

SECTION -III

TECHNICAL SPECIFICATION FOR PURCHASE OF 8.0 MVA 33/11 KV POWER TRANSFORMERS AGAINST TN-2516.

3.01 SCOPE :

This specification covers the design, manufacture, stage inspection and testing at the manufacturer's works before despatch, supply and delivery at the destination in area of Jaipur Discom, of 33/11KV Power Transformer having ratings of 8.0 MVA for the quantities as mentioned in this tender specification/NIT.

3.02 CLIMATIC CONDITIONS :

Max. ambient air temperature.	50 degree C.
Max. daily average ambient temp.	45 degree C.
Max. yearly weighted ambient temp.	35 degree C.
Min. ambient air temp.	(-) 5 degree C.
Max. humidity.	100%
Average number of thunder storm days per annum.	40
Average annual rain fall.	15 cm to 100 cm.
No. of months during which tropical monsoon conditions prevail.	4 months (June to Sept.)
Maximum wind pressure	195 Kg./Sq.M
Altitude above MSL	Varies from 61 meters to 815 meters
Average number of rainy days per annum.	120 days.

3.03 GENERAL REQUIREMENTS :

The intention of the specification is to provide information for the design of the above mentioned 33/11 KV power transformers to be fully suitable in every respect for the functions designated. It is required that the supplier in accepting the contract agrees to furnish all apparatus, appliance and material whether specifically mentioned or not, but which may be found necessary to complete, perfect, or test any of the herein specified units in compliance with the requirements implied in this specification without extra charges.

3.03.1 All terminal screws, studs, nuts and bolts shall be in accordance with the Indian Standards.

3.03.2 All electrical and mechanical equipments shall be designed and manufactured so that no damage will result from transportation, installation and operation of the equipment under the climatic conditions to which it will be subjected.

3.03.3 All materials used shall conform to this specification and appropriate standards and shall be new in all respects.

3.03.4 Consideration may be given to alternatives which the supplier considers advisable by reason of his own manufacturing requirements and experiences, provided descriptive matter is submitted and the recommended device or arrangement equal to, or superior to that required by the accompanying specification and if the purchaser is convinced of the quality and/or superiority of the equipment.

3.04 STANDARDS :

The power transformers, their accessories and fittings, transformer oil, etc. shall conform to the latest edition of the following standards (as amended upto date) except where specified otherwise in this specification :

IS:5/1961: Colour for ready mixed paints
 IS 2026 (Part 1): 2011 GENERAL (Second Revision);
 IS 2026(Part2):2010 Temperature Rise (First Revision);
 IS 2026 (Part 3): 2009 Insulation Levels, Dielectric Tests and External clearance in Air (Third Revision);
 IS :2026 (Part IV)-1977 Reaffirmed 2011 - Terminal Markings, Tapping and Connections;
 IS 2026 (Part 5):2011 - Ability to withstand short circuit.
 IS:6600/1978:Guide for loading of oil immersed Transformers
 IS:335/1983:New insulation oils for Transformers
 IS:3347(PART-III/Sec-1 & 2): Dimensions of Porcelain parts & Metal parts for Transformer bushing (17.5 KV).
 IS:3637: Gas & Oil operated Relay.
 IS:3639/1966: Fittings & accessories for Transformers
 IS:1866/1978: Code of practice for maintenance & supervision of insulating oil in service.
 IS:9335: Specifications for insulating craft paper.
 IS:1576: Specifications for solid insulating press Boards for electrical purposes.
 IS:104: Ready mixed paint, brushing zinc chromate, painting
 IS:649: Testing of steel sheets and strips for magnetic circuits.
 IS:2362: Determination of water content in oil for porcelain bushing transformers.
 IS:4257: Dimensions for clamping arrangements for bushings.
 IS:6160: Rectangular conductor for electrical machines.
 IS:10028: Selection, Installation and maintenance of transformers
 IS:3401 : Silica gel
 IS:5561: Terminal Connector
 IS:2070: Method of impulse voltage testing

3.04.1 Equipment meeting the requirements of any other authoritative standards which ensures a quality equal to or better than that as per the standards mentioned above, shall also be acceptable. Where the equipment conforms to any other standards, salient points of difference between the standards adopted and the specified standards shall be clearly brought out in the tender.

3.05 DEPARTURE FROM SPECIFICATION :

Should the tenderer wish to depart from the specification in any respect, he should draw attention to such departures, stating the reasons there of under Schedule-VI. Unless this is done the departmental specification will hold good. In the event of this specification and contractor's drawings, specification, table etc. being found to disagree during the execution of the contract, the requirement of this specification shall be held as binding unless the departures have been duly approved in writing by the purchaser.

3.06 TROPICAL TREATMENT :

Under the climatic conditions prevalent at the site, the equipment supplied under the specification will be subjected to operation under the ambient temperature specified under clause 3.02 and very high relative humidity. All equipments shall, therefore be suitably designed and tested for normal life and satisfactory operation under the extreme climatic conditions prevalent at the site and shall be dust and vermin proof. All parts and surfaces which are subjected to corrosion shall be made of such material and shall be provided with such protective finishes as would protect the equipment installed from any injurious effects of excessive humidity. All electrical auxiliary equipment shall be specifically tested for tropical conditions and the materials for this treatment shall be as per modern engineering practices.

3.07 ELECTRICITY RULES :

All work shall be carried out in accordance with the latest edition of the Indian Electricity Act-1910, Electricity supply Act-1948, Electricity Act-2003, Electricity rules-2005 and rules formed there under and as amended from time to time.

3.08 TYPE AND RATING :

- 3.08.1 The transformers shall be of 3 phase, copper wound, core type construction, oil immersed and shall be suitable for outdoor service as step down transformers (At times however these may be required to work under reversal of power also).
- 3.08.2 The tentative requirement of 33/11 KV Power Transformers with off circuit tap changer (OCTC) are given below.

Rating	Tentative quantity
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8.0 MVA with OCTC	15 Nos.

The quantity may however increase/decrease to any extent.

3.08.3 These transformers may be required to run in parallel with existing transformers of the similar capacity. The technical particulars of transformers required are as under:

- i) Maximum continuous rating at reference : 8.0 MVA
ambient temperature specified under clause 3.02
- ii) Frequency : 50 Hz
- iii) No. of phases : 3 phase
- iv) Rated primary Voltage on principal tapping : 33 KV
- v) Rated secondary Voltage : 11 KV
- vi) Winding connections:
 - a) HV side : Delta
 - b) LV side : Star
 - c) Vector group reference : Dyn11
- vii) Type of cooling : ONAN
- viii) Percentage impedance at normal voltage & 75 deg.C average winding temp.(on 20 MVA base) between HV-LV for:-

Tap No.	8.0 MVA	Tolerance
a) Normal tapping (Tap-3)	8.00%	± 10%
b) At max. tapping (+5%)	7.60%	± 15%
c) At min.tapping (-10%)	8.80%	± 15%

However, firm already having valid type tests with the following impedance value on the date of opening of Techno-commercial Bid then same shall also be acceptable:-

Tap No.	8.0	Tolerance
a) Normal tapping (Tap-3)	8.35%	± 10%
b) At max. tapping (+5%)	8.30%	± 15%
c) At min. tapping (-10%):	8.75%	± 15%

- ix) Off circuit tap changer: Having 6 equal steps (7 position) of 2.5% of each, to have voltage variation of +5% to -10% on HV side.
- x) Neutral unbalance current : Not exceeding 2.0%
- xi) Type of terminal : Vertical take off type suitable for ACSR "Panther" conductor on both sides.
- xii) Max.current density in all parts: 8.0 MVA

of HV and LV windings including tapped winding. 2.8Amp./Sq.mm for minimum tap in HV & LV.

xiii) Bushing metal part for HV & LV : M -20 size (copper/brass) bushing.

3.09 EFFICIENCY :

The percentage loading for the max. efficiency shall be clearly stated in the tender at unity power factor as well as 0.8 p.f. lagging.

3.10 INSULATION :

3.10.1 The dielectric strength of the winding, given insulation and the bushings shall conform to the values given in IS:2026(Part.3)/2009 (or its latest amendment) for highest system voltage of 36KV,12KV and shall be suitable for the following impulse test \ power frequency test voltages.

SYSTEM VOL.	H.SYSTEM VOL.	IMPULSE TEST VOL.	PF TEST VOL.
33 KV	36 KV	170 KVp	70 KV
11 KV	12 KV	75 KVp	28 KV

H.V. & L.V. Winding of Transformer shall have uniform insulation.

3.11 TEMPERATURE RISE :

Each transformer shall be capable of operating continuously at their normal rating without exceeding temperature rise limits as specified below :

	Type of cooling.	Temp.rise	External cooling medium (Air)
1. Winding(Temp.rise measured by resistance method)	ONAN	50 degree C.	When the oil circulation is natural non directed
2. Oil (Temp.rise measured by thermometer method)	As above.	45 degree C.	-

The reference temperature conditions for which the transformers shall be designed are as under (as per clause 3.02).

- a) Maximum ambient temperature. : 50 degree C.
- b) Maximum daily average ambient temp. : 45 degree C.
- c) Maximum yearly weighted ambient temperature. : 35 degree C.

The hottest spot temperature shall not exceed 98 degree C when calculated over an annual weighted average ambient temperature of 35 degree C when transformer is loaded to its rated capacity. The transformer shall be capable of being over loaded to 150% of its rating in accordance of IS 6600-1972.

- i) Bushing and its terminal connectors shall have minimum continuous current rating corresponding to 120% rated current of transformer at lowest tap.

3.12 PARALLEL OPERATION :

The transformers covered by this specification are to run in parallel with transformers which are either already installed or are being installed (for same rating) and as such the characteristics of the transformers covered in this specification for the sub station will be identical so as to enable these transformers to run in parallel.

3.13. IMPEDANCES :

Suppliers shall indicate the guaranteed impedances and tolerances taking into account the limits at minimum and maximum tap position so as to fulfill requirements of clause 3.12.

3.14. GUARANTEED LOSSES:

- 3.14.1. The Losses shall not exceed the values given below:

Rating	No load losses in KW	Load losses at 75 deg.C.in KW (At normal tap condition)
8.0 MVA	5.5 KW	40 KW

The above mentioned losses are maximum permissible and there shall not be any plus tolerance above this limit. Design calculations of No-load and load losses along with complete Technical details and factors assumed will be enclosed Along with the GTP in tender documents.

- 3.14.2 In case during testing, the actual loss (es) are found within guaranteed figure, the transformers shall be accepted without any advantage to contractor for lower losses.
- 3.14.3 Measurements of losses shall form part of type test/ routine test.
- 3.14.4 The losses on transformer supplied shall also be guaranteed at the time of pre-commissioning test and transformers having losses exceeding figures mentioned in clause 3.14.1 above shall stand rejected.
- 3.14.5 The supplier shall supply two copies of the Routine test certificate to consignee with each transformer on receipt of despatch instructions.

3.14.6 The supplier shall provide along with the tender the design details of core assembly showing the construction details, core diameter, net/ gross sectional area of the core assembly etc. The information must also be given in respect of volts per turn at principal tap for normal voltage. The loss curves for type/grade of steel laminations being used for the core shall also be provided along with the tender.

3.15 COOLING :

3.15.1 Each transformer shall be provided with ONAN type cooling as specified under the schedule of requirements.

3.15.2 The ONAN cooling of the transformers shall be by natural circulation of air while the circulation of oil shall be effected by natural convection, the maximum oil flow being assured by a method whereby the return flow of cooled oil is made to enter the tank at a level coinciding with the bottom of the hot columns of oil thus avoiding centre heads of cold oil at the bottom of the tank. Out flow shall be arranged to coincide as nearly as possible with the hot oil level at the top of the tank so that the total available difference will be fully employed in circulating the oil round the shortest possible paths.

3.15.3 The windings of the transformers shall be designed to deliver continuously rated MVA corresponding to ONAN cooling.

Radiators shall be provided for cooling purpose. These shall be directly mounted on the tank on both sides in a balanced manner & not on one side only.

3.15.4 The Radiator to be used should be of PSR type for all three type of rating.

3.15.5 For heat dissipation calculation for tank surface at 45 Degree, 500 watt per Sq. meter will be considered and for Radiator, heat dissipation will be worked out as per manufacturing chart provided by manufacturer, firm will enclose the chart.

3.15.6 The cooling arrangement shall consist of detachable radiators which may be directly mounted on the transformers. Connections between the radiators and tank shall be made with flanges provided with gaskets and an indicating sheet valve provided at both connection ends, which can be fastened in either open or closed position.

3.15.7 The radiators shall be so arranged that these can be detached from the tank or bank without disturbing the oil in transformer. These shall be designed to withstand the vacuum and pressure specified for the tank.

3.15.8 Radiators shall be so designed as to be for cleaning & painting to prevent accumulation of water on the outer surface to completely drain oil from the

tank or bank and to ensure against formation of gas pockets when the tank is being filled. All connections between the radiators and tank or bank and between the bank & tank shall be provided with flanges when the particular item is detached. Each radiator shall have a lifting eye, an oil drain and vent at top.

- 3.15.9 The height of the radiator should not be above the transformer tank & All the Radiator shall be so arranged that they can be directly be connected to tank without any bend.
- 3.15.10 The indication regarding state of opening/ closing of radiator valve should be clearly identified through paint-marking.

3.16 TRANSFORMER CORE :

- 3.16.1 The core shall be built up with thin lamination of high grade, non ageing, low loss, high permeability, cold rolled, grain oriented silicon steel specially suitable for transformer core. The particulars of laminated steel to be employed shall be supplied with the tenders along with DC magnetization, B-H and iron loss curves.
- 3.16.2 After being sheared the laminations shall be treated to remove all burrs and shall be re-annealed to remove all residual stresses. At least one side of each lamination shall be coated with a double baked enamel insulation coating which will not deteriorate due to pressure and the action of hot oil. The nature of insulation shall be specified in the tender.
- 3.16.3 Every care shall be exercised in the selection, treatment and handling of core steel to ensure that as far as practicable, the laminations are flat and the finally assembled core is free from distortion.
- 3.16.4 The design of the magnetic circuit shall be such as to avoid discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of flux components at right angles to the plane of the laminations which may cause local heating.
- 3.16.5 The core shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during operation. The core/clamping bolts shall not pass through Core/Yoke and clamping structure shall be so constructed that eddy currents will be minimum.
- 3.16.6 The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer. The core and the coil shall be so fixed in tank that shifting will not occur when the transformer is moved or during a short circuit.
- 3.16.7 The core shall be of high grade cold rolled grain oriented annealed steel laminations, having low loss and good grain properties, coated with hot oil proof insulation, bolted together to the frames firmly to prevent vibration or

noise. All core clamping bolts shall be effectively insulated. The complete design of core must ensure the permanency of the core losses with continuous working of the transformers. The value of the flux density allowed in the designs and grade of laminations used shall be clearly stated in the offer, along with the curves. The transformer core shall be constructed out of the prime class of materials. The transformer core shall be of prime quality CRGO steel. The bidder shall import the core directly or shall purchase directly from the imported and he will furnish the following documents at the time of stage inspection of the transformer:-

- a) Invoice of supplier.
- b) Mill's test certificate.
- c) Packing list.
- d) Bill of landing
- e) Bill of entry certificate by custom.

Description of material, electrical analysis, physical inspection, certificate for surface defects, thickness and width of the material.

3.16.8 FLUX DENSITY :

The flux density in any part of the core built from cold rolled grain oriented steel shall not exceed 15000 (in case of 8.0 MVA) lines per sq. cm. at any tap position necessary to maintain No Load terminal voltage of 11KV on LV side as required. The transformer shall also be suitably designed to withstand upto 10% upward primary voltage variation at normal tap continuously without saturation and excessive heating of the core and windings. Due regard shall also be given to limiting the flux density based on the characteristics of the material used.

The tenderer shall furnish magnetization curve for material indicating max working flux density without saturation. The tenderer shall indicate max. flux density in core/yoke at rated voltage to establish that the max. flux density at 10% over voltage (with reference to nominal voltage) does not cause core saturation.

The design calculations in support of flux density shall be furnished by the tenderer along with drawing of cores steps and calculations of effective cross sectional area of the core. For finding out no load current, average values of all the three limbs and phases should be taken into consideration.

3.17 WINDING :

- 3.17.1 The windings shall be so designed that all coil assemblies of identical voltage ratings shall be inter changeable and field repairs to the windings can be made readily, without special equipment. The coils shall be supported between adjacent sections by insulating spacers and bracers. 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. The windings shall be designed to reduce to a minimum the out of balance forces in the transformer at all ratios.

- 3.17.2 The insulation of the coils shall be suitable to develop the full electrical strength of the windings. All materials used in the insulation and assembly of the windings shall be insoluble, non catalytic, and chemically inactive in the hot transformer oil, and shall not soften or otherwise be adversely effected under the operating conditions.
- 3.17.3 All threaded connections shall be provided with locking facilities. All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.
- 3.17.4 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. The electrolytic copper conductor 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 welded or braced except compression type which may be used for terminal connections. Bolted connection may be used at the bushings and at terminal board with suitable locking device. The drying out procedure of the core coil assembly shall be indicated in the tender.

3.18 FAULT WITHSTANDING CAPACITY OF WINDINGS :

All the windings shall be suitably designed to withstand short time rating for not less than 2 seconds by feeding the fault level of 1000 MVA on HV side, 750 MVA on 11 KV side respectively from both ends and considering the severe most form of system faults that can arise in service. Tenderer(s) should furnish the detailed calculations for thermal as well as dynamic ability of windings to withstand short circuits as prescribed above, failing which their quotations are likely to be ignored. The max. temp. attained for short time rating shall not exceed 250 degree C.

3.19 INSULATING OIL :

- 3.19.1 The oil for first filling shall be supplied with each transformer. The oil shall be EHV grade-I and shall comply IS:335/1993 latest version & amendment.
- 3.19.2 Particular attention shall be paid to deliver the oil for topping up free from moisture having uniform quality through out in the non-returnable new steel drums.
- 3.19.3 The quantity of oil for first filling of each transformer shall be stated in the tender . Quantity of oil required for filling of conservator and radiators shall be stated in the guaranteed technical particulars.

3.19.4 The transformer oil purchased from M/s. Savita Chemical, M/s. Apar, M/s. Raj Lubrichem, M/s. Raj Petroleum, M/s Tashkant, M/s Sharavathy, M/s Rinki/M/s Madras Petrochem and M/s. Lubrichem, M/s Columbia shall only be supplied. Invoice and test certificates of manufacturer of transformer oil shall have to be furnished as and when desired by the Nigam.

3.20 TANK :

3.20.1 The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate plate thickness. The tank and the cover shall be of welded construction. All seams shall be welded and where practicable they shall be double welded. The transformer tank shall have sufficient strength to withstand without permanent distortion. The punching on all 4 sides of Power Transformer tank with letter size of 10x5mm will be carried out. The details to be punched are as under:-

- i) TN No.
- ii Serial No.
- i) Make
- ii) Rating.

The thickness of tank sheet shall be as under:-

S.No.	Dimensions of	8.0 MVA
i.	Top Cover	10mm
ii.	Side Cover	8mm
iii.	Bottom Cover	10mm

3.20.2 At least one manhole/inspection cover with a welded flange and a bolted cover shall be provided on the tank cover. The manhole shall be of a sufficient size to afford easy access to the lower ends of the bushings, terminals etc.

3.20.3 All bolted connections to the tank shall be fitted with suitable oil tight gaskets which shall give satisfactory service under the operating conditions. Special attention shall be given to the methods of making the hot oil tight joints between the tank and the cover as also between the cover and the bushing and all other outlets to ensure that the joints can be remade satisfactorily and with ease , with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over compression. Suitable guides shall be provided for positioning the various parts during assembly or dismantling.

3.20.4 Lifting eyes or lugs shall be provided on all the parts of the transformers requiring independent handling during assembly or dismantling. In addition the transformer tank shall be provided with lifting lugs and bolts properly secured to the sides of the tank, for lifting the transformer either by cranes or by jacks.

- 3.20.5.1 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. The tank shall be provided with two suitable copper alloy, lugs for the purpose of groundings.
- 3.20.5.2 The main body of the tank shall have sufficient strength to withstand and without permanent distortion
- i) A vacuum of 760mm of mercury.
 - ii) Continuous internal gas pressure of 0.7 atmosphere above atmosphere pressure with oil at operating level i.e. the transformer tank should be able to withstand 100% vacuum and also one atmosphere pressure above atmosphere internal pressure.
- 3.20.5.3 The tank cover shall be belled to the tank and the transformer design shall be such that at the tank will not split between the lowest and upper cooler connections.
- 3.20.5.4 Each tank shall be provided with the following
- a) Lifting lugs suitable for lifting the transformer complete with oil accessories lifted with oil by cranes.
 - b) A minimum of four jacking lugs, in accessible position to enable the transformers complete with oil to be raised or lowered using hydraulic or screw jacks.

The minimum height of jacking lugs above base shall be

- i) Transformer above 10 tonnes weight : 500 mm
- ii) Transformer upto and including 10 tons weight: 300 mm.

Horizontal plates with 50mm dia drew holes drilled therein shall be fitted adjacent to each corner of the rectangular tank at more than 750 mm from the base to permit haulage in any direction. On the rounded tanks drew holes shall be located on the diagonals of the rectangular formed by the overall boundaries of the tank.

- 3.20.6 Each tank cover shall be adequate strength and shall not distort when lifted. Inspection opening shall be provided to give easy access to lower ends of bushings, terminals etc. for changing ratio or winding connection or testing to each connections. These shall be of adequate to size not less than 450mm x 350mm
- 3.20.7 Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space should be provided between the cores and winding and the bottom of tank for collection of any sediment.
- 3.20.7.1 The base channel for transformer shall be 250 x 6 x 82 mm.

3.20.7.2 Prismatic oil level gauge indicator on transformer tank shall be provided to indicate level of oil in Transformer tank at a suitable place on LV bushing side.

3.21 UNDER CARRIAGE :

- 3.21.1 The transformer tank shall be supported on a structural steel base.
- 3.21.2 Pulling eyes shall be provided to facilitate moving the transformer and they shall be suitably braced in a vertical direction so that bending does not occur when the pull has a vertical component.

3.22 OFF LOAD TAP CHANGER MECHANISM:

3.22.1 The off circuit tap changer shall be of high quality and robust in construction. It shall be located at a convenient position so that it can be operated from ground level by a standing operator. The handle of OCTC shall be provided with a locking arrangement, thus enabling the OCTC to be locked in position. Arrangement for indicating of tap position shall also be provided. It shall be suitable for local manual operations. The tap changer shall be capable of permitting parallel operation with other transformer of the same type. When one unit is in parallel with another of same type as mentioned in clause No.3.12 under normal condition, the tap changer shall not become out of step. The OFF Load Tap Changer should be of following makes only:-

- i) M/s Paragone Associates, Thane.
- ii) M/s Always, Bangalore.

3.22.2 The OCTC shall be capable of carrying rated MVA on all taps. The breaking capacity of the OCTC shall be compatible with the highest system voltage and current based on maximum over loading permissible under IS:6600 -1972 (150% of rated value). The voltage rating for each step shall be 2.5% on HV side. However, each step of OCTC shall withstand voltage not less than 115% of rated step voltage. The rated through current of OCTC at this voltage will not be less than 150% of rated current of HV winding at lowest tap.

3.23 CONSERVATOR:

- 3.23.1. Oil preserving equipment shall be conventional conservator tank type. The minimum oil level in the conservator tank shall not be below the level of the bushing flanges.
- 3.23.2 Oil conservator tank shall be located well clear of the bare connection of the transformer terminals. The conservator tank shall have adequate capacity between highest and lowest permissible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from min. amb. temperature to highest oil temp. as per desired.

- 3.23.3 The total volume of the conservator shall be min. 10% of the total quantity of oil in transformer. The inside diameter of the pipe connecting the conservator to the main tank shall be min.50mm and it should be projected into the conservator in such a way that its end is projected 30mm above the bottom so as to create sump for collection of impurities. The min. oil level should be above the sump level.
- 3.23.4 A conservator complete with sump and drain valve shall be provided in such a position as not to obstruct the electrical connections to the transformer, having a capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature shall be with 0 Deg. C to 90 Deg.C. The minimum indicated oil level shall be with the feed pipe from the tank covered with not less than 15mm depth of oil and the indicated range of oil level shall be minimum to maximum.
- 3.23.5 The oil connection from transformer tank to the conservator vessel shall be arrange at a rising angle of 3 Deg. to 9 Deg. to the horizontal up to gas and oil actuated relay and shall consist of 50mm inside diameter pipe.
- 3.23.6 Each conservator vessel shall be fitted with a breather in which silica gel is the dehydrating agent and designed so that
- The passage of air is through silica gel.
 - The external atmosphere is continuously in contact with silica gel.
 - The moisture absorption indicated by a change in colour of the tinted crystals can be observed from distance.
 - Breathers shall be mounted at approx. 1400 mm above ground level.

3.24 TEMPERATURE INDICATING DEVICE:

- 3.24.1 The tripping contacts of above temperature indicators shall be adjustable to close between 60 Deg.C and 120 Deg.C and alarm, contacts to close between 50 Deg. C & 10 Deg.C and both shall reopen when the temperature has fallen by above 10 Deg.C.

3.25 MARSHALLING BOX OR KIOSK

- 3.25.1 A sheet vermin proof well ventilated and weather proof marshalling box of the suitable construction shall be provided for the transformer ancillary apparatus. The box shall have domed or sloping roofs and the interior and exterior painting shall be in accordance with specification.
- 3.25.2 The marshalling box, wherever provided shall accommodate the following equipments alternatively weather proof instruments can be mounted outdoor.
- Temperature indicators.
 - Terminal boards and gland plates for incoming and out going cables.
- 3.25.3 All the above equipments except (b) shall be mounted on panels and back of panel wiring shall be used for inter connection.

- 3.25.4 The temperature indicators shall be so mounted that the dials are not more than 1600 mm from ground level and the door (s) are of adequate size.
- 3.25.5 To prevent internal condition an approved type of metal clad heater shall be provided controlled by a suitable switch. Ventilation louvers shall be provided.
- 3.25.6 All incoming cables shall enter the kiosk from the bottom and the gland plate shall be not less than 450mm from the base of box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

3.26 DIAGRAM AND RATING PLATE

Each transformer shall be provided with a non-detachable brass or stainless steel plate mentioning complete information as given in clause 7 of latest version of IS 2026 (Part 1): 2011 and diagram of winding connection and taps shall be provided. The property of respective Discom and specification no. shall be engraved on the plate Guaranteed values of No-Load loss and Load loss at 75 Deg.C without and plus tolerance along with measured values as well as temperature rise figures should also be inscribed on the diagram and rating plates.

3.27 BUSHINGS :

- 3.27.1 All main winding and neutral leads for 33/11 KV transformers shall be brought out through outdoor type bushings. The electrical characteristics of bushing shall be in accordance with IEC-137 as well as IS-3347/8603 and IS-2099. The bushing shall be rated for highest voltage and current rating of the respective windings. The current ratings of bushing shall be at least 150% of the rated current at minimum tap to permit overloading.
- 3.27.2. The bushings shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings and between the bushings and ground parts. The spacing between the bushings shall be adequate to utilize full flashover strength preventing flashover between the phases or between phase and ground parts under all conditions of operation. The creepage distance of bushing shall not be less than 25 mm per KV.
- 3.27.3. All bushings shall be equipped with suitable solder less terminals of approved type. The type and size shall be specified in the tender. All external current carrying contact surfaces shall be placed adequately.
- 3.27.4. Bushings of identical voltage ratings shall be interchangeable .

- 3.27.5 Special adjustable arcing horns shall be provided with HV & LV bushings. Each bushings shall be so coordinated with the transformer insulation that all flashover occur outside the tank.
- 3.27.6. All porcelain used in bushings shall be of the wet process homogeneous impervious to moisture and free from cavities or other flaws and throughout vitrified and smoothly glazed. The glazing shall be of the uniform colour and free from blisters, burns and other defects. All bushings shall have puncture strength greater than the dry flashover voltage.
- 3.27.7. The creepage distance of 33 KV bushing surfaces shall not be less than 900 mm & for 11 KV shall not be less than 300 mm.
- 3.27.8. Terminal conductor of HV & LV shall be vertical take off type and suitable for ACSR PANTHER.

3.28 (A) SUPPRESSION OF HARMONICS:

The transformer shall be designed with particular attention to the suppression of harmonics voltages especially in the third & fifth harmonics so as to eliminate wave form distortion and any possibility of high frequency disturbances.

3.28 (B) MARKING

All transformers shall have the marking in paint on the body for identification as per Indian Standards or as instructed by purchaser.

3.29 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 in the outline drawing in all the views showing their position of Transformer track also.

3.30. FITTINGS AND ACCESSORIES :

- 3.30.1. Each transformer shall be provided with the following fitting and accessories in accordance as specified in IS:2026:
- (i) Oil Temperature Indicator (OTI)
The transformer shall be provided with one 150 mm dial type, oil Temperature Indicator for indicating top oil temperature. The indicator shall have adjustable electrically independent ungrounded alarm and trip contacts with **Micro Switches** and maximum reading pointer. The temperature-sensing element shall be suitably located in a pocket on the top of the transformer and shall be connected to the oil temperature indicator by means of capillary tubing protected with a metal sheath. The accuracy class of the OTI shall be +/- 1%

Suitable contacts shall also be provided for remote indication of oil temperature.

(ii) Winding Temperature Indicator:-

The Transformer shall also be provided with a device for indicating the temperature of winding (HV and LV separately). It shall comprise the following:-

- a) Temperature sensing element suitably located on the top cover of the transformer.
- b) 150 mm dial, local indicating instrument with maximum reading pointer, mounted in the cooler control cabinet and two adjustable electrically independent ungrounded contacts with **Micro switches** (beside that required for control of cooling equipment). The tripping contacts shall be adjustable to close between 60 Deg. C and 120 Deg.C and alarm contacts to close between 50 Deg. C and 100 Deg. C and both shall reopen when the temperature has fallen by a desired amount between 5 Deg. C and 50 Deg.C. All contacts shall be adjustable on a scale. They shall be accessible on removal of the cover and it shall be possible to check the operation of the contacts and associated equipments. Connections from the contacts shall be brought down to the terminal Block, placed inside the marshalling box. The accuracy class of the WTI shall be +/- 1%.

c) Calibration device:

Suitable contacts shall also be provided for remote indication of oil temperature.

- iii) One filter valve located at the top of the tank on the LV side. The opening of this valve shall be baffled to prevent aeration of oil.
- iv) One drain cum filter valve with sampling valve for main tank with plug or core plate of suitable size with locking arrangement located near the bottom of the tank on the HV side of the transformer but diagonally opposite to LV side.

The above filter/drain valves shall be located on non-bushing side of the Transformer. It should be placed on bottom side of tap changer and on top of the diagonally opposite side.

- v) Air release device. It shall be of adequate capacity and shall be provided to release the trapped air during/after filling of the oil.
- vi) Explosion vent (Pressure release device).
- vii) One No. double float Buchholz relay shall be provided with alarm and tripping contacts to detect accumulation of gas and sudden changes of

oil pressure, complete with shut-off valves on either side and flange coupling to permit easy removal without lowering oil level in the main tank, a bleed valve for gas venting and a test valve. The Buchholz relay shall be of best indigenous make having ISI certification. Buchholz relay must be made of cast iron/ aluminum.

- viii) Detachable radiators complete with shut off valves as necessary for cooling as per clause 3.15.
- ix) An oil conservator having detachable end plates, with following provisions.
 - a) Magnetic type oil level gauge:-
The conservator shall be fitted with one magnetic oil level gauge with nitro-phyll float having:
 - i) Dial with minimum, maximum & normal (at 30 Deg.C) Oil level marking and a pointer.
 - ii) Low Oil level alarm contacts of 0.5 Amp. 110V/ 30V DC.
 - b) One oil filling hole with plug and drain valve on the conservator.
 - c) one prismatic oil level gauge having painted/embossed marking as min., normal, and max. oil level.
 - d) Silica gel breather with Oil seal and Dehydrating agent.
 - x) Eye bolts and lugs on all parts for ease of handling.
- xi) Two grounding terminals as per clause No.3.20.5.
- xii) Rating, Diagram and terminal marking plates :

 Rating, diagram and terminal marking plates of stainless steel or brass for transformers and other accessories giving details as per IS:2026 shall be provided. Value of full wave (1.2/50 micro second) impulse level, short circuit current. its duration, weights of all important items, Impedances, loss values at normal/extreme taps and Postal address. Performance guarantee clause 3.43 shall also be indicated.
- xiii) All transformers shall have the marking in paint on the body for identification as per Indian Standard or as instructed by purchaser. Further, the following should be embossed at the top of the tank cover.
 - a) Sr. No. of the transformer.
 - b) The details of P.O. i.e. Order No. & Date.
 - c) Name of the firm.
 - d) Month and year of manufacture.

- xiv) Bimetallic terminal connectors suitable for "ACSR Panther" for HV and LV bushing and earthing clamps should be as per IS:5561.
- xv) Suitable weather proof cubicles (Marshalling box) for housing the local control equipment for fans, terminal blocks, for current transformer secondary and for mounting winding temperature indicators and oil temperature indicator as (i) and (ii) above.
- xvi) HV and LV bushings with adjustable arcing horns 3 Nos. and 4 Nos. respectively.
- xvii) Triple pole type off load tap changer as per cl.no.3.22
- xviii) Skids :
- xix) Hauling Eyes : Hauling eyes shall be provided on all the four sides of the transformer base.
- xx) Jacking Pads :Four, sturdy jacking pads shall be provided for lifting complete transformer. Lifting height and safe capacity of jacks shall be specified in Bid.
- xxi) Lifting Lugs : Two sets of forged or tested mild steel plate lifting lugs, one set for top cover, core and coil assembly and other set of complete transformer shall be provided. Lifting lugs shall be of adequate strength and size for attaching steel rope slings. Should lugs for lifting complete transformer be located on the base, sling guides shall be provided on cover.
- xxii) Inspection Covers :One inspection covers of sufficient size for access to the interior of the tank shall be provided on the cover. The inspection covers shall be provided with suitable lifting arrangements.

All type of valves shall be of gun metal except radiator shut off valves which may be of cast iron/steel. All valves shall be provided either with blind companion flanges or with pipe plugs for protection.

The makes of fitting & accessories will be as under:-

S.No.	Fitting & Accessories	Makes
1	Buchholz relay	Atvus, Sukrat, Suvidha.
2	Winding Temperature Indicator/ Oil Temperature Indicator	OTI/WTI Model integrated RTD Scheme for ROTI/RWTI with remote indicator of M/s Preci Measure Control Pvt. Ltd./Thermal System, Belltek
3	Magnetic type oil level gauge	Atvus, Sukrat, Instrument & Control
4	Radiator Valve	Hari Industries, Atvus, Vinayak, Vimal Techno, Petsun, Kailash
5	Filter valve & Drain valve	Zolote, L&T, G.G., Leader, Uttam, Punjab Metal (ELMS mark), Leader, Hari Ind., Newman Ind.

Radiator valves shall have clear & distinct OPEN/CLOSE indication embossed/ casted as well as painted on the both sides of main body of valve. Radiator valve should have zero leakage with cap remove.

The new makes of fitting & accessories may be accepted with the approval of CE(MM), JVVNL, Jaipur on the basis of ISI approval certificate/ tests reports from any NABL accredited Lab./Govt. Lab./ performance report from utilities.

3.30.2 LOCKING ARRANGEMENT

To curb the theft of oil from power transformers, the following parts are either required to be blocked/ plugged or provided under provisions of locking:-

S. No.	Transformer Part	Mode of blocking
1.	Conservator drain plug/ valve	Cap shall be provided as per drawing `b`.
2.	Both oil filtration valves	Cap shall be provided as per drawing `a`.
3.	Transformer Oil drain valve.	Cap shall be provided as per drawing `a`.
4.	Radiator drain plug (Bottom)	Cap shall be provided as per drawing `c`.
5.	Radiator Air release plug (Top)	Locking on top for which provision is to be provided by firm and informed to SE(MM) for approval.
6.	Conservator filling hole.	To provide locking arrangement for which provision is to be provided by firm and informed to SE(MM) for approval.
7.	Air release plug on top cover.	To provide wire mesh cap arrangement so that only air can be released.

Drawing is enclosed.

3.31 FACTORY ASSEMBLY AND TESTS :

- 3.31.1 The transformer shall be completely assembled and tested at the Factory. It shall be at the option of the purchaser to send a representative(s) for carrying out stage inspection and various tests during actual manufacture and assembly of transformer(s) so as to satisfy regarding the quality of product and material being used.
- 3.31.2 All Type and Routine tests as per specification are to be conducted and no deviation in respect of conducting these tests will be acceptable. No extra charges for these tests will be paid. Test charges shall be part of cost of the equipment. Even if charges for such test are indicated elsewhere in the tender, it will be presumed that these tests will be conducted free of cost. If purchaser selects to send a representative, all tests shall be carried out in his presence.

3.32 STAGE INSPECTION :

Before carrying out the stage inspection the following documents shall be given to Inspecting Officer(s) for verification:

- a) Invoice of supplier
- b) Mill's test certificate
- c) Packing list
- d) Bill of landing
- e) Bill of entry certificate by custom
- f) description of material, electrical analysis, physical inspection, certificate for surface defects, thickness and width of the material.

The purchaser's representative may carry out stage inspection of the transformers during manufacturing/ assembling stage. The purchaser shall have absolute right to reject the raw material/ component/ sub assemblies or complete equipment not found to be conforming to the requirement of the specification or being of poor quality/ workmanship. The stage inspection will particularly include following tests/ check besides the general routine tests to be conducted during manufacturing stages as per manufacturer's standard practice.

- a) Physical inspection/checking of winding insulating material, core material and other accessories/fitting of transformer.
- b) Measurement of core area, cross sectional area of winding(s), number of turns in each winding.
- c) Verification of HV and LV Coils, conductor size, I.D., O.D., Axial Length, Weight, Insulation covering etc.
- d) Measurement of thickness of tank plates (Bottom and sides) and to conduct pressure & vacuum tests as per CBIP manual for transformer tests to ensure the adequate strength of tank plates.
- e) Sample testing of core material for checking specific loss, magnetization characteristics (i.e. B.H. Curve plot) and thickness.
- f) Visual and dimensional check during assembly stage of core.
- g) high voltage test(2KV,50Hz for one minute) between all core-bolts if provided and agreed to frame bars/fish plates etc. and ferro-magnetic steel of core.
- h) Check on completed core for measurement iron loss and check for any hot spot by exciting the core so as to induced the design values flux density.

- i) Check for proper provisions of spacers and bracings to arrest the movement of core and winding assembly inside the tank.
- j) Check complete transformer against approved outline drawing, provision for all fittings, finish oil level etc.

The purchaser at his option may collect the sample of the following raw material/ component for independent testing:

a)	CRGO Laminations	One specimen sheet of 300-500mm length and 50-75mm width (for each lot).
b)	HV winding wire	1250 mm length specimen for each type
c)	LV winding wire	1250 mm length specimen for each type
d)	Transformer oil	2 samples of 5 litres each.

To facilitate stage inspection, the supplier should intimate complete schedule of manufacturing programme of the transformers at least 15 days in advance to the SE (MM) of respective Discom. At least 50% of the transformers shall be offered in the shape of finished core-coil assembly. (The inspecting Officer during the course of stage inspection shall seal these core-coil assemblies for purpose of identification of the core coil assembly. The manufacturing programme shall not be interrupted in case purchaser's representative does not reach within seven days of the date of intimation.

3.33 ROUTINE TESTS :

Each completed transformer shall be subjected to following routine tests as per IS:2026 Part.I & III (latest amendment). No extra charges for any of the tests shall be paid. No deviation shall be acceptable. If the supplier desires, he may not fix radiators on transformers (other than the one which is to be type tested) during routine testing. However in that case, radiator manufacturer's test certificate shall be furnished for reference of inspecting officer with undertaking that supplier shall be responsible for proper alignment/fixing of radiator on transformer at site.

- a) Measurement of resistance of each winding.
- b) Measurement of turns ratio between HV-LV windings at each tap.
- c) Checking of polarity and phase relation-ships for each winding.
- d) Measurement of no load loss and no load current .
- e) Positive phase sequence impedance/short circuit impedance between HV-LV windings on minimum ,maximum and normal taps.
- f) Separate source voltage withstand test.
- g) Test certificate along with invoice of original manufacture of transformer oil as per IS:335 (latest amended) and to meet the requirement of EHV grade oil shall be furnished and provided to Nigam's representative during inspection & shall be attached with Inspection Report. However, EHV Grade Transformer Oil shall be subject to BDV test.

- h) Induced over voltage withstand test.
- i) Measurement of neutral unbalance current.
- j) Regulation at rated load at unity, 0.90 and 0.80 lagging power factor.
- k) Load losses measured at rated frequency by applying voltage sufficient to produce the rated relevant current in one winding with the other winding short circuited.
- l) Measurement of insulation resistance.
- m) The total losses shall comprise of the No Load Losses, load losses at rated output duly converted at 75 degree 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 winding.
- n) Routine dielectric tests as per IS:2026 (Part.I & III).
Sticker/ Poly-carbonate seals will be provided on locking chamber of Top filter wheel valve & Bottom drain/sampling wheel valve by Inspecting Officers and details of seals will be mentioned in their inspection report.

3.34 TYPE TEST CERTIFICATE WITH TENDER :

The detailed legible test certificates for the similar transformers manufactured in the recent past for all the type tests mentioned in the IS:2026 (amended upto date) shall be furnished along with the tender in absence of which tender is liable for rejection. However, the requirement of furnishing of valid type test certificate along with tender shall not be insisted from those bidders who are considered to be meeting the type test criteria as per Qualifying Requirement Schedule-III-A.

- 3.34.1 The firm (s) having authenticated type tests certificates viz. (a) Impulse test with chopped wave test, (b) Thermal and dynamic ability to withstand short circuit test and (c) Temperature Rise Test, got conducted from a Govt. approved/ Govt. Recognized/ NABL Accredited laboratory/ ILAC i.e. International laboratory Accreditation Corporation (in case of foreign laboratory) of the offered rating/ type and design (having same losses as specified by them under GTP), not older than **Five** years as on date of opening of the tender from the date of conducting type tests shall be considered as meeting the type test criteria and such firm(s) shall not be insisted for arranging fresh type tests. The type test certificate by in house laboratory of bidding firms, even if it is Govt. approved/ Govt. Recognized/ NABL Accredited / ILAC Accredited laboratory shall not be accepted, in case of their own bid. This will not apply if bidding firm is Govt. Company / Public Sector Undertaking. The bidder should furnish documentary evidence in support of laboratory whose type test certificates have been furnished, that the said laboratory is a Govt. approved/ Govt. Recognized/ NABL Accredited laboratory/ ILAC Accredited. The bids of only those bidders will be considered to be meeting the type test criteria who will furnish complete valid type test certificates with the bid as per above provisions.

The above Type test shall be carried out by the firm at the Testing house as specified above. Type test carried out by above testing house at firm's works will not be considered.

- 3.34.2 In case firm(s) are not having type test reports in respect of offered rating/ type and design (not having same losses as specified in GTP) shall have to arrange type tests for i) Impulse Voltage Withstand Test, ii) Short Circuit Thermal & Dynamic Ability Test and iii) Temperature Rise Test on one unit free of cost.

Bidder should also furnish the test certificates of bushing from original manufacturer of bushings along with the tender. The detailed certified drawing of such transformers shall also accompany the tender document indicating clearly that the transformers offered are of same tested design.

3.35 TYPE TESTS :

One transformer (Complete in all respects) of each rating, selected at random, out of the first lot of minimum two numbers (of respective rating) shall be subjected to the following type tests. No extra charges shall be paid for these tests. Type tested unit shall be guaranteed for satisfactory normal use. The sample for type test at random shall be selected by purchaser's representative. The tests shall be arranged by transformer manufacturer at any of the testing house as mentioned in clause No. 3.34 at their own cost. All the testing shall be witnessed by the representative of the purchaser for which programme(s) indicating date and place of type tests shall be intimated in advance enabling purchaser to depute his representative. The original preliminary/provisional type test results shall have to be forwarded by testing house directly to the purchaser in sealed cover for consideration/approval of tests as having been satisfactorily withstood by the transformer. Detailed reports shall also be forwarded at the earliest.

- a) Dielectric test : The lightning impulse test along with chopped wave test shall be made in accordance with IS:2026 (Part.3), 2009 (latest amended) on complete transformer i.e. on all the three limbs of the transformer of both HV and LV. The tests on three phases of high voltage winding of transformers shall be performed on extreme tapings and the principal tapping respectively i.e. one terminal will be with minimum tap other with maximum and third with principal tap position.
- b) Short circuit test, Thermal & Dynamic ability test shall be conducted as per IS:2026 (Part.1)/2011 (Latest amended). No load losses and load losses during the short circuit test at normal and minimum tap shall be measured and mentioned in the test report. These losses shall be final for acceptance of the transformers. The un-tanking of type tested Transformer at testing house shall also be done mandatorily in presence of representative of purchaser.
- c) Temperature rise test : It shall be conducted as per IS 2026 (Part2):2010 at min tap by feeding max total guaranteed losses relevant to min. tap.
- d) Leakage/pressure on completely assembled transformer as per CBIP specification. This test will be carried out at firm's work.

No supplies shall be accepted without successful type testing of selected transformer. However, in case some supplies are accepted prior to getting the type tests on selected transformer conducted, and if the transformer fails to withstand such type tests, the supplier shall have to replace the supplies already made and no further transformers shall be accepted based on such design. However the purchaser at his option may accept the transformers already supplied with double the normal guarantee period and the bank guarantee shall have to be extended accordingly.

- 3.36** The requirement of arranging Short Circuit Test (both Thermal & Dynamic Ability), Impulse Voltage Withstand Test and Temperature Rise Test shall however not be insisted on the suppliers who have arranged these type Tests within last **Five** years as on the date of opening of this tender specification from the date of conducting type tests on similar design(having same losses as specified).

3.37 CHALLENGE CLAUSE

The other manufacturer who have either participated in the instant tender enquiry can request challenge testing for tests covered in this clause based on specification & losses. The challenger would request for testing with testing fee. The cost of to & fro transportations of all transformer tested under the provision of this clause along with loading & unloading and transit insurance at actual shall be borne by Challenger firm. The challenge testing fees shall be at least three times the cost of testing. The challenger would have the opportunity to select the sample from the store. The party challenged ,challenger & the utility could witness the challenge testing. The challenge testing would cover the

- i. Measurement of Magnetizing current
- ii. No Load Losses test
- iii. Load Losses test
- iv. Temperature Rise Test.

The challenge test could be conducted at any Govt. / NABL accredited Lab. like ERDA / CPRI. If the values are within limits as per specification including tolerance allowed in CTL, the products gets confirm else not confirmed. If the product is not confirmed, the manufacturer will pay the challenge fee and challenger would get the fee refunded. However, as a redressal system, the manufacturer (challenged firm) would be allowed to ask for fresh testing of two more samples from the store and the same be tested in a NABL/Govt. laboratory in presence of party challenged, challenger & the utility. If any one or both sample does not confirm the tests then the product is said to have failed the test. In such cases, the manufacturer (challenged firm) will be declared as unsuccessful manufacturer for the said product and balance supply shall not be availed and the balance order shall be cancelled with levy of maximum penalty. Firm shall also be debarred for one year or participating against next tender for that rating, whichever is later. The transformers already supplied (including tested in challenge testing) shall be accepted with the following conditions:

- i) Guarantee period of the supplied Transformers shall be increased by double the normal guarantee period.
- ii) Bank guarantee shall be extended to cover the additional guarantee period.

3.38 TESTS AT SITE :

After erection at site all transformer(s) shall be subjected to the following tests:

- i) Insulation resistance test.
- ii) Ratio and polarity test.
- iii) Dielectric test on oil.

In case the equipment is not found as per the requirements of the purchase order, all expenses incurred during site testing will be to the tenderer's account and the material shall be replaced by him at site, free of cost.

3.39 FURTHER TESTS :

The purchaser reserves the right of having other reasonable tests carried out at his own expenses either before despatch or at site to ensure that the transformer complies with the requirements of this specification.

3.40 TEST REPORTS :

After all tests have been completed, seven certified copies of each test report shall be furnished. Each report shall supply the following information:-

- i) Complete identification data including serial number of the transformer.
- ii) Method of application, where applied duration and interpretation of results for each tests.
- iii) Temperature data corrected to 75 degree C including ambient temperature.

3.41 FREQUENCY AND SYSTEM VOLTAGE :

The transformer shall be suitable for continuous operation with a frequency variation of plus minus 3% from normal of 50 cycles per second without exceeding the specified temperature rise. The highest system rated voltage shall be 145 KV. However the flux density requirements shall be as per clause 3.16.8.

3.42 DRAWINGS :

3.42.1 The drawings, calculation and the technical literature list below shall be submitted by each tenderer with the tender.

- i) General outline drawings showing front, side elevations and plan views of the transformer and all accessories and external features with detailed dimensions, net and shipping weight, crane lift for unloading and for erection/ removal of bushing, size of lifting and pulling eyes, HV & LV terminal clearances, live terminal to ground clearances, quantity of insulating oil etc.
- ii) Assembly drawings of HV and LV bushing.

- iii) Wiring diagrams and drawings showing temperature indicator/recorder circuits alarm circuit.
- iv) Drawing showing typical sectional views of the winding with details of insulation, cooling circuit method of coil bracing and core construction along with flux density & current density calculations.

Core assembly drawing showing complete constructional details and flux density calculations.
- v) Detailed drawings showing loading for the design of foundations for transformers.
- vi) Drawings showing position of variable fittings.
- vii) Drawings showing construction and mounting details of marshalling boxes.
- viii) Drawing showing loadings and centre of gravity of transformer.
- ix) Drawings giving details of name plate, terminal marking and connection diagrams.
- x) Drawings of bimetallic terminal connectors with test certificates within 15 days of unless otherwise specified of order.

Thermal/dynamic calculations to provide transformers capability to withstand short circuit under worst conditions.

- 3.42.2 In the event of an order the supplier shall also supply 3 sets of the above drawings/documents listed at 3.42.1, based on final design to the purchaser for approval within 15 days of receipt of order unless otherwise specified. The purchaser will review the drawings and return one copy to the contractor within 15 calendar days after their receipt.
- 3.42.3 Each drawing returned by the purchaser will be stamped (a) "Generally Approved" or (b) "Generally approved subject to observation". In case of (a), no further resubmission of drawings shall be required for purchaser's approval. In case of (b), the contractor shall correct his original drawings to conform to the comments made by the purchaser and resubmit in the same manner as stated above within two weeks after the receipt of the marked up print by him.
- 3.42.4 Should the supplier wish to resubmit a revision or change for approval such resubmission shall be made in three prints. The contractor shall

also supply prints of each approved revised drawing(s) within 15 days of receiving the approved revised drawing(s).

- 3.42.5 Any shop work done prior to approval of the drawing shall be at the supplier's risk. The supplier shall make all such changes in the design as are considered necessary to make the equipment conform to the provisions and intent of this specification without any additional cost to the purchaser.
- 3.42.6 Each drawing shall be identified by a drawings number and each subsequent resubmission/ revision or addition to the drawings or procedure. All drawings shall be thoroughly checked for accuracy and completeness and signed or initialed by a responsible officer of the contractor.
- 3.42.7 Checking and approval of the drawings by the purchaser is for the benefit of the supplier and shall not relieve the supplier of full responsibility for ensuring correct interpretation of design drawings and specifications or for completeness and accuracy of the shop drawings and relevant specifications.
- 3.42.8 The supplier shall report and incorporate only after purchaser's approval, all deviations, concessions, omissions changes etc. occurring through the manufacturing assembly and testing phases and submit a complete set of drawings in reproducible forms within 30 days of the date of the equipment is considered to be placed in satisfactory operating condition.
- 3.42.9 All drawings shall be in English language and dimensions in metric system.

3.43 PERFORMANCE GUARANTEE :

Performance guarantee of transformer shall be for the period of **36** (Thirty Six) months from the date of receipt in stores of purchaser of such transformer complete in all respect. The period during which transformer remained defective/ failed will not be accounted in this performance guarantee period. The period of defective will be reckoned from the date of first intimation to date of delivery after repair.

3.44 REPAIR GUARANTEE :

The transformer got damaged/failed during the guarantee period due to manufacturing defects or poor workmanship shall be repaired by the supplier within 60 days period from the date of information to the supplier without any liability on the purchaser. In case the transformer warrants return to the firms works the same can be done as per clause 1.32.6 of GCC. The failed Power

Transformers shall be mandatorily lifted by the firm from site/ store wherever same is lying failed/ defective.

The GP failed transformer after due repair & inspection by the purchaser, will be routed through Nigam's in-house Testing Laboratory (CTL) and deliver to the store where CTL exists. Mandatory Testing as mentioned at Clause No. 3.46 (B) shall be carried out and transformer will be accepted on the basis of CTL results. In case Excess No Load /Load losses found than Guaranteed losses, penalty will be levied as per provision of clause 3.46 (B). The difference in penalty on account of excess No Load/Full load losses observed at CTL at the time of original supply and 'GP failed' repaired supply will be recovered.

The repaired transformer shall bear a repair warrantee for further 12 months after repair or unexpired period of 36 months from the date of supply whichever is later.

The firm shall provide non-detachable metallic plate with engraved following details of the repaired transformers for the purpose of identification:-

- 1) Date of first failure
- 2) Date of expiry of GP after 1st repair under G.P.
- 3) Date of second/third failure
- 4) Date of expiry of GP after 2nd /3rd re-repair under G.P.

The above details shall also be punched/embossed on the cover of the transformer. On every re-repair of transformer the date of repair and date of expiry of guarantee period shall have to engraved on rating plate by the contractor. The original name plate of transformer will be retained on the repaired transformers.

3.45 CLEANING AND PAINTING:

- i) Before painting or filling with oil, the external surfaces of transformer tank and structural steel work shall be completely cleaned and made free from rust, scale and grease by applying shot blasting or sand blasting. Cavities on castings shall be filled by metal depositions.
- ii) The interior of transformer tank, other oil filled chambers and internal structural steel work shall be cleaned of all the scales and rust by application of standard approved methods. Thereafter these surfaces shall be painted with hot-oil resistant varnish or paint.
- iii) Except for nuts, bolts and washers which may have to be removed for maintenance purposes all external surfaces shall receive minimum of four coats of paint. The total paint thickness shall be in the range of 52 to 60 microns.

- iv) The 1st and 2nd coats of painting shall be of primer and shall be applied immediately after cleaning. The 3rd coat shall be of an oil and weather resisting quality of a shade or color easily distinguishable from the primary coats and shall be applied after the primary coats have been touched up where necessary. The final coats shall be of glossy oil finish and weather resisting non-fading paint of shade No.632 (Admiral grey) of IS 5 or relevant International Standard Primer paint shall be ready mix Zinc Chromates as per IS 104 or relevant International Standard Intermediate and final coat of paint shall be as per IS:2932 or relevant International Standard.
- iii) Metal parts not accessible for painting shall be made of corrosion-resistant material.
- iv) Marshalling box shall also be painted with Admiral grey as per shade-632 of IS-5
- v) Dry Film Thickness:-
 - a) To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness & free of pores. Overspray, skips, runs, sags & drips should be avoided. The different coats may or may not be of the same colour.
 - b) Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.
 - c) Particular attention must be paid to full film thickness at the edges.
 - d) Except for nuts, bolts and washers which may have to be removed for maintenance purposes, all external surfaces shall receive minimum of four coats of paint. The total paint thickness shall be in the range of 52 to 60 microns.
- viii) Test for painted surface:-
 - a) The painted surface shall be tested for paint thickness.
 - b) The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and salt spray test and hardness test as type test as per the relevant ASTM standards.
 - c) Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

3.46 RANDOM SELECTION AND TESTING (RST):

A) The purchaser's may select transformer(s) from the supplied lot(s) at random from the stores for conducting the type tests, at any test house(s) as mentioned at clause 3.35, The supplier shall arrange these tests viz. (a) Impulse test with chopped wave test, (b) Thermal and dynamic ability to withstand short circuit test and (c) temperature Rise including loading, unloading and to and fro transportation from our stores to the test house(s). The charges for such tests shall be reimbursable to the suppliers on actual basis on production of documentary evidence in case the selected sample successfully withstands type test(s). In case of otherwise, no charges will be reimbursed.

1. Short circuit withstand test for Dynamic & Thermal ability. Measurement of no load and load loss shall form part of routine tests conducted before and after the short circuit test and recorded in the test report.
2. Impulse test as per clause no. 13 of IS: 2026 (Part-III).
- 3.. Temperature rise test as per IS:2026 (Part.2):2010 at min tap by feeding max guaranteed losses relevant to min. tap

B) MANDATORY TESTING/VERIFICATION AT STORES:-

The supplier shall route the power transformers through specified lab headquarter for testing and checking of No Load, Load Loss, Magnetizing Current, Percentage Impedance & Fitting & Accessories. Every transformer shall be tested for measurement of losses, Magnetizing Current & Percentage Impedance before delivery of the transformer at the respective store/ site destination. The verification of fitting & accessories of each Transformer shall also be carried out at Stores. The inspecting officer shall issue a provisional Form-9 after satisfactory inspection. However, the No Load, Load Loss, Magnetizing Current & Percentage Impedance measured and verification of fitting & accessories at CTL shall be final.

- i) Each & Every Transformer shall route through CTL Testing. In CTL, Transformers will be subjected to the following tests:-
 - a) No Load Losses at 100% & 110% of rated voltage and Magnetizing current will be measured at both voltages.
 - b) Load losses by Resistance Calculation method.
 - c) Percentage Impedance.
 - d) Verification of fittings & accessories.
 - e) Measurement of tank thickness.

XEn (CTL) shall provide 2 Nos. Poly-carbonate Seals on diagonally opposite side of Transformer after successful testing in CTL as a token of proof that Transformers have been tested at CTL.

- (a) No Load Losses:

8.0 MVA

10% tolerance is allowable. Penalty shall be leviable @ Rs.386.00 per watt for losses exceeding 5500 watts and upto 6050 watts.

- (b) Load Losses:

3% tolerance is allowable. Penalty @ Rs.178.00 per watt on losses exceeding 40000 watts and upto 41200 Watts for 8.0 MVA rating.

The transformers having measured No Load Losses/ Load Losses beyond the above permissible limit shall be stand rejected.

(c) Magnetizing Current & Percentage Impedance:

The transformer selected for No Load and Load Losses shall also be subjected to magnetizing current and percentage impedance test and in case found beyond the limit mentioned in specification, the lot shall stand rejected. The tolerance will be as $\pm 10\%$ for Normal Tap and $\pm 15\%$ for any other Taps for percentage impedance.

(d) The following makes of fittings & accessories shall be verified jointly by the concerned ACOS (consignee) & XEn (CTL) at the time of CTL testing of Power Transformers:-

- a. Buchholz Relay
- b. WTI & OTI.
- c. MOG
- d. Radiator Valve.
- e. Filter valve & Drain valve.
- f. Off Circuit Tap Changer.

(e) Measurement of Transformer tank thickness shall be done as follows:-

1.	Top Cover	At 2 places to be measured & average is to be taken.
2.	Bottom cover	-do-
3.	Side walls	On all four sides (average is to be taken)

The nominal value of sheet thickness shall be considered as mentioned in the above specification.

The following rolling tolerance shall be allowed as per IS:1852 with latest amendments and no penalty shall be charged on such measured thickness till tolerance limit of IS:-

Tolerance on Thickness (in mm)

Thickness of Sheet	Over 5.0mm upto and including 8.0 mm	Over 8.0mm upto and including 10.0 mm
Tolerance in mm	+/- 0.35	+/- 0.40

If the observed values of thickness are within or upto 5% less after allowing rolling tolerance as per above, the Transformer may be accepted with levy of penalty after imposing double the penalty of the approximate amount saved by using thin sheet (e.g. if the observed value of thickness are say 5% less after accounting for rolling tolerance and transformer tank weight is 120 Kg. (say),

the penalty imposed will be $5/100 \times 120 \times 80$ (considering present price of sheet steel is Rs.40/- per Kg. approx. $2 \times 40 = 80$) = Rs.480/-.

Highest percentage variation on negative side shall be taken for accounting the penalty.

If the tank thickness is found beyond 5% of tolerance limit after allowing rolling tolerance, the transformer will be rejected.

(ii) No Load and Load Losses:

The No Load & Load Losses for various ratings of transformers shall be as under (without tolerance):

Rating	No Load Losses in Watts	Load Losses in Watts
-----	-----	-----
8.0 MVA	5500	40000

3.47 FAILURE IN RANDOM SELECTION TEST:

Failure in Type Test(s) :

In the event of failure / unsatisfactory results of the transformer(s) in short circuit test / impulse test / Temperature rise Test, the supplier shall have to replace the supplies already made and no further transformers shall be accepted. The purchaser, however, at his option, may accept the transformers already supplied with the following conditions:

- i) Guarantee period of the supplied transformers issued to the field shall be Increased by double the normal guarantee period.
- ii) Bank guarantee shall be extended to cover the additional guarantee period.
- iii) For failure in any of the type tests listed under RST, i.e. Short circuit test, Impulse withstand test and Temperature rise Test, no further supplies shall be accepted. The Type Test Charges shall also not be reimbursable in this case and shall be borne by the supplier.
- iv) The transformers lying in the stores shall be replaced as per sub para (v) below.
- v) The bidder shall, however, be allowed to check the reasons of failure and if need be, to improve / modify the design. Further supplies, including replacement against supplies already made, shall be accepted only after successful type test(s) are arranged on fresh transformer selected by the purchaser. All the type tests shall be arranged in case there is change in the design, otherwise, type test shall be repeated only for the test in which failure has occurred. Charges for such test(s) shall be borne by the

supplier. However, in the event of failure of transformer in the repeat type tests, the purchaser may take following actions:

- a) Cancel pending orders of the rating in which failure(s) has occurred, &
- b) Not place any order of power transformers on the firm for one year.

3.48 INSTALLATION & COMMISSIONING

Mainly following activities are required to be carried out before commissioning of Power Transformers:-

- a) Assembling of Power Transformer accessories.
- b) Testing activities in presence of XEn (P&EA/AEn(P&EA)/ XEn(O&M/HTM/Proct.)/AEn(O&M/HTM/Proct.)/Feeder Manager or Engineer nominated by concerned SE(O&M/M&P) such as
 - (i) Ratio Test
 - (ii) Megger Value
 - (iii) Magnetic balance.
 - (iv) Oil BDV
 - (v) Earth Resistance
 - (vi) Buchholz Relay checking.
 - (vii) WTI/OTI/MOLG (oil level) checking.
 - (viii) Checking of points of leakage of oil from Transformer body/Radiator/Valve.
 - (ix) Setting of Relays in Panel & Sealing by Protection Wing.

Installation & Commissioning will be carried out in presence of firm's representative for which concerned AEn (O&M) will intimate to firm and AEn (P&EA)/ XEn(P&EA) XEn(O&M/HTM/Proct.)/ AEn(O&M/HTM/Proct.)/Feeder Manager or Engineer nominated by concerned SE(O&M/M&P) by FAX/Telegram/Telephone.

3.49 The variation in quoted prices of power transformers shall be as Schedule-III(A). **The prices are variable with base date as 01.12.2018, as per IEEMA latest circular.**

3.50 ADDITIONAL ORDER

Repeat orders for additional quantities, upto 50% of original ordered quantities, may be placed by the Nigam, on the same rates, terms and conditions given in the contract.

IMPORTANT NOTES :

1. The tenderer should read the clause No. 3.30 carefully and indicate specifically any deviation in the fittings and accessories as required to be provided on the transformers. In absence of such indicating in the tender it will be presumed that all fittings and accessories would be provided as per specification.
2. The Tolerance in weight and Dimension of the transformer shall not be more than plus/minus five percent subject to maintenance of all specified external/ internal electrical clearance. However, there shall be no negative tolerance in tank dimensions, radiator tube lengths, conservator dimensions, and core cross section area. Phase-Phase electrical clearance on 11kV side shall not be less than 280mm with bi-metallic connectors in position.
3. Make of each accessories/components shall be clearly and invariably indicated in the GTP/bill of material.