# EARTHING TRANSFORMER

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*Engineering Department*

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED
পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড
( পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ )

**Regd. Office: Vidyut Bhawan, Block – DJ, Sector-II, Bidhannagar, Kolkata – 700091.**
**CIN: U40101WB2007SGC113474; Website: www.wbsetcl.in**

Updates for WBSETCL / TECH SPEC / Rev.-4.1

1. This following point is added in Clause no.13: -

"For Remote indication & metering through SAS, please follow our technical specification for **Substation Automation system**."

**Technical Specification of Earthing Transformer**

## 1. SCOPE :

This specification is intended to cover the design, engineering, manufacture, testing at manufacturer's works of 3 ph, Copper wound, oil immersed 33KV Earthing transformers for efficient and trouble free operation as specified herein. The neutral of the earthing transformer shall be solidly earthed to provide earthed neutral in the 33 KV systems. The Earthing Transformer shall have impedance to restrict earth fault current.

The earthing transformer covered by this specification shall be complete in all respect. Any material or accessories which may not specifically mentioned here but which is usual and necessary for satisfactory and trouble free operation and maintenance of the transformer shall be supplied without any extra charge.

## 2. STANDARDS :

The equipment to be furnished under this specification, shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions of the following Indian Standards:

| | |
|---|---|
| IS:3151 | Specification for Earthing Transformer |
| IS 2026 | Specification for Power Transformer |
| IS 2099 | Bushing for alternating voltage above 1000V. |
| IS 6600 | Guide for loading of oil immersed transformer |
| IS 335 | Specification of new insulating oil |
| OTHERS | CBIP Manual on Transformers |

## 3. I) DEVIATION :

Normally the offer should be as per Technical Specification without any deviation.

**II) MODIFICATION :**

If any modification felt necessary to improve performance, efficiency and utility of equipment, the same must be mentioned in the 'Modification schedule' with reasons duly supported by documentary evidences and advantages. Such modifications suggested may or may not be accepted, but the same must be submitted along with Pre-Bid Queries. The modifications not mentioned in Schedule will not be considered.

## 4. BRIEF DESCRIPTION OF THE TRANSFORMER :

(a) 33KV Earthing Transformer, ONAN Cooled, 3 ph, oil-immersed, class A insulated, fitted with outdoor type bushings on HV side. Neutral of HV bushings shall be earthed for non-effectively earthed 33 KV system. Earthing transformer shall consist of a single winding in which case this winding shall be connected inter-star (zigzag) in accordance with the relevant IS group.

(b) INTERPHASE CONNECTION:HV :Inter-star (Zigzag) with neutral brought out through Bushing for solid earth connection.

## 5. GENERAL DESIGN CRITERIA :

(a) The transformer will be installed at outdoor. All equipment accessories and wiring shall be provided with tropical finish to prevent fungus growth.

(b) If not specifically mentioned in BOQ, the transformer shall be capable of withstanding a fault current of 874 Amps at rated voltage and frequency through the neutral for a time duration of 30 seconds without using neutral grounding resistor and without exceeding the temperature of 250 $^{0}$C for copper.

(c) The earthing transformer shall be capable of withstanding the mechanical and thermal stresses caused by the rated short time current flowing in the windings under fault conditions. This shall be determined by tests as per relevant IS and the results furnished along with the bid.

(d) The maximum flux density in any part of the core and yokes, at normal voltage and frequency of each transformer shall be consistent with the material used. The maximum flux density shall be 1.7 Tesla.

(e) The thermal ability to withstand short circuit shall be proved by calculation and shall be furnished along with the drawings.

(f) The transformer shall be free from annoying hum or vibration. The design shall be such as not to cause undesirable interference with radio or communication circuit.

(g) TYPE & RATING :

i) The Earthing Transformer shall be of 33 KV, 3-phase, 50 c/s Copper wound, oil immersed, interconnected Star (Zig-Zag) winding. The earthing transformer shall have 100% impedance to allow rated fault current at rated system voltage in the event of occurrence of a solid single phase to ground fault. The fault MVA rating of the earthing transformer shall be 50 MVA for duration of 30 seconds, if not specifically mentioned in BOQ.

ii) The rating and other guaranteed particulars of the earthing transformer shall be as per specific technical parameters of this specification, submitted G.T.P. and relevant ISS.

## 6. TERMINAL BUSHING :

The terminals shall be brought out through outdoor type bushings on HV side conforming to IS: 2099 and provided with suitable Bi-metallic terminal connectors for suitable dia. ACSR conductors for phases and suitable size copper flat for neutral.

The bushing shall have high factors of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the high voltage winding.

Each bushing shall be so coordinated with the transformer insulation that all flash-over will occur outside the tank.

All porcelain used in bushings shall be homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burns and other defects. All bushings shall be porcelain shed type. The neutral bushings shall be insulated for 33 KV.

Bushings shall conform to IS: 3347, IS: 2099 and IEC: 137. Main terminals shall be solder less. The spacing between the bushings must be adequate to prevent flashover between phases under all conditions of operation.

All bushings shall be suitable for heavily polluted atmosphere.

## 7. CORE :

i) The material circuit of the earthing transformer shall be constructed from high quality, low loss and high permeability cold rolled grain oriented silicon steel laminations especially suitable for transformer core.

ii) The prime core materials are only to be used. Bidders should furnish following document as applicable as a proof towards use of prime Core material to be submitted before the stage inspection :

- Invoice of supplier
- Mill's test certificate
- Packing List
- Bill of landing
- Bill of entry certificate by Custom.

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

iii) All transformers shall be subjected to routine test and no load loss measurement as per relevant IS as mentioned in the Clause ": TEST AT FACTORY AND TEST REPORTS".

iv) Core materials should be directly procured from either the manufacturer or their accredited marketing organisation of repute and not through any agent.

v) Inter-laminar insulation shall be coated over laminations during manufacturing process.

vi) The legs and yokes of cores shall have similar section to minimise heating and noise. Necessary cooling ducts shall be provided for heat dissipation.

vii) The whole core shall be electrically connected by copper strip of not less than 6.25 sq.mm cross section to the tank inside for being earthed to drain off any electrostatic potential that may build up.

viii) Each core bolt and part of the core clamping frame work shall be insulated from the core lamination. The core shall be tested to withstand a voltage of 2500 volts AC for a duration of one minute.

ix) Only No-load losses are to be specified. The tolerance on specified No-load losses will be subject to limits specified in IS:2026.

## 8. WINDING :

Earthing Transformer with single inter-star connected windings shall consist of two distinct sections, each representing one half of each inter-star winding and shall be rated for one third of the line voltage.

The winding shall be made of paper insulated continuous and smooth electrolytic copper conductor and shall be so designed that all the coil assemblies of identical voltage rating shall be interchangeable and field repairs to the winding can be made without special equipment. The insulation of the coils and assembly of windings shall be insoluble, non-catalytic, chemically inactive in the hot transformer oil & shall not be adversely affected under the operating conditions.

The insulation of the windings shall withstand the impulse and power frequency test voltages as specified in technical parameters.

Windings shall be designed to withstand the Electromechanical stresses exerted during the short circuit conditions as per IS:2026.

Liberal ducts shall be provided for oil circulation and prevention of any hot spot temperature in the winding that may affect the life of the transformers. All leads and

connections shall be mechanically strong, heavily insulated and rigidly clamped, so as to withstand stresses due to terminal short circuit.

## 9. TANK :

Tank shall be of welded construction and fabricated from good quality sheet steel of adequate thickness. The thickness of top, bottom and side plates shall be stated by the bidder. The tank shall be so shaped as to reduce welding to a minimum. All seams shall be double welded for absolute oil tightness.

Bushing turret covers, access-holes covers, pockets of thermometer shall be so designed to prevent any ingress of water. The conservator shall be liberally dimensioned so that oil level remains above the bushing top at the lowest ambient temperature and noload, and the oil shall not spill into the breather pipe, or the exterior as waste. The conservator shall be provided with a window type oil gauge. The tank shall withstand specified pressure and vacuum tests without any deformation in excess of the permissible deflections.

## 10. INSULATING OIL :

The transformer oil shall be duly filled in with required quantity for first filling and to supply 10% extra . The oil shall conform to IS:335. The transformer should be filled in with oil having dielectric strength 60 KV (rms) minimum after filtration .The oil in the transformer being supplied shall be provided with test result conforming to IS:335.

## 11. COOLING EQUIPMENTS :

Transformer shall be suitable for 100% continuous maximum current rating with ONAN Cooling within the specified maximum temperature rise of 50$^{o}$C by oil & 55$^{o}$C rise by winding .

The transformer if required, shall be fitted with radiators of tubular construction. Thickness of radiator tubes should not be less than 2.5 mm and material should be mild steel.

## 12. CURRENT TRANSFORMER FOR E/F PROTECTION

One no. 11 KV class, outdoor type current transformer conforming to IS-2705 having ratio 100/1A (if not specifically mentioned) with one secondary winding of ALF-15, class 5P accuracy, 30VA burden and P.F. withstand voltage of 28 KV Bushing mounted and connectors as applicable shall be provided by the manufacturer for 33 KV neutral bushing.

The CT shall be used for protection of 33 KV system against earth fault.

## 13. FITTINGS & ACCESSORIES :

The Earthing Transformer shall be complete with necessary fittings and accessories, but not limited to the following:

i) Conservator with filling hole, cap and drain valve having flanged terminal.
ii) Conservator and supporting bracket for mounting on transformer tank.
iii) Isolation valve for the conservator.
iv) Magnetic oil level gauge with low oil level alarm contacts.
v) Silica gel breather with oil seal and connecting pipe for non-inert gas sealed transformer.
vi) Pressure relief pipe, double diaphragm type, complete with port-hole type oil gauge for indication of the puncture of lower diaphragm and necessary air equalizer connection between the conservator and the pressure relief pipe.
vii) Access holes/Inspection holes with bolted covers for access to inner ends of bushing.
viii) Lifting eyes for cover, core and winding and lifting lugs for the complete transformer.
ix) Air release plugs on top of cover and bushing turrets.
x) Upper & Bottom filter valve and Drain valve flanged with oil sampling device.
xi) Jacking pads with hauling holes.
xii) Flat roller wheels.
xiii) Two nos. tank earthing terminal.
xiv) Buchholz (gas) relay, double float type with one set of alarm contacts and one set of trip contacts and a testing cock. The contacts shall be wired up to terminal cabinet with insulted cables.
xv) Dial type thermometer for oil temperature indication complete with two sets of alarm and trip contact.
xvi) Pocket for inserting alcohol thermometer for oil temperature with necessary thermometer.
xvii) Rating plate and Diagram plate.
xviii) Rigid type terminal connectors on the HV bushing.
xix) Insulating oil required for first filling.
xx) Other attachment/accessories required to complete the equipment for satisfactory operation.
xxi) For Remote indication & metering through SAS, please follow our technical specification for **Substation Automation System**

## 14. PAINTING :

All steel surfaces shall be cleaned by sand blasting or chemical process as required to produce a smooth surface, free of scale, grease and rust. Steel surface in contact with insulating oil shall be painted with heat resistant oil insoluble insulating varnish. External surfaces shall be given a coat of high quality red or yellow chromate primer and finished with gray colour (IS:631) with two coats of synthetic enamel paints. Paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle

or be removed by abrasion due to normal handling. Sufficient quantity of touch up paint shall be furnished by application at site.

## 15. AUXILIARY SUPPLY :

The auxiliary supply available for the equipment are :

i) 220 V D.C±10% . ii) 415 V ± 10%, 3 phase , 4 wire , 50 c/s AC.

## 16. EQUIPMENT FOUNDATION AND STEEL STRUCTURE :

i) The earthing transformers shall be furnished complete with base frame, anchor/ foundation bolts and hardwares

ii) The equipment shall be designed for mounting on concrete base.

## 17. CONTRACT DRAWINGS AND MANUALS :

In the event of placement of P.O. six (6) copies of following drawings, GTP & leaflets shall be furnished for approval :

(a) Dimensional general arrangement drawing transformer showing constructional features and dispositions of various fittings and accessories.

(b) Technical leaflets on transformer and accessories explaining the functions and special features.

(c) Type test certificates on similar transformers.

(d) Transport/shipping dimensions with weights.

(e) Dimensional general arrangement and sectional view with plan and elevation of bushing with technical parameters.

(f) Foundation and anchor details including dead-load and impact load with direction.

(g) Assembly drawing for erection at site with part numbers and schedule of materials.

(h) Electrical schematic and wiring diagram.

(i) Any other relevant drawings and data necessary for erection, operation and maintenance.

(j) Instruction manuals and data sheets for each piece of equipment. The manuals shall clearly indicate the installation methods, checkups and tests to be carried out for covering the equipment and maintenance procedure.

(k) Rating and diagram plate of the transformer.

After approval four (4) sets of approved drawings and maintenance manual/catalogue of all equipment both in hard and soft copy shall be submitted for our record and distribution to site.

## 18. TEST AT FACTORY AND TEST REPORTS :

All routine tests are to be carried out on each transformer as per relevant IS. Those routine test reports are to be submitted along with inspection offer.
After completion of the manufacture, the following routine tests shall be carried out at manufacturer's works on each Transformer in presence of representative from WBSETCL.
The contractor shall give at least 15 (fifteen) days advance notice intimating the actual date of inspection and details of all tests that are to be carried out.

i) Measurement of Zero-sequence impedance
ii) Measurement of no-load loss and no load current.
iii) Measurement of winding resistance.
iv) Measurement of insulation resistance.
v) Induced voltage withstand test.
vi) Separate source voltage withstand test.

Any other test not specified above but required to be carried out as per relevant IS & IEC shall be within the scope of contractor.

Rejection and retesting shall be guided by relevant IS.

Porcelain bushing, Bushing current transformers, winding temperature indicating device, Dial Thermometers, Buchholz relays, Insulating oil and other accessories to be supplied by the manufacturer shall be tested by the manufacturer in accordance with the relevant I.S. Publication. Three (3) copies of test reports of each of the component shall be furnished along with the test certificate of the main equipment.

## 19. GUARANTEE :

Electrical characteristics shall be guaranteed by the bidder. In case of failure of materials to meet the guarantee, WBSETCL shall have right to reject the material. Guaranteed Technical Particulars are to be submitted by successful bidder during detailed engineering along with submitted drawings/documents. However format for submission of GTP shall be handed over to intending bidders at the time of sale of tender documents.

## 20. TEST REPORTS & TYPE TESTS :

Only type tested Earthing transformer are to be offered conforming to our technical specification, and relevant IS and IEC. Earthing transformer offered should be similar with ones on which type testing has been carried out as per relevant IS and IEC. Three sets of complete type test reports carried out in Govt. recognized Test House or Laboratory /NABL

accreditated laboratory shall have to be submitted by successful bidder positively along with submission of drawing during detail engineering.

Successful Bidder may require producing original copies of type test report at the time of detail engineering if asked by WBSETCL.

Each type test report shall comply the following information with test result

a. Compete identification, date and serial number.
b. Method of application, Where applied, duration and interpretation of each test.
c. Relevant drawings as documented with test report.

**SPECIFIC TECHNICAL PARAMETERS**

| SNO | DESCRIPTION | TECHNICAL PARAMETERS |
|---|---|---|
| i) | Service | Outdoor |
| ii) | Type | 33KV, 50Hz., Oil filled, Copper wound natural air cooled (ONAN), 3ph, Earthing transformer, CLASS-A insulation for winding. |
| iii) | Zero sequence Impedance (Ohm) per phase.<br>(tolerance +20%, - 0%) | As per design |
| iv) | Maximum permissible neutral current for single phase to ground fault (amps) for 30 secs. | 874 or as specified in BOQ |
| v) | Basic Insulation level<br>(a) Winding<br>(b) Bushing | <br>170 KVp<br>170 KVp |

| | | |
|---|---|---|
| vi) | Power frequency withstand voltage<br>Dry one minute<br>(i) HV Winding<br>(ii) HV Bushing | <br><br>70 KV (rms.)<br>70 KV (rms.) |
| vii) | Temperature rise over ambient ($50^0$C) for continuous rating<br>(a) Winding, by resistance<br>(b) Oil by thermometer (c)<br>Core | <br>$55^0$C<br>$50^0$C<br>As permitted by adjacent winding |
| viii) | Flux density | 17000 Lines/sq.cm (max.). In the event of over voltage to the extent of 12.5%, the core shall not get saturated |
| ix) | Whether uniformly insulated or graded | Uniformly Insulated |

**GUARANTEED TECHNICAL PARTICULARS FOR 33KV EARTHING TRANSFORMER**

(To be filled in and signed by the Bidder)

1. Name of the Manufacturer and Address :

2. Type and Designation :

3. Conforming Standard :

4. Continuous Maximum Rating (KVA) :

5. Vector Group :

6. Rated temperature rise over specified average ambient (50oC air) at rated output :

a) Of oil by thermometer (oC) :

b) of winding by resistance (oC) :

7. No load voltage ratio :

8. Exciting current referred to H.V. and 50 C/S at :

a) 90% rated voltage (Amps.) :

b) 100% rated voltage (Amps.) :

c) 110% rated voltage (Amps.) :

9. Power factor for excitation current at 100% rated voltage , 50 C/S :

10. Iron losses at 50 C/S and :

a) 90% rated voltage (KW) :

b) 100% rated voltage (KW) :

c) 110% rated voltage (KW) :

11. Copper losses (at 750C) (KW) :

12. Total losses (KW) :

13. Reactance voltage (at 75oC) at full load :

a) HV (%) :

b) LV (%) :
(All values shall be referred to rated KVA)

14. Impedance voltage (at 75oC) at full load

a) HV (%) :

b) LV (%) :
(All values shall be referred to rated KVA)

15. Resistance per phase (at 20oC)

a) HV (Ohm) :

b) LV (Ohm) :

16. Zero sequence Impedence (Ohm) per phase :

17. Maximum permissible neutral current for single phase to ground fault (amps) for 30 seconds :

18. 1.2/50 micro second Impulse withstand voltage (KVp) :

a) Winding :

b) Bushing :

19. 1 min. Power frequency withstand voltage on Bushing (KVrms) :

a) Dry :

b) Wet :

20. Core :

a) Material & grade :

b) Thickness of stampings :

c) Type :

d) Flux density in the core at rated Voltage and 50 Hz. :

e) Flux density at 110 percent voltage and 50 Hz. :

21. 1 min. Power frequency withstand voltage (Dry) on winding (KVrms) :

22. Untanking height of core and coils (mm) :

23. a) Weight in Kg of the following :

i) Transformer in oil : ii) Core & coils :

iii) Tank and fittings :

iv) Oil :

v) Shipping weight of heaviest package :

b) Quantity of oil in litres :

24. Dimensions of the Transformer (mm) :

a) Length :

b) Width :

c) Height from plinth level :

25. Width of Rail gauge suitable : for rollers of Tr.

26. Whether the similar equipment is type tested : (Yes/No). If Yes, furnish details.

27. Confirm compliance to specification w.r.t.
i) Transformer Oil (Yes/No) : ii) Bushings (Yes/No) :