**Annexure- B**

**TECHNICAL SPECIFICATION FOR 33/11 KV, 5 MVA, CU WOUND, CRGO CORE, POWER TRANSFORMER.**

1. **SCOPE**:

This specification covers the design, manufacture, shop testing, supply and delivery of oil immersed naturally cooled, three phase 50 Hz conventional power transformers required for power Sub-station in Jharkhand State. The transformers will be copper wound.

2. **STANDARDS**:

The transformers shall conform in all respect to IS:2026/1977 & RE. Specification (wherever applicable) as amended from time to time except where specified otherwise. Equipment meeting any other authoritative standard which ensures an equal or better quality than the standard mentioned above will also be acceptable, In such case, a copy of the relevant standard (English version) should be enclosed with the tender.

3. **CLIMATIC CONDITIONS**:

1. Maximum ambient temperature in shade : 50 deg C

2. Maximum average ambient temperature : 45 deg C

3. Maximum temperature attainable by an object

exposed to sum : 60 deg C

4. Minimum ambient temperature : 4 deg C

5. Maximum relative humidity : 95 %

6. Average number of thunderstorm days per annum­ : 50

7. Average number of rainy days per annum : 80

8. Average annual rainfall ­ : 1270 mm

9. Number of months of tropical monsoon conditions : 4 months

10. Maximum wind pressure : 100 Kg/square m

11. Altitude not exceeding : 1000 Mtrs

4. **TYPE AND RATING**:

The transformers shall be of core type construction and oil immersed, naturally cooled as mentioned below and shall be suitable for outdoor service as step down transformers. The rating and electrical characteristics of the transformers shall be as below­ :

Continuous capacity (KVA) : 5 MVA

Rated HT voltage : 33 KV

Rated L T voltage : 11 KV

Frequency : 50 Hz

No of Phases : 3

­

Connection (HT) : Delta

Connection (L T) : Star

Vector group : Vector Group Dy-11

Type of cooling : ONAN

The neutral point of the secondary (LV) winding shall be brought out to a separate insulated terminal enabling it being earthed solidity or enabling a. current transformer for on earth leakage relay to be connected wherever required.

All transformers should be oil immersed, weather proof and suitable for outdoor installations (in lighting areas).

The transformers shall be designed and constructed to withstand without damage, thermal and dynamic effects of external short circuits. The manufacturer *I* supplier shall furnish all relevant design data and calculation in support of having fulfilled this requirement as stipulated under relevant clause of IS:2026-1977 (Part-I).

5. **1NSULATION**:

5.1 The dielectric strength of the winding insulation and of bushing shall conform to the values given IS:2026.

5.2 For rated system voltage of 33 KV and 11, KV following impulse test voltage will be offered

**System Impulse test voltage**

33 KV 170 KV

11 KV 75 KV

5.3 All windings of the transformer shall have uniform insulation.

1. **TEMPERATURE RISE**:

The temperature rise of hottest layer of **oil shall not exceed. 45° C** as measured by thermometer and temperature rise of **winding shall not exceed 55° C** as measured by resistance method on continuous full load over a maximum ambient temperature of 50° C when tested as per 155:2026/1977 (part-II).

7. **FREQUENCY**:

The transformer shall be suitable for continuous operation with a frequency variation of +/- 2 ½% from normal 50 Hz without exceeding the specified temperature rise.

7.**0 PARALLEL OPERATIONS** :

8. The transformers shall operate satisfactorily in parallel with similar unit already in service.

9. **IMPEDANCE**:

The percentage impedance at 75 deg C should be 7.15 % for 5 MVA transformers. The impedance value refers to the principal tapping are subject to tolerance of +/- 10%. The impedance value measured on any other tapping shall not exceed the value measured on the principal tapping by more than +/- 10%.

Impedance shall include positive and zero sequence and shall be expressed in terms of the branches of the star connected equivalent diagrams all on the same MVA basis and the range shall be given for each branch of the equivalent circuit in turn.

10. (A**) LOSSES WITHOUT POSITIVE TOLERANCE**:

The losses shall not exceed the value given below :-

|  |  |  |
| --- | --- | --- |
| **KVA Rating** | **No Load Loss (In KW)** | **Load Losses (in KW) at 75° C** |
| 5000 | 4.00 KW | 23 KW |
| ----- | ----- | ----- |
| ----- | ----- | ----- |

Transformers of lower losses will be preferred. The Guaranteed losses should be certified by CPRI /ERDA/NTH, Govt of India only.

10. (B) The maximum flux density shall not exceed 16000 lines per mm2 under worst condition of loading. Detailed confirmatory calculations must be submitted with the tender.

11. **GUARANTEE**:

The manufacture shall among other things guarantee the following:

i. Quality and strength of materials used.

ii. Satisfactory operation for a period of 36 months from the date of last Supply ?

iii. Performance figures are to be supplied by the tenderer in the schedule of guaranteed technical particulars enclosed.

1. **TOLERANCE**:

The tolerance in the guaranteed performance figures shall be as specified in the latest issue of IS : 2026 , if not mentioned in the specification.

13. **COOLING**

13.1 All radiators shall preferably be attached to and mounted on the transformer tank. The

arrangements of radiator shall be such that accessories may be mounted as specified herein.

13.2 Radiator units shall be connected to the tank by machined steel flanges welded to the radiator unit and to the tank and provided with gaskets. At each radiator unit connections, there shall be provided on the tank indicating shut off valve which can be fastened in either open or

closed position. Separate oil light blank flag shall be provided for each tank connection for

use when the radiator unit is detached. Each radiator unit shall have a lifting eye, an oil drain

valve at bottom and vent at the top.

13.3 Radiator shall be designed to withstand the vacuum and pressure condition specified for the

tank.

14. **CORE**-

The core shall be built up with high grade cold rolled non-ageing low loss, and high permeability drain oriented silicon steel lamination specially suitable for transformer cores with main flux density of 1.6 Tesla.

After being sheared, the lamination shall be treated to remove all burns and shall be re-annealed to remove all residual stresses. At least one side of each lamination shall be coated with a durable baked enamel insulations coating which shall be inert to the action of hot transformer oil. Paper and varnish insulation will not be accepted. The nature of insulation should be specified in the tender.

The core shall be rigidly clamped and bolted to ensure adequate mechanical strength and to prevent vibration during transportation operation. The bolts used in the assembly of the core shall be suitably insulated and clamping structure shall be so constructed that eddy current will be minimum.

The core assembly shall be provided withlugs suitable for lifting the complete core and coil assembly of the transformer.

The core and the coil shall be so fixed in the tank that shifting will not occur when the transformer is moved or during a short circuit.

15. **WINDING**-

The winding shall be so designed that all coil assemblies of identical voltage /rating shall be interchangeable and in field repairs to the winding can be made possible, without special equipment. The coils shall be supported between adjacent sections by insulating spacers and the barriers, bracings and other

Insulations used in the assemble of the winding shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings.

The insulation of the coils shall be treated with suitable insulating varnish or equivalent compound 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 chemically inactive in the hot transformer oil and shall not soften or otherwise be adversely affected under the operating conditions. This shall generally conform to class insulating material as per IS: 1271 :1958.

All threaded connections shall be provided with locking facilities. All leads from the windings to the terminal Nigam and bushing shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

The winding shall be clamped securely in place so that they will not be displaced or deformed during short circuit. The assembly core and windings shall be vacuum dried and suitably impregnated before removal from the treating tank. The copper conductors used in the coil structure shall be best suited to the requirements and all permanent current carrying joints in the windings and tie leads shall be welded or brazed.

16.0 **INSULATING OIL**:

Oil for first filling shall be supplied with each transformer. The oil shall comply in all respects with the provisions of IS 335 (latest assessment) with ageing characteristics. Particular attention shall be paid to deliver the oil free from moisture having uniform quality through out in non returnable steel drums.

The quality of oil for first filling of each transformer shall be stated in the tender. B.D.V of the transformer oil (at 2.5 mm gap) should not be less than 40 KV in assembled condition at the time of commissioning.'

17.0 ­**TANK**

The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness. The tank and the cover shall be of welded construction. All sheets shall be welded and wherever practicable they shall be double welded. The tank shall have sufficient strength to withstand permanent, distortion (i) a vacuum of *760* mm of mercury and (ii) continuous internal gas pressure of 0.7 atmospheres with oil at operating level i.e., the transformer tank should be able to withstand *100% of vacuum* and also one atmospheric pressure above atmospheric internal pressure.

The tank cover shall be bolted to the tank and the transformer design shall be such that the tank will not be split between the lower and upper radiator connection. The minimum thickness of tank plates shall be 6.0 mm for the sides and 10 mm for the top and bottom where the longer sides have a horizontal length up to but not exceeding 1800 mm . For horizontal length in excess of 1800 mm side thickness shall be 10 mm and minimum top and bottom plate thickness shall be 12 mm.

A manhole with welded flanges and a bolted cover shall be provided on the cover. The manhole shall be sufficient size to afford easy access to the longer side of the bushing terminals etc.

All bolted connections to the tank shall be fitted with suitable oil gasket which shall give satisfactory service under operating conditions. Special attention shall be given to the method of making the proper tight joints and between the tank and the cover as also between the cover

and all other outlets to ensure that the joints can be remade with ease with, the help of semi skilled labour. Where compressible gaskets are used, steps shall be provided to prevent cover compression.

Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between core and winding and the bottom *of* tank for collection of any sediment.

Lifting eyes and lugs shall be provided on all parts *of* the transformer requiring independent handling during assembly or dismantling. In addition, the transformer shall be provided with lifting lugs and bosses properly secured in the sides of the tank forlifting the transformer either by cranes or jacks.

The design of the tank, the lifting lugs and bosses shall be such that the complete transformer assembly filled with oil can be suitable for use these lugs without any damage.

The tank shall be provided with two suitable copper alloy lugs for the purpose of grounding.

**Each tank shall be equipped with the following valves with standard screw connection for external fitting ­-**

I. One drain and lower filter valve located on the lower voltage side of the transformer and placed to completely drain the tank. At the option of the contractor, a large valve may be furnished with an concentric reduce. This valve shall be equipped with a small sampling cock.

ii. One filter valve located at the top of the tank on the high voltage side. The opening *of* this valve shall be baffled to prevent accretion of the coil.

III. One filter valve located on the high voltage side *of* the transformer above the bottom of the tank.

IV. One relief valve to operate at a pressure below the test pressure for the tank.

V. Oil filling valve.

18. **UNDER CARRIAGE**:

The transformer tank shall be supported on a structural steel base equipped with forged steel or cast steel single flanged wheels suitable moving the transformer completely filled with oil.

The transformer shall be provided with bi-directional flat rollers suitable for use on a 1000 mm gauge track.

Pulling eyes shall be provided to facilitate .pulling of transformers and they shall be suitably braced in a vertical direction so that handing does not occur when the pull has a vertical components.

19. **TAPS**:

The transformer shall be provided with off-circuit taps (for 5000 KV A only).

Transformers with off-circuit tap changing gear shall have taps ranging from +5% to -10% in steps of 2.5% each on H,V. winding for voltage variation. Steps other then 2.5 % are not acceptable.

The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with a locking arrangement along with tap position indication, thus enabling the switch to be locked in position.

Equipment for only local electrical and local hand operation shall be provided.

20. **CONSERVATOR**:

Conservators should be of sufficient capacity with drain cock, oil gauge and silicagel breather and a shut off valve on the fold pipe between the conservator and the transformer tank located between Buchholz relay and the conservator. Oil gauge shall be mounted on the conservator. The conservator should be provided with arrangement to make it detachable from the main body of the transformer.

21. **BUSHING**:

Transformer shall be provided with bushing insulator on both 33KV and 11 KV sides, 33 KV and 11 KV bushing shall be located on opposite side.

The electrical characteristics of bushing insulators shall be in accordance with 15:2099 as amended from time to time. All type and routine test shall be carried out in accordance with 15:2099. The test voltage for various test as stipulated in 15:2099-1973 are reproduced below­

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nominal Voltage System | Rated Voltage of the bushing | Visible discharge test | One minute wet & dry withstand test | Lighting Impulse  Test ( Impulse Voltage) |
| 11 KV | 12 KV | 9KV | 35 KV | 75 KV |
| 33 KV | 36 KV | 27 KV | 75 KV | 170 KV |

The dimensions of the 12 KV bushing (11 KV side) shall conform to IS:3347 (Part-III)-1973 and those of 36 KV bushing (33 KV side) shall conform to !5:3347 (part-I)-1973 or the latest version thereof.

22. **SUPPRESSION OF HARMONICS**:

The transformers shall be designed with particular attention to the suppression of harmonic voltage especially in the third and fifth so as to eliminate wave from distortion and any possibility of high frequency disturbance inductive effects or of circulating current between neutral points a1 different transforming stations reaching such as magnitude as to cause interference with postal or other communication circuits.

23. **CENTRE OF GRAVITY** :

The centre of gravity of the assembled transformers shall be low and as near the vertical centre line as possible. The transformers shall be stable with or without oil. If the centre of gravity is eccentric relative to truck either with or without oil, its location shall be shown on the outline drawing.

24. **ACCESSORIES AND FITTING**:

Each transformer shall be provided with the following accessories and fittings in accordance with the details to the extent these are specified in IS:2026-1977.

a. Inspection cover

b. Name plate

c. Diagram plate

d. Two earthing terminals

e. Lifting lugs for conservators

f. Dehydrating breather

g. Thermometer (dial type with one contact for alarm and one for trip).

h. Oil level gauge with three position of oil marked as follows ­

Minimum (-) 5°C

(+) 32°C

Maximum (+) 98° C

i. Oil filling hole and cap

j. Air release device

k. Pressure release device

i. Gas and oil actuated relay

m.. Filter valves (Lower valve to be also used as drain valve).

n. Terminal marking plate

o.Bi-directional roller

p. Thermometer pocket .

q. Winding temp. indicator with alarm & trip.

r. Bimetallic connectors 7 Nos suitable for ACSR DOG.

**N. B. - The order no. and date must clearly be mentioned on the rating plate.**

25. **CLEARING AND PAINTING**:

Before painting and filling with oil, all non gal-vanished parts shall be completely clean, free from rust, scale and grease and all external surface cavities shall be filled by metal deposition.

Interior of all transformer tanks and oil filled chamber and internal structural steel work shall be cleaned of all scales and rust by sand blasting. Incase the process of sand blasting is not adopted it is to be thoroughly cleaned by chipping, wire brushing and sand papering etc.

These surface shall be painted with hot oil resisting varnish. or paint as per contractor's standard practice.

External surface shall be given a priming coat of anti rust primer and two finishing coats of durable oil and weather resisting paint or enamel. The colour, of the finishing coats shall be admiralty grey conforming to no. 632 of ISS colour for ready mixed prints (second revision).

26. **PACKING**:

The packing may be in accordance with the supplier's standard practice but he should give full particulars of packing for the approval of the purchaser. Special arrangement should e made to facilitate handling and to protect the projecting connections for damage in transit.

The' transformer shall be shipped filled with oil.

All parts shall be adequately marked to facilitate fixed erection, Boxes and crates shall be marked with the contract number shall have packing list enclosed showing the parts contained therein.

27. **TESTS**:

The transformer shall be completely assembled and tested at the factory. If the purchaser desires to send its representative. all tests shall be witnessed by him. Test shall be performed in compliance with IS:2026-1977 or any other authoritative standard agreed upon between the purchaser and the manufacturer.

**ROUTINE TEST**:

All the transformers shall be subjected to the following routine test as per 15:2026/1977 at the manufacturer' works.

The tests are to be carried out in accordance with the details specified in 15;2026 or as agreed upon between the purchaser 'and the manufacturer- ­

a.. Measurement of winding resistance

b. Measurement of voltage ratio polarity and check of voltage vector relationship ­

c. Measurement of impedance voltage and short circuit impedance (principal tapping) and load loss

d. Measurement of no load losses and current

e. Measurement of Insulation resistance

*f.* Separate source voltage withstand test

g. Induced over voltage withstand test

h. Oil leakage, gas collection, oil surge and test on gas actuated relays.

i. Air pressure test *for* tank as per ISS.

**TYPE TEST**:

In addition to above routine test, the transformer may be subjected to the following type test as specified in IS:2026, *for* which no extra charge shall be paid if the prototype transformer has not been tested *for* type test: ..

a. Measurement of winding resistance

b. Measurement of voltage ratio and - check of voltage vector relationship

c. Measurement of impedance voltage and short circuit impedance (principal tapping) and load loss

d. Measurement of no load losses and current.

e. Measurement of Insulation resistance

f: Lightning impulse voltage withstand test.

g. Temperature rise test

h. Short circuit withstand test

If records of type tests done on a transformer which is essentially a representative of the one being purchased. are furnished to the purchaser, may accept these, as evidence of type tests instead of actual test.

28. **INSPECTION**:

All tests and inspection shall be made at the place of manufacturer unless otherwise specially agreed upon by the manufacture and purchaser at the time *of* purchase. The manufacturers shall provide the inspector representing the purchaser all reasonable facilities, without charges, to satisfy him that the material is being furnished in accordance with this specification.

The purchaser has the right to have the test carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

29.0 **TEST AT SITE**:

After erection at site, the purchaser shall carry out the following test of transformer - ­

a.. Insulation resistance test

b. Ratio and Polarity test

c. Dielectric test on oil

d. Function of buckles relay (alarm and trip)

30.0 **FURTHER TESTS**:

The purchaser reserves the right of having other reasonable test carried out at his own expanses either before shipment or at site to ensure that the transformer complies with the requirements of these specifications.

31, **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 ­

a. Complete identification data including serial number of the transformer

b. Method of application, where applied, duration and interpretation of results for each test.

c, Temperature data corrected to 75°c including ambient temp.

d. Tolerance on test result shall conform to the relevant clause of IS:2026.

32,0 **DRAWlNG DATA AND GUARANTEED TECHNICL PARTICULARS** :

As far as possible after the award of the contract the supplier shall supply four copies of drawings which will describe the equipment in details for approval.. The following drawings for each item are to be supplied as part of this contract­

a. Outline dimensional drawings of transformer and accessories.

b. Assembly drawings and weights of main' component parts

c. Drawing giving the weights for foundations

d. Tap changing and name plate and diagram

e. Test reports

f. Descriptive literature and data on transformer construction, winding, bushings heat exchange, tap changing gear etc.

**33.0 DEVIATION FROM THE SPECIFICATIONS:**

Should be clearly listed and brought out at schedule of deviation, Annexure-‘F’ only.

34.0 **CRGO Core**:

It is to be noted that only Imported fresh Cold Rolled Grain Oriented (CRGO), Silicon Steel Sheets are to be used for the manufacture of transformers. Use of imported secondhand/ defective/ used/ scrap CRGO sheets are not allowed. During pre-dispatch inspection and testing of transformers by the authorised representative of JBVNL if it is found that imported secondhand/ defective/ used scrap CRGO steel sheets have been used in the transformer by the supplier the entire lot shall be rejected. and Purchase order may be cancelled and no further order for supply of transformer shall be placed in future by J.S.E.B to the supplier.

The following documents are to be produced by the supplier before the

inspecting officer at the time of pre-dispatch inspection & testing of transformers: ­

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 inspecting officer will submit the photocopies of above documents alongwith the inspection report.