	Neutralisation value, mgKOH/g	≤ 0.01
8.	Corrosive sulphur	Non Corrosive
9.	Water content mg/kg	≤ 30 in bulk supply ≤ 40 in drum supply
10.	Anti oxidants additives	Not detectable
11.	Oxidation Stability Neutralization value, mgKOH/g Sludge, % by mass	≤ 1.2 ≤ 0.8
12.	Breakdown voltage As delivered, kV After treatment, kV	≥ 30 ≥ 70
13.	Dissipation factor, at 90° C And 40 Hz to 60 Hz	≤ 0.005
14.	PCA content	≤1%

S.No.	Property	Permissible values
15.	Impulse withstand Level, kVp	≥ 145
16.	Gassing tendency at 50 Hz after 120 min, mm <sup>3</sup> /min	≤ 5

Subsequently oil samples shall be drawn at:

(a) After placement of transformer on foundation, Oil of main tank shall be tested for

i)	BDV	60 kV (min)	Applicable for all transformers including 16 MVA.
ii)	Moisture content	10 ppm (max.)	
iii)	Tan delta at 90 deg. C	0.002 (max.)	Applicable for 16 MVA & above Transformers only.
iv)	Resistivity at 90 deg. C	35 x 10 <sup>12</sup> ohm-cm (min)	
v)	Interfacial tension	0.040 N/m (min)	

(b) Prior to energization at site for following properties & acceptance norms:

i)	BDV	60 kV (min)	Applicable for all transformers including 16 MVA.
ii)	Moisture content	10 ppm (max.)	
iii)	Tan delta at 90 deg. C	0.05 (max.)	Applicable for 16 MVA & above Transformers only.
iv)	Resistivity at 90 deg. C	1 x 10 <sup>12</sup> ohm-cm (min)	
v)	Interfacial tension	0.035 N/m (min)	

**3.04.02**

**Oil Preservations System**

(a)

The transformers rated below 7.5 MVA shall have the following types of oil preservation systems:

(i.) Conventional Conservator

The transformer shall be provided with conventional single compartment conservator with dry air filling the space above the oil. The top of the conservator shall be connected to the atmosphere through a cobalt free indicating type silicagel breather with transparent enclosure. The Buchholz relay shall also be provided.

The conservator shall be fitted with a cobalt free indicating type silicagel filter breather of transparent enclosure breather, which shall be so designed that:

- Passage of air is through a dust filter and silicagel.
- Silicagel is isolated from atmosphere by an oil seal.
- Moisture absorption indicated by a change in colour of the tinted crystal can be easily observed from a distance.
- Breather is mounted not more than 1400 mm above rail top level.

(b)

For transformers rated 7.5 MVA and above, bidder shall offer air cell type oil sealing in the conservator to prevent oxidation and contamination of oil due to contact with

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	<p>water. The requirement of air cell type constant oil preservation system are given below:</p> <ol style="list-style-type: none"> <li>i. Contact of the oil with atmosphere is prohibited by using a flexible urethane or nitrile rubber reinforced with nylon cloth air cell.</li> <li>ii. The connection of air cell to the top of reservoir is by air proof seal preventing entrance of air into the conservator.</li> <li>iii. The temperature is likely to rise upto 100 Deg C when the transformer is in operation. As such air cell used shall be suitable for operating continuously at 100 deg. C.</li> <li>iv. A silicagel breather shall be provided in the air side vent line.</li> </ol> <p><b>3.05.00 Terminal Arrangements</b></p> <p><b>3.05.01 Bushings</b></p> <ol style="list-style-type: none"> <li>(a) The electrical &amp; mechanical characteristics of bushings shall be in accordance with IS: 2099, IS: 3347 &amp; IS: 12676.</li> <li>(b) Bushings for 52 kV &amp; above shall be of the oil filled condenser type &amp; shall be of draw lead/ rod type to facilitate removal. Bushings of rating below 52 kV shall be solid porcelain or oil communicating type.</li> <li>(c) Condenser type bushings shall be provided with :               <ol style="list-style-type: none"> <li>(i.) Oil level gauge,</li> <li>(ii.) Oil filling plug &amp; drain valve ( if not hermetically sealed)</li> <li>(iii.) Tap for capacitance &amp; tan delta test.</li> </ol> </li> <li>(d) Clamps &amp; fittings shall be of hot dip galvanized steel.</li> <li>(e) Bushing &amp; fittings shall be provided with vent pipes that shall be connected to route any gas collection through the Buchholz relay.</li> <li>(f) No arcing horns shall be provided on the bushings.</li> <li>(g) Wherever cable termination is specified, bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable termination.</li> <li>(h) Where current transformers are specified, the bushings shall be removable without disturbing the current transformer.</li> </ol> <p><b>3.05.02 Neutral Terminal Arrangement (As per site requirements)</b></p> <p><b>3.05.03 Neutral Termination</b></p> <ol style="list-style-type: none"> <li>(a) The neutral terminal of 433 V winding shall be brought out on a bushing alongwith the 433 V phase terminal to from a 4 wire system for the 433 V. Neutral CT's shall be located in the lead coming out of the winding and location of these CT's shall not be inside the tank.</li> <li>(b) The neutral terminal of winding not connected to NGR, shall also be brought out through an outdoor bushing. Further this neutral terminal shall be connected by a copper flat of size 50 mm x 8 mm, which shall be brought down upto 100 mm above ground. The copper flat shall be insulated and supported from the tank</li> </ol>			
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<p>(c)</p> <p><b>3.05.04</b></p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p><b>3.05.05</b></p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p> <p>(f)</p> <p>(g)</p>	<p>body. The connection shall be made by using two (2) bolted neutral grounding terminals with necessary accessories.</p> <p>The neutral terminal of winding connected to NGR, shall be brought to an outdoor bushing, away from the busduct termination arrangement (wherever applicable). It shall be connected to associated neutral grounding resistor by a copper flat, which shall be supplied &amp; installed by the contractor along with the necessary intermediate supporting insulators &amp; supporting structure. Also NGR shall be grounded through copper flat which shall be insulated and properly supported and shall be brought down upto 100 mm above ground.</p> <p><b>Bus Duct Terminations</b></p> <p>A flanged throat or equivalent connection shall be provided for termination of busduct enclosure. The winding termination shall be on outdoor type of bushings. The Employer would provide necessary flexible connection between the bushing terminal &amp; the bus duct conductor. The material of the busduct termination shall be non-magnetic.</p> <p>The shape of the bus duct conductor shall be informed during detailed engineering. The bushing pads shall be silver/tin plated. A drain with stopcock arrangement shall be provided at flange to drain leakage of oil/water at termination. As bus duct will be pressurized stopcocks shall be airtight.</p> <p>Tolerance permissible for the height of the terminal connected to busduct over rail top level is <math>\pm 10</math> mm. Contractor has to ensure that radiator &amp; conservator does not obstruct the path of the bus ducts in position &amp; during movement of transformer. The contractor shall co-ordinate final design of terminal arrangement to suit bus duct arrangement during detailed engineering.</p> <p>The transformer bushing enclosed in bus duct enclosure shall be designed for satisfactory operation in the high ambient temperature existing inside the bus duct enclosure. The temperature inside the bus duct enclosure may be of the order of 90 – 100 deg. C. The bus duct conductor temperature may be as high as 105 deg. C &amp; temperature in the bus duct enclosure will be of the order of 80 deg. C.</p> <p><b>Cable boxes &amp; disconnecting chamber</b></p> <p>HV Cable boxes shall be of phase segregated air insulated type &amp; shall be of sufficient size to accommodate Employer's cable &amp; termination. Phase segregation shall be achieved by insulating barriers.</p> <p>Cable boxes shall have bus bars / terminal connectors of adequate size &amp; bolt holes to receive cable lugs.</p> <p>A suitable removable gland plate of non-magnetic material drilled as per the Employer's instruction shall also be provided in the cable box.</p> <p>The support from base for the cable box shall be of galvanized iron.</p> <p>The contractor shall provide earthing terminals on the cable box, to suit Employer's GI flat.</p> <p>The final cable size &amp; type, number &amp; length of terminating cable (from cable gland plate to the cable lug) shall be furnished during detailed engg.</p> <p>Cable boxes shall be designed such that it shall be possible to move away the transformer without disturbing the cable terminations, leaving the cable box on external supports.</p>			
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(h)	Cable boxes shall have removable top cover & ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.
3.05.06	<p><b>TERMINAL CONNECTOR</b> (If applicable)</p> <p>(a) Bushing terminal shall be provided with terminal connectors of approved type &amp; size for connection to external part. Terminal connectors must have been successfully type tested as per IS: 5561.</p> <p>(b) Aluminium alloy if used shall conform to designation 4600 M of IS: 617 or of better quality.</p> <p>(c) No current carrying part of a clamp shall be less than 10 mm thick.</p> <p>(d) All ferrous parts shall be hot dip galvanized conforming to IS: 2633.</p> <p>(e) For bi-metallic clamp, copper alloy liner of minimum 2-mm thickness shall be cast integral with aluminum body. Alternatively Bidder may offer bimetallic connector with loose bimetallic sleeve.</p> <p>(f) Flexible connectors shall be made from tinned copper sheets.</p> <p>(g) Size of terminal/conductor for which the clamp is suitable &amp; rated current under the conditions shall be embossed / punched on each component of the clamp, except hardware.</p> <p>(h) Rated current of the terminal connectors shall be same as that of corresponding bushing.</p>
3.06.00	<p><b>Bushing Current Transformer</b></p> <p>(a) Current transformer shall comply with IS: 2705.</p> <p>(b) It shall be possible to remove turret mounted current transformers from the transformer tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents &amp; local heat generated in the turret.</p> <p>(c) All secondary leads shall be brought to a weatherproof terminal box near each bushing. These terminals shall be wired out to transformer marshalling box using separate cables for each core.</p>
3.07.00	<p><b>Terminal Marking</b></p> <p>The terminal marking &amp; their physical position shall be as per IS: 2026 unless specified otherwise.</p>
3.08.00	<p><b>Marshalling Box(M. BOX) Unit</b></p> <p>(a) Each transformer shall be provided with one Marshalling Box housing all the cooler control, OTI &amp; WTI etc.</p> <p>(b) The sheet steel used for all the cabinet boxes shall be at least 2.5 mm thick. The gasket used shall be of neoprene rubber. A space heater &amp; cubicle lighting with on-off switch shall be provided in each cabinet. A circuit breaker/contactors with thermal overload device for controlling the AC auxiliary supply shall be provided.</p> <p>(c) Terminal Blocks</p> <p>(1.) The terminal blocks to be provided shall be fully enclosed with removable covers &amp; made of molded, non-inflammable plastic material with blocks &amp; barriers molded integrally. The terminal blocks shall be of 650V grade &amp;</p>

have 10 A continuous rating. Terminal blocks for current transformer secondary leads shall be provided with test links & isolating facilities. Also current transformer secondary leads shall be provided with short circuiting & earthing facilities. At least 20% spare terminals shall be provided on each panel & these spare terminals shall be uniformly distributed on all terminal blocks.

- (2.) Terminal blocks shall be suitable for connecting the following conductors on each side :
  - (i.) Current transformer circuits – minimum of two No. of 2.5 sq. mm copper wires each side
  - (ii.) Other circuits— minimum of one No. of 2.5 sq. mm copper wire each side

- (d) The temperature indicators shall be so mounted that the dials are not more than 1500 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.
- (e) All incoming cables shall enter the marshalling box from the bottom. A removable undrilled gland plate shall be provided at the bottom of the box for accommodating glands for Employer’s incoming and outgoing cables, which shall not be less than 450 mm from finished floor level.
- (f) All devices and terminal blocks inside the marshalling box shall be clearly identified by symbols corresponding to those used on applicable schematic or wiring diagram.
- (g) It shall be located in such a way that, the same shall not face towards the transformer.
- (h) The gland plate shall be made into two detachable halves, for facilitating the termination of Employer’s cable and Contractor’s cables separately. The gland plate and the associated compartment shall be sealed in a suitable manner to prevent the ingress to moisture, rodents, insects etc.
- (i) One dummy terminal block in between each trip wire terminal shall be provided.
- (j) Wiring Scheme shall be engraved in a plate and the same shall be fixed inside the Marshalling Box door.

**3.09.00 Control Wiring & Cabling**

Supply, laying & termination of all cables & accessories required of proper termination from the M. Box except for those stated under next clause below so as to make equipment complete & functional shall be in scope of supplier. The cable between the M. Box & transformer shall be laid by the supplier through GI conduits/ pipes. Cable box / sealing end shall be suitable for following types of cables

1)	415 V power	1100 V grade PVC insulated aluminum conductor cable with armour.
2)	Control	1100 V grade PVC insulated 2.5 sq. mm stranded copper conductor with armour.

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<p><b>3.10.00</b></p> <p><b>PAINTING</b></p> <p>Painting of transformer and its accessories shall be in accordance with the following chart.</p> <table border="1" data-bbox="201 344 1481 1167"> <thead> <tr> <th data-bbox="201 344 320 421">S.No.</th> <th data-bbox="320 344 647 421">PARTS NAME</th> <th data-bbox="647 344 1118 421">TYPE OF PAINT</th> <th data-bbox="1118 344 1299 421">NO.OF COATS</th> <th data-bbox="1299 344 1481 421">TOTAL DFT</th> </tr> </thead> <tbody> <tr> <td data-bbox="201 421 320 524">(1.)</td> <td data-bbox="320 421 647 524">Inside of tank and accessories (except M Box)</td> <td data-bbox="647 421 1118 524">Oil &amp; heat resistant fully glossy white</td> <td data-bbox="1118 421 1299 524">One coat</td> <td data-bbox="1299 421 1481 524">atleast 30 micron</td> </tr> <tr> <td data-bbox="201 524 320 759">(2.)</td> <td data-bbox="320 524 647 759">External surface of transformer and accessories including M Box (except radiator)</td> <td data-bbox="647 524 1118 759">Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint followed by polyurethane finish paint of blue colour corresponding to RAL 5012.</td> <td data-bbox="1118 524 1299 759">One coat each</td> <td data-bbox="1299 524 1481 759">Atleast 100 micron</td> </tr> <tr> <td data-bbox="201 759 320 929">(3.)</td> <td data-bbox="320 759 647 929">External radiator surface</td> <td data-bbox="647 759 1118 929">Anticorrosive primary paint followed by high quality full glossy outer finish paint (blue colour corresponding to RAL 5012.)</td> <td data-bbox="1118 759 1299 929">Two coats each</td> <td data-bbox="1299 759 1481 929">Atleast 100 micron</td> </tr> <tr> <td data-bbox="201 929 320 1032">(4.)</td> <td data-bbox="320 929 647 1032">Internal radiator surface</td> <td data-bbox="647 929 1118 1032">Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil</td> <td data-bbox="1118 929 1299 1032">---</td> <td data-bbox="1299 929 1481 1032">---</td> </tr> <tr> <td data-bbox="201 1032 320 1167">(5.)</td> <td data-bbox="320 1032 647 1167">Internal surface of M Box</td> <td data-bbox="647 1032 1118 1167">Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint</td> <td data-bbox="1118 1032 1299 1167">Two coats each</td> <td data-bbox="1299 1032 1481 1167">Not less than 100 micron</td> </tr> </tbody> </table>	S.No.	PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT	(1.)	Inside of tank and accessories (except M Box)	Oil & heat resistant fully glossy white	One coat	atleast 30 micron	(2.)	External surface of transformer and accessories including M Box (except radiator)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint followed by polyurethane finish paint of blue colour corresponding to RAL 5012.	One coat each	Atleast 100 micron	(3.)	External radiator surface	Anticorrosive primary paint followed by high quality full glossy outer finish paint (blue colour corresponding to RAL 5012.)	Two coats each	Atleast 100 micron	(4.)	Internal radiator surface	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---	(5.)	Internal surface of M Box	Chemical resistant epoxy zinc phosphate primer followed by chemical and heat resistant epoxy enamel white paint	Two coats each	Not less than 100 micron				
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<p><b>3.11.00</b></p> <p><b>Cooling Equipment</b></p> <p>The radiators shall be detachable type, mounted on the tank. Each radiator shall be provided with the following:</p> <p>(a) A drain plug at the bottom.</p> <p>(b) An air release plug at the top.</p> <p><b>3.12.00</b></p> <p><b>TAP CHANGER DEVICE</b></p> <p>3.12.01 Off Circuit Tap change Switch</p> <p>(a) The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating on external hand wheel.</p> <p>(b) The tap changing shall be possible without disturbing the transformer in any way except de-energising.</p> <p>(c) Arrangement shall be made for securing and pad-locking the tap changer in any of the working positions, and it shall not be possible for setting or padlocking it in any intermediate position. An indicating device shall be provided to show the tap in use.</p>																																		



CLAUSE NO.	TECHNICAL REQUIREMENTS			
<p>(d)</p> <p><b>3.13.00</b></p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p> <p>(f)</p> <p>(g)</p> <p><b>3.14.00</b></p>	<p>The Cranking device for manual operation of the off circuit tap changing gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:-</p> <ul style="list-style-type: none"> <li>(i.) Mechanical tap position indicator which shall be clearly visible from near the transformer.</li> <li>(ii.) Mechanical stops to prevent over cranking of the mechanism beyond the extreme tap positions.</li> <li>(iii.) The manual operating mechanism shall be labeled to show direction of operation for raising the secondary voltage and vice versa.</li> <li>(iv.) A warning plate indicating “The switch shall be operated only when the transformer has been de-energised” shall be fitted.</li> </ul> <p><b>VALVES</b></p> <p>All valves upto and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clockwise when facing the hand wheel.</p> <p>Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.</p> <p>Each valve shall be provided with the indicator to show clearly the position of the valve.</p> <p>Gland packing/gasket material shall be of teflon rope/nitrile rubber. In case of gate/globe valves, gland packing preferably of teflon rope shall be used to prevent oil seepage through the gland.</p> <p>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. 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.</p> <p>All hardware used shall be cadmium plated/electro galvanised.</p> <p>Sampling &amp; drain valves should have zero leakage rate.</p> <p><b>Neutral Grounding Resistors (If applicable)</b></p> <p>The earthing resistors are required for LV neutral point earthing of the various transformers. (as specified elsewhere in this specification)</p> <p><b>(a) Resistor Elements</b></p> <p>The resistors shall be of punched stainless steel grid element type. The grids shall be securely supported at sufficient number of points so that no damage is caused to the grids due to vibrations and no mechanical stresses are developed. The resistor element shall be insulated from supporting base by mica tubes. The insulating material used in the construction shall be heat resistant such as mica.</p>			
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	<p><b>(b) Stacking</b></p> <p>Various sections comprising the neutral grounding resistor shall be capable of being stacked one above the other. The insulators supporting the resistor assemblies shall be of outdoor type. Connecting links shall be provided to connect adjacent stacks.</p> <p><b>(c) Enclosure</b></p> <p>The neutral grounding resistor shall be housed in a 2.5 mm thick sheet steel enclosure. The enclosure shall be weather proof having IP 33 degree of protection in accordance with IS: 13947. The resistor neutral side terminal shall be brought out on the roof and the ground side terminal at the side of the enclosure through porcelain bushings. The ground side terminal shall be brought to ground level by a copper flat supported from the mounting structure by porcelain insulators. The copper bar shall have two (2) bolted neutral grounding terminals with hole size suitable for M10 bolt size and necessary accessories for connecting to ground mat through two MS 'flats'. The enclosure shall be supported on insulators placed on the mounting structure.</p> <p><b>(d) Mounting Structure</b></p> <p>The Contractor shall supply and erect a galvanized structure to support the NG resistor enclosure so that the base of the enclosure shall be at a minimum height of 2.4M above ground level. The NG resistor enclosure mounting and the neutral connection shall be such that it does not obstruct the busduct routing in any way.</p> <p>A heating circuit with Thermostat to be provided inside the enclosure to control humidity.</p>			
3.15.00	<b>Bolts &amp; Nuts</b>	All bolts & nuts exposed to weather shall be hot dip galvanised steel /cadmium plated steel.		
3.16.00	<b>Gasket</b>	The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. Supplier shall also recommend quality & make of gaskets to be used for replacement during maintenance if required. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.		
4.00.00	<b>Fittings</b>			
4.01.00		The following fittings shall be provided with each transformer covered in this specification:		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<ol style="list-style-type: none"> <li>1) Conservator for main tank with oil filling hole and cap, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts and dehydrating cobalt free indicating type silicagel breather with transparent enclosure. Breather for conservators shall be mounted not more than 1400 mm above rail top.</li> <li>2) Oil preservation system: - as specified elsewhere.</li> <li>3) Minimum two Nos. of spring operated pressure relief devices with alarm/trip contacts for transformer of 2 MVA &amp; above rating. Discharge of PRD shall be properly taken through pipes &amp; directed away from the transformer /other equipment.</li> <li>4) Buchholz relay double float type with isolating valves on both sides, bleeding pipe with Gas collecting device at the end to collect gases and alarm and trip contacts. Control cable termination at Buchhloz relay shall be properly sealed to prevent water entry.</li> <li>5) Air release plug.</li> <li>6) Inspection openings and covers.</li> <li>7) Bushing with metal parts and gaskets to suit the termination arrangement.</li>   <li>8) Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.</li> <li>9) Protected type Mercury or alcohol in glass thermometer.</li> <li>10) Bottom and top filter valves with threaded male adapters, bottom Sampling valve &amp; drain valve.</li> <li>11) Rating and diagram plates on transformers (English &amp; Hindi) and auxiliary apparatus.</li> <li>12) Radiator as specified.</li> <li>13) Prismatic/toughened glass oil gauge for transformers.</li> <li>14) 150 mm dial type oil temp indicator with alarm and trip contacts, maximum reading pointer &amp; resetting device. Accuracy class shall be <math>\pm 1.5\%</math> or better.</li> <li>15) 150-mm dial type Winding temp indicator with alarm and trip contacts, maximum reading pointer &amp; resetting device. Accuracy class shall be <math>\pm 1.5\%</math> or better.</li> <li>16) Flanged bi-directional wheels.</li> <li>17) Marshalling Box.</li> <li>18) Off load tap changing gear</li> <li>19) Cooling equipment.</li> <li>20) Bushing current transformers.</li> <li>21) Insulating oil.</li> <li>22) Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently. Sludge valve at bottom most point of tank to be provided for easy flush out/removal of sludge during maintenance.</li> <li>23) Terminal marking plates.</li> <li>24) Valves schedule plates.</li> <li>25) Two (2) earthing terminals on all the equipment mounted separately suitable for connection to suitable GI flat along with 2 Nos. tapped holes.</li> </ol>			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
<p>4.02.00</p> <p>5.00.00</p>	<p>M10 bolts etc.</p> <p>26) Rain hoods to be provided on Buchholz, MOG &amp; PRD. Entry points of wires shall be suitably sealed.</p> <p>The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the transformer, are deemed to be included.</p> <p><b>INSPECTION AND TESTING:</b> (As per latest revision of standard quality plan SQP-No: 0000-999-QOE-S-036)</p> <p>(a) The Contractor shall carry out a comprehensive inspection and testing program during manufacture of the transformer. An indication of inspection envisaged by the Employer is given elsewhere in the specification. This is however not intended to form a comprehensive program, as it is Contractor's responsibility to draw up and carry out such a program in the form of detailed quality plan duly approved by Employer for necessary implementation.</p> <p>(b) The Contractor shall carry out all type tests and routine tests on the transformers. The tests are listed elsewhere in the specification.</p> <p>(c) The bidder shall indicate the charges for each of these type tests separately in the Techno- Commercial bid and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.</p> <p>(d) The equipment checks to be carried out by the Contractor are given elsewhere in the specification.</p> <p>(e) The requirements of site tests are given elsewhere in the specification.</p> <p>(f) The makes of all major bought out items shall be subjected to Employer's approval. The contractor shall also prepare a comprehensive inspection and testing program for all bought out/sub-contracted items and shall submit the same to Employer.</p> <p>(g) Each transformer shall be completely assembled with all fittings and accessories meant for the particular transformer before offering for inspection and testing by Employer.</p> <p>(h) The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.</p> <p>(i) In case the contractor has conducted such specified type test(s) within last ten years as on the date of Techno- Commercial bid opening, he may submit during detailed engineering the type test reports to the owner for waiver of conductance</p>			
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- of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
- (j) Following components to be supplied shall be of tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed below in specification and carried out within last ten years from the date of Techno- Commercial bid opening. The reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witness by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from date of Techno- Commercial bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/employer's representative and submit the reports for approval.
- (a) Tank Pressure and Vacuum test
- (b) Neutral Grounding Resistor (NGR)
- (k) All routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
- (l) The type test reports once approved for any project shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

**Type and Routine tests**  
**Routine Tests**

Sr. No.	Routine Tests	OIL FILLED OUTDOOR TRANSFORMER
1	All routine test in accordance with IEC 60076 shall be carried out in all the transformers.	√
2	Measurement of Voltage Ratio	√
3	Measurement of winding resistance on HV & LV on all the taps (as per cl. No. 10.2 of IEC 60076-1)	√
4	Vector group and Polarity Check (Cl.no.10.3 of IEC 76-1)	√
5	Magnetic Balance Test	√
6	Measurement of no load current with 415 V, 50 Hz AC supply	√
7	Measurement of no load losses and current at 90%, 100% & 110% of rated voltage (as per cl.10.5 of IEC 60076-1)	√
8	Impedance & Load Loss Measurement on principal, Max & Min. Taps	√
9	IR measurement (As per cl. no:- 10.1.3 of IEC 60076-1)	√
10	Dielectric tests shall be carried out as per IEC 60076-3.	√
11	Separate Source Voltage Withstand Test (Table-2, 4 & cl. 11 of IEC 60076-3)	√
12	Induced Over Voltage Withstand test as per IEC 60076-3	√

CLAUSE NO.	TECHNICAL REQUIREMENTS																																									
	<table border="1"> <thead> <tr> <th data-bbox="320 188 448 286">Sr. No.</th> <th data-bbox="448 188 1238 286">Routine Tests</th> <th data-bbox="1238 188 1481 286">OIL FILLED OUTDOOR TRANSFORMER</th> </tr> </thead> <tr> <td data-bbox="320 286 448 353">13</td> <td data-bbox="448 286 1238 353">Repeat no load current/loss measurement &amp; IR measurement after completion of all dielectric test</td> <td data-bbox="1238 286 1481 353">√</td> </tr> <tr> <td data-bbox="320 353 448 421">14</td> <td data-bbox="448 353 1238 421">Measurement of capacitance &amp; tan delta to determine capacitance between winding &amp; earth. (As per cl. no:- i, 10.1.3 of IEC 60076-1)</td> <td data-bbox="1238 353 1481 421">√</td> </tr> <tr> <td data-bbox="320 421 448 454">15</td> <td data-bbox="448 421 1238 454">Oil leakage test: (as per cl 6.02.00 (a) (1) of this sub section)</td> <td data-bbox="1238 421 1481 454">√</td> </tr> <tr> <td data-bbox="320 454 448 488">16</td> <td data-bbox="448 454 1238 488">Jacking test followed by D.P. test</td> <td data-bbox="1238 454 1481 488">√</td> </tr> <tr> <td data-bbox="320 488 448 555">17</td> <td data-bbox="448 488 1238 555">Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.</td> <td data-bbox="1238 488 1481 555">√</td> </tr> <tr> <td data-bbox="320 555 448 589">18</td> <td data-bbox="448 555 1238 589">IR measurement on wiring of Marshalling Box.</td> <td data-bbox="1238 555 1481 589">√</td> </tr> <tr> <td colspan="3" data-bbox="320 589 1238 645" style="text-align: center;"><b>Type Tests</b></td> <td></td> </tr> <tr> <td data-bbox="320 645 448 712">19</td> <td data-bbox="448 645 1238 712">Short circuit test (special test) as per IEC 60076-5. <b>(If quantity is Two or more)</b></td> <td data-bbox="1238 645 1481 712">√</td> </tr> <tr> <td data-bbox="320 712 448 846">20</td> <td data-bbox="448 712 1238 846">Temp. rise test at a tap corresponding to maximum losses. DGA shall be conducted on oil sample taken before &amp; immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).</td> <td data-bbox="1238 712 1481 846">√</td> </tr> <tr> <td data-bbox="320 846 448 913">21</td> <td data-bbox="448 846 1238 913">Lightning impulse (Full &amp; Chopped Wave) test on windings (as per cl 14 of IEC 60076-3)</td> <td data-bbox="1238 846 1481 913">√</td> </tr> <tr> <td data-bbox="320 913 448 981">22</td> <td data-bbox="448 913 1238 981">Lightning impulse test on Neutral</td> <td data-bbox="1238 913 1481 981">√ (refer note iii)</td> </tr> <tr> <td data-bbox="320 981 448 1048">24</td> <td data-bbox="448 981 1238 1048">Measurement of acoustic noise level as per NEMA TR-1 (special test)</td> <td data-bbox="1238 981 1481 1048">√</td> </tr> </table>	Sr. No.	Routine Tests	OIL FILLED OUTDOOR TRANSFORMER	13	Repeat no load current/loss measurement & IR measurement after completion of all dielectric test	√	14	Measurement of capacitance & tan delta to determine capacitance between winding & earth. (As per cl. no:- i, 10.1.3 of IEC 60076-1)	√	15	Oil leakage test: (as per cl 6.02.00 (a) (1) of this sub section)	√	16	Jacking test followed by D.P. test	√	17	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√	18	IR measurement on wiring of Marshalling Box.	√	<b>Type Tests</b>				19	Short circuit test (special test) as per IEC 60076-5. <b>(If quantity is Two or more)</b>	√	20	Temp. rise test at a tap corresponding to maximum losses. DGA shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).	√	21	Lightning impulse (Full & Chopped Wave) test on windings (as per cl 14 of IEC 60076-3)	√	22	Lightning impulse test on Neutral	√ (refer note iii)	24	Measurement of acoustic noise level as per NEMA TR-1 (special test)	√	<p><b>Note:</b></p> <ul style="list-style-type: none"> <li>i) (√) mark indicates that the test to be carried out. (x) mark indicates that the test need not be carried out.</li> <li>ii) All the type tests shall be conducted after short circuit test. If Tank Vacuum &amp; Pressure Test is to be carried out then it shall be conducted before SC test.</li> <li>iii) Applicable on transformer neutral connected with NGR.</li> </ul> <p><b>5.01.02 Type tests on Components</b></p> <p>Type test reports shall be submitted for following:</p> <ul style="list-style-type: none"> <li>(a) Tank Vacuum &amp; Pressure Test</li> <li>(b) Neutral Grounding resistors</li> </ul> <p><b>5.02.00 TANK TEST</b></p> <p><b>(a) Routine test</b></p> <p><b>(1.) Oil leakage test on assembled transformer</b></p> <p>All tank &amp; oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature &amp; applying pressure equal to the normal pressure plus 35 KN/sq. m measured at the base of the tank. The pressure shall be maintained for a period of not less than <b>6 hours</b> during which time no sweating shall occur. This test shall be done on completely assembled transformer.</p>
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18	IR measurement on wiring of Marshalling Box.	√																																								
<b>Type Tests</b>																																										
19	Short circuit test (special test) as per IEC 60076-5. <b>(If quantity is Two or more)</b>	√																																								
20	Temp. rise test at a tap corresponding to maximum losses. DGA shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599).	√																																								
21	Lightning impulse (Full & Chopped Wave) test on windings (as per cl 14 of IEC 60076-3)	√																																								
22	Lightning impulse test on Neutral	√ (refer note iii)																																								
24	Measurement of acoustic noise level as per NEMA TR-1 (special test)	√																																								
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CLAUSE NO.	TECHNICAL REQUIREMENTS
<p><b>(b)</b></p> <p><b>5.03.00</b></p> <p><b>5.04.00</b></p> <p><b>5.05.00</b></p> <p><b>5.05.01</b></p>	<p><b>Type Tests</b></p> <p>(1.) <b>Vacuum Test</b> Each type of transformer tank shall be subjected to the vacuum test as per CBIP norms.</p> <p>(2.) <b>Pressure Test</b> Transformer tank of each type shall be subjected to a pressure test as per CBIP norms.</p> <p><b>NGR Testing</b></p> <p>(a) The following routine tests shall be conducted on each resistor covered in this package.</p> <p>(1.) Ohmic value measurement (For resistance &amp; reactance separately).</p> <p>(2.) Insulation resistance measurement before &amp; after HV test</p> <p>(3.) HV test for 1 min. at a voltage corresponding to the insulation level of the resistor.</p> <p>(b) DOP test on enclosure (routine test) as follows. It shall not be possible to insert a 2.5mm dia. steel wire into the enclosure from any direction without using force.</p> <p><b>Type tests</b></p> <p>Type test reports shall be submitted for following:</p> <p>(a) Short time current test along with temperature rise test.</p> <p>(b) Degree of protection test for IPX3.</p> <p><b>Pre-shipment Checks at Manufacture's Works</b></p> <p>(a) Check for mounting dimensions as per approved drawing.</p> <p>(b) Check for proper packing and reservation of accessories like radiators, bushings, dehydrating breather, rollers, Buchhloz relay, fans, control cubicle, connecting pipes, conservator etc.</p> <p>(c) Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.</p> <p><b>Inspection and Testing at Site</b></p> <p>The Contractor shall carry out a detailed inspection and testing program for field activities covering areas right from the receipt of material stage up to commissioning stage. An indicative program of inspection as envisaged by the Employer is given below. This is however not intended to form comprehensive program, as it is contractor's responsibility to draw up and carry out such a program duly approved by the Employer. Testing of oil sample at site shall be carried out as specified elsewhere in this specification.</p> <p><b>Receipt and Storage Checks</b></p>

CLAUSE NO.	TECHNICAL REQUIREMENTS
<p>(a)</p> <p>(b)</p> <p><b>5.05.02</b></p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p> <p><b>5.05.03</b></p> <p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p> <p>(f)</p> <p>(g)</p> <p>(i)</p> <p>(h)</p> <p>(i)</p>	<p>Following checks as detailed out in finalized/agreed FQP shall be followed.</p> <p>Check and record condition of each package, visible parts of the transformer etc. for any damage.</p> <p>Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general, if transformer filled with N<sub>2</sub>/dry air.</p> <p><b>Installation Checks</b></p> <p>Inspection and performance testing of accessories like tap changers etc.</p> <p>Check whole assembly for tightness, general appearance etc.</p> <p>Check oil sample.</p> <p>Leakage test on bushing before erection, if bushing is transported separately.</p> <p>Capacitance &amp; tan delta measurement of condenser bushing before fixing / connecting to the winding, contractor shall furnish these values for site reference.</p> <p><b>Commissioning Checks</b></p> <p>Check the colour of silica gel in silicagel breather.</p> <p>Check the oil level in the breather housing, conservator tanks, cooling system, condenser-bushing etc.</p> <p>Check the bushing for conformity of connection to the lines etc. and tan delta test for bushing.</p> <p>Check for correct operation of protection devices and alarms:</p> <ul style="list-style-type: none"> <li>(i.) Buchholz relay.</li> <li>(ii.) Excessive winding temperature</li> <li>(iii.) Excessive oil temperature</li> <li>(iv.) Low oil level indication</li> <li>(v.) Pressure relief valve</li> </ul> <p>Check for the adequate protection on the electric circuit supplying the accessories.</p> <p>Check resistance of all windings on all steps of the tap changer.</p> <p>Insulation resistance measurement for the following:</p> <ul style="list-style-type: none"> <li>(i.) Control wiring.</li> <li>(ii.) Main windings</li> <li>(iii.) Tank &amp; turret mounted CT's</li> </ul> <p>Check for cleanliness of the transformer and the surroundings.</p> <p>Check the following</p> <ul style="list-style-type: none"> <li>(i.) Buchholz, oil level indicator, pressure gauges, temp indicators etc. for fitting &amp; operation.</li> </ul>



CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>(ii.) Earthing of main tank, marshaling Box, tap changer driving gear, cable box, fan motor etc.</p> <p>(iii.) Neutral earthing</p> <p>(iv.) Calibration of WTI and OTI</p> <p>(v.) Earthing of bushing test tap</p> <p>(vi.) Connection of WTI CT with its heater</p> <p>(vii.) Tightness of CT secondary connection and shorting of unused CTs</p> <p>(viii.) All valves for their correct opening and close sequence</p> <p>(j) Phase out and vector group test.</p> <p>(k) Ratio test on all taps.</p> <p>(l) Magnetizing current test (HV winding &amp; LV winding).</p> <p>(m) Capacitance and Tan delta measurement of winding</p> <p>(n) Oil Dielectric strength test-the various test on oil shall be conducted prior to filling in main tank at site &amp; prior to energization at site as specified elsewhere in this specification. Oil samples are to be drawn from top &amp; bottom of main tank &amp; cooling system.</p> <p>(o) DGA of oil before commissioning</p> <p>(p) Magnetic balance test</p> <p>(q) Short circuit impedance measurement</p> <p>(r) Test on tank/turret mounted CT's</p> <p>(i.) IR value between secondary winding &amp; earth and between windings</p> <p>(ii.) Secondary resistance</p> <p>(iii.) Polarity</p> <p>(iv.) Ratio test</p> <p>(v.) Magnetization current</p> <p>(s) WTI and OTI setting for alarm/trip, fan start/stop (if applicable) and pump start/stop (if applicable).</p> <p>(t) Final IR Value</p> <p>(i.) HV/E+LV</p> <p>(ii.) LV/E+HV</p> <p>(iii.) HV/LV</p> <p>(u) Continuously observe the transformer operation at no load for 24 hrs. w.r.t. Voltage, no load current, temperature rise and noise.</p> <p>(v) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.</p>			
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