

 TP SOUTHERN ODISHA DISTRIBUTION LIMITED (A Joint Venture of Tata Power and Government of Odisha)	TP SOUTHERN ODISHA DISTRIBUTION LIMITED		F01- (09.07.04)	Revision: 03
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Prepared By	Reviewed By	Approved By	Issued By	
DEBI PRASAD ROY	SHAILENDRA KUMAR JAISWAL	ASHOK SARAF	D R DHARMADHIKARI	

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1. SCOPE

This specification covers design, soil resistivity survey, engineering, manufacture, testing, inspection, supply, transportation, storage, installation, commissioning and performance testing of complete earthing system for TPSODL substations.

The scope shall include but not be limited to:

- Main earth mat.
- Earth electrodes.
- Earth risers.
- Transformer neutral earthing.
- Transformer body earthing.
- Equipment earthing.
- Structure earthing.
- Fence earthing.
- Cable rack earthing.
- Street light pole earthing.
- Flexible earthing bonds.
- Earth pit chambers.
- Earthing hardware and accessories.

The bidder shall be responsible for carrying out soil resistivity measurements, design of the earthing system, preparation of earth mat layout drawings, conducting all necessary calculations and obtaining approval from Plant Engineering Group, TPSODL before commencement of work.

The complete grounding system shall be designed to ensure:

- Personnel safety.
- Equipment safety.
- Reliable fault current dissipation.
- Safe touch voltage.
- Safe step voltage.
- Acceptable ground potential rise.
- Long term corrosion resistance.

The bidder shall be responsible for achieving the specified earth grid performance irrespective of the quantities indicated in the BOQ.

The bidder shall be responsible for achieving the specified performance criteria of the earthing system. Any additional electrodes, conductors, chemical electrodes or improvements required to achieve the specified grid resistance, touch voltage and step voltage limits shall be deemed included within the bidder's scope unless specifically approved otherwise by TPSODL. This technical specification applicable for earth mat design only. For technical specification of earth electrode material and earth conductor material respective specification to be considered.

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2. APPLICABLE STANDARDS

The earthing system shall comply with the latest editions of the following standards:

- IEEE Std. 80 – Guide for Safety in AC Substation Grounding.
- IS 3043 – Code of Practice for Earthing.
- IS 2062 – Structural Steel.
- IS 1852 – Rolling and Cutting Tolerances.
- IS 1239 Part-I – Mild Steel Tubes and Pipes.
- IS 2629 – Hot Dip Galvanizing.
- IS 2633 – Testing of Zinc Coating.
- IS 4759 – Hot Dip Galvanized Coating on Structural Steel.
- CBIP Manual on Substation Grounding.
- Relevant IEC Standards.

In case of conflict between standards and this specification, the requirements of this specification shall govern.

3. CLIMATIC CONDITIONS OF INSTALLATION

S.NO	CONDITIONS	VALUES
1	Maximum ambient temperature	50 deg C
2	Max. Daily average ambient temp	35 deg C
3	Min Ambient Temperature	0 deg C
4	Maximum Humidity	95%
5	Average Annual Rainfall	150cm
6	Average No. of rainy days per annum	120
7	Altitude above MSL not exceeding	1000m
8	Wind Pressure	300 Km/hr.
9	Earthquakes of an intensity in horizontal direction	Equivalent to seismic acceleration of 0.3g
10	Earthquakes of an intensity in vertical direction	Equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

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TPSODL service area has heavy saline conditions along the coast and High cyclonic Intensity winds with speed up to 300 Kmph. The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months.

4. GENERAL TECHNICAL REQUIREMENTS

4.1 General

The grounding system shall provide a low impedance path for dissipation of fault currents, lightning currents and switching surges into the earth.

The grounding system shall be capable of safely carrying the maximum anticipated fault current for the specified duration without mechanical or thermal damage.

The completed grounding system shall ensure that touch voltage, step voltage and ground potential rise remain within permissible limits as specified in IEEE Std. 80.

The earth mat shall be designed to achieve an earth grid resistance of 1.0 Ohm or lower. Compliance with permissible touch voltage and step voltage limits as per IEEE Std. 80 shall be mandatory.

4.2 Soil Resistivity Survey

Prior to earth mat design, the bidder shall carry out soil resistivity measurements throughout the substation area using a calibrated four terminal digital earth tester.

The measurements shall be taken using Wenner Four Pin Method in:

- North-South Direction.
- East-West Direction.

Measurements shall be taken at the following minimum electrode spacings:

- 0.5 m
- 1.0 m
- 2.0 m
- 3.0 m
- 5.0 m
- 7.0 m
- 10.0 m

Additional readings shall be taken wherever instructed by Site-In-Charge of TPSODL.

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The soil resistivity survey report shall include:

- Raw field observations.
- Instrument details.
- Calibration details.
- Site sketch.
- Test point locations.
- Direction of measurements.
- Resistivity calculations.
- Average resistivity adopted for design.
- Soil layer interpretation.

The complete soil resistivity survey report shall be submitted within 7 days from the date of Release Order. The soil resistivity measurement shall be carried out in the presence of TPSODL representative. The bidder shall provide adequate advance notice to the Site-In-Charge of TPSODL before carrying out the measurements.

4.3 Earth Mat Design

The earth mat shall be designed strictly in accordance with IEEE Std. 80.

The bidder shall perform detailed calculations covering:

- Grid resistance.
- Grid current.
- Ground potential rise.
- Touch voltage.
- Step voltage.
- Mesh voltage.
- Conductor sizing.
- Electrode sizing.
- Ground rod effectiveness.
- Thermal withstand capacity.
- Corrosion allowance.

The design shall be site specific and shall not be based on standard drawings or assumed soil resistivity values.

The design shall demonstrate compliance with all IEEE-80 safety requirements.

Compliance with touch voltage and step voltage limits shall take precedence over merely achieving specified earth resistance.

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4.4 Design Basis

Unless otherwise specified by TPSODL, the design shall be based on:

Three Phase Fault Current (I_f) = 25 kA

Fault Current Division Factor (S_f) = 0.60 (unless otherwise specified by TPSODL)

Decrement Factor (D_f) = 1.00

Corrective Projection Factor (C_p) = 1.00

Fault Duration (T_f) = 3 Seconds

Accordingly, the grounding system shall be designed.

TPSODL reserves the right to revise the fault level, fault duration or design factors based on future network studies, system expansion or protection coordination studies. The bidder shall incorporate such revisions without altering the fundamental design philosophy.

4.5 Earth Grid Configuration

The preferred grounding grid shall be square grid configuration.

The grid spacing shall be determined through IEEE-80 calculations.

Under no circumstances shall the grid spacing be less than 1 metre × 1 metre.

The design shall remain practically executable considering:

- Transformer foundations.
- Equipment foundations.
- Control room foundations.
- Cable trenches.
- Oil pits.
- Internal roads.
- Future expansion provisions.

4.6 Earth Electrode Design

Earth electrodes shall form an integral part of earthing design.

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Earth electrodes shall be installed at:

- All corner nodes of the earth mat.
- Additional locations indicated by design calculations.

Minimum centre-to-centre spacing between two electrodes shall be 3 metres.

Each earth electrode shall be connected to the earth mat through two separate and independent GI strip connections.

No earth electrode shall be connected through a single strip only.

4.7 Design Submission and Approval

The bidder shall submit:

1. Soil Resistivity Survey Report.
2. Earth Mat Design Calculations.
3. Earthing Safety Calculations.
4. Ground Potential Rise Calculations.
5. Touch Voltage Calculations.
6. Step Voltage Calculations.
7. Draft Earthing Layout Drawing.
8. Earthing BOQ.

The Earth Mat Design Calculations and Draft Layout Drawing shall be submitted within 14 days from the date of Release Order.

The complete design package shall be submitted to Plant Engineering Group, TPSODL for CAT-A approval.

The bidder must obtain CAT-A approval from Plant Engineering Group, TPSODL within 21 (Twenty-One) days from the date of Release Order (RO) after complying with all review comments, observations and due diligence requirements of TPSODL.

No earthing work, excavation, material installation or related field activity shall be commenced prior to obtaining CAT-A approval from Plant Engineering Group, TPSODL.

Any delay in submission of documents, responding to review comments, resubmission of revised documents or obtaining CAT-A approval, attributable to the bidder/Business Associate (BA), shall be treated as bidder's delay and shall not constitute valid grounds for extension of project timelines or completion schedules.

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The bidder shall ensure that all construction activities, procurement quantities and site execution are based only on the latest CAT-A approved drawings, calculations and design documents. Any deviation from the approved design without prior written approval of TPSODL shall not be permitted.

5. GENERAL CONSTRUCTION REQUIREMENTS

5.1 Earthing Conductor

Main Earth Grid Conductor:

75 mm × 10 mm GI Flat

Earth Risers:

50 mm × 6 mm GI Flat or 50 mm × 8 mm GI Flat

Transformer Neutral Earthing:

75 mm × 10 mm GI Flat

5.2 Burial Depth

As per the table depth of the earth grid need to be selected after the survey and soil resistivity

Sl. No.	Soil Resistivity (Ω -m)	Economical Depth of Burial (m)
1	50 - 100	0.5
2	100 - 400	1.0
3	400 - 1000	1.5

For PSS soil resistivity below 100(Ω -m): The earth mat should be laid minimum 600 mm. Remaining earth trench is to be back filled with the excavated soil. It is therefore important to ensure the earth conductor (MS flat) is laid at least 0.6 M deep, but preferably deeper, say 1M as this will reduce the surface potentials.

For PSS soil resistivity above 100(Ω -m): Where the measured soil resistivity is greater than 100 Ω -m, the buried earth mat conductor shall be surrounded by a minimum 100 mm thick layer of black cotton soil on all sides (bottom, sides, and top). The balance portion of the earth trench shall be backfilled with the excavated soil and suitably compacted.

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5.3 Routing of Conductors

The routing of earthing conductors shall be planned to avoid interference with foundations, structures, trenches and underground services. Where unavoidable, crossings shall be routed below or around such obstructions without compromising grid integrity.

- Civil foundations.
- Transformer foundations.
- Control room foundations.
- Cable trenches.
- Drainage systems.
- Existing underground services.

5.4 Foundation Earthing

One continuous run of 75 × 10 mm GI flat shall be provided around major civil foundations and transformer foundations.

5.5 Equipment Earthing

50 × 6 mm or 50 × 8 mm GI flat shall be used for earthing connections of:

- Circuit Breakers.
- Current Transformers.
- Voltage Transformers.
- Lightning Arresters.
- Marshalling Kiosks.
- Junction Boxes.
- Metering Panels.
- Control Panels.
- Fence.
- Cable Trays.

Each equipment shall be connected to nearest earth conductor through dedicated earthing connection.

Loop earthing through another equipment shall not be permitted.

5.6 Transformer Earthing

Transformer body earthing and neutral earthing shall be independent.

Both body and neutral earthing shall have two distinct connections to the earth grid.

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Transformer neutral earthing shall utilize separate dedicated electrodes.

5.7 Marshalling Kiosk Earthing

Transformer marshalling kiosks and OLTC kiosks shall be connected at two separate locations to the nearest horizontal conductor.

5.8 Earth Electrodes

Earth electrode should be 14.2mm dia. copper coating steel rod (250microns.) 3mtrs long considered for maintenance free earthing.

Length = 3000 mm

Minimum electrode spacing = 3 m

The number of earth electrodes indicated in the design shall be considered minimum.

5.9 Fence Earthing

Fence shall not be connected directly to switchyard earth grid.

A separate fence earthing conductor shall run approximately 2 m outside the fence line and shall be connected to fence at intervals not exceeding 5 metres.

5.10 Cable Rack Earthing

One continuous 50 × 6 mm or 50 x 8 mm GI flat shall run along cable racks and cable trays and shall be connected to main earth grid at intervals not exceeding 5 metres.

5.11 Flexible Earthing Bonds

Flexible tinned copper earthing bonds shall be provided for:

- Isolator operating handles.
- Earth switches.

Each earth switch shall be provided with two flexible earth bonds.

5.12 Welding Requirements

Minimum overlap length: 150 mm

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Welding shall be:

- Continuous.
- Double welded.
- Carried out on both sides.

Zinc coating shall be removed before welding.

5.13 Protection of Welded Joints

All welded joints shall be protected by:

- Two coats anti-corrosive paint.
- Two coats bituminous paint.
- Bituminous tape wrapping.
- PCC protection.

5.14 Backfilling

Earthing trenches shall be backfilled with:

Loam Soil : Bentonite = 10 : 1

Proper compaction shall be ensured.

5.15 Earth Pit Chambers

Earth Pit Chambers Each earth electrode shall be provided with: 450 × 450 × 600 mm masonry earth pit chamber(Ready-made concrete block with RCC cover slab).

5.16 Execution Based on Approved Design

The earth mat shall be executed strictly as per CAT-A approved drawings and calculations. Any modification in grid spacing, conductor size, electrode quantity, electrode location or routing of earthing conductors shall require prior written approval from Plant Engineering Group, TPSODL.

6. MARKING

Each individual earth resistance and combined mat resistance should be painted with non-washable paint on the cover of the pit.

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7. TESTS

The following tests shall be carried out:

- Soil Resistivity Measurement.
- Continuity Test of Earth Grid.
- Individual Earth Electrode Resistance Test.
- Combined Grid Resistance Test.
- Visual Inspection.
- Dimensional Verification.
- Galvanization Test.

Testing shall be carried out using a calibrated Four Terminal Earth Resistance Tester.

Calibration certificate valid on the date of testing shall be submitted.

The final earth resistance test report shall clearly indicate:

- Individual electrode resistance.
- Combined earth mat resistance.
- Test method adopted.
- Instrument details.
- Calibration details.
- Date of testing.

The overall earth mat resistance after completion shall be less than 1.0 Ohm.

Where achieving 1.0 Ohm is difficult due to site conditions, re-designing to be done with the Plant Engineering Group, TPSODL.

8. TYPE TEST CERTIFICATES

Type test reports from NABL accredited or Government approved laboratories shall be furnished.

Type test reports shall not be older than five years from date of bid opening.

9. PRE-DISPATCH INSPECTION

Not covered under this tender. Shall be as per NIT of tender/RC/RO.

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10. INSPECTION AFTER RECEIPT AT STORES

Raw materials shall be inspected upon receipt for

- Quantity verification.
- Physical damage.
- Galvanization defects.
- Dimensional compliance.

TPSODL reserves the right to reject defective material.

11. GUARANTEE

The guarantee period shall be as specified in the NIT, Tender, Rate Contract or Release Order, whichever is applicable.

12. PACKING

Materials shall be packed suitably to prevent:

- Corrosion.
- Moisture ingress.
- Mechanical damage.
- Transport damage.

13. TENDER SAMPLE

NIL

14. TRAINING

Not Applicable

15. QUALITY CONTROL

The manufacturer/agency shall maintain documented quality control procedures covering:

- Design review and design documentation.
- Raw material inspection.
- Material handling and storage at site.
- Cutting, drilling and fabrication activities.
- Welding activities.
- Galvanization quality verification.
- Installation practices.

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- Testing and commissioning activities.
- Final documentation and record keeping.

16. TESTING FACILITIES

The manufacturer shall possess adequate tools for testing as per IEEE 80.

17. MANUFACTURING ACTIVITIES

Not applicable

18. SPARES, ACCESSORIES AND TOOLS

The supplier shall provide:

- GI Clamps.
- GI Bolts.
- GI Nuts.
- Spring Washers.
- Flexible Earth Bonds.
- Funnels.
- Earthing Accessories.

19. DRAWINGS AND DOCUMENTS

The bidder shall submit:

Within 7 Days

- Soil Resistivity Survey Report.

Within 14 Days

- Earth Mat Design Report.
- Draft Earth Mat Layout Drawing.
- Earthing BOQ.
- Conductor Sizing Calculations.
- GPR Calculation.
- Touch and Step Voltage Calculation.

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The drawing shall clearly show:

- Grid dimensions.
- Grid spacing.
- Electrode locations.
- Corner electrodes.
- Neutral earthing.
- Fence earthing.
- Cable rack earthing.
- Equipment risers.
- Design parameters.

No work shall commence without CAT-A approval from Plant Engineering Group, TPSODL.

After Completion

The bidder shall submit:

- As-Built Earthing Layout Drawing.
- Final Earth Resistance Test Report.
- Electrode Location Drawing.
- Material Reconciliation Statement.
- Joint Inspection Report.

The as-built drawing shall include all deviations from approved CAT-A drawings and shall be submitted in hard copy and editable soft copy format.

20. SCHEDULE-A: GUARANTEED TECHNICAL PARTICULARS

(Insert bidder data)

Particular	Requirement
Main Grid Conductor	75 × 10 mm GI Flat
Earth Riser	50 × 6 mm or 50 × 8 mm GI Flat
Electrode Type	14.2mm dia. copper coating steel rod (250microns) 3mtrs long. The specified Earth Rod can carry 15 KA for 1 sec and peak current of 38 KA for 0.5sec
Electrode Length	3000 mm
Minimum Grid Depth	500 mm
Minimum Grid Spacing	1 × 1 m

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Preferred Grid	Square Grid
Minimum Electrode Spacing	3 m
Corner Electrodes	Mandatory
Two Independent Electrode Connections	Mandatory
Fault Current	25 kA
Fault Duration	3 Sec
Grid Resistance	≤ 1 Ohm
Soil Survey N-S Direction	Mandatory
Soil Survey E-W Direction	Mandatory
Survey Distance	0.5,1,2,3,5,7,10 m
Soil Report Submission	Within 7 Days from the date of RO
Design Submission	Within 14 Days from the date of RO
CAT-A Approval	Mandatory, within 21 Days from the date of RO

21. SCHEDULE-B : DEVIATIONS

SCHEDULE OF DEVIATIONS

(TO BE ENCLOSED WITH TECHNICAL BID)

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to confirm the purchaser's specifications:

S.NO	CLAUSE NO.	DETAILS OF DEVIATION WITH JUSTIFICATION.

We confirm that there are no deviations apart from those detailed above.

 TP SOUTHERN ODISHA DISTRIBUTION LIMITED (A Joint Venture of Tata Power and Government of Odisha)	TP SOUTHERN ODISHA DISTRIBUTION LIMITED		F01- (09.07.04)	Revision: 03
			TS Release Date- 31.07.2026	
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Name of the Specification	Technical Specification for Soil Resistivity Survey, Earth Mat Design, Supply, Installation, Testing and Commissioning of Substation Earthing System			
Prepared By	Reviewed By	Approved By	Issued By	
DEBI PRASAD ROY	SHAILENDRA KUMAR JAISWAL	ASHOK SARAF	D R DHARMADHIKARI	

Seal of the Company:

Signature with Designation

ANNEXURE-I : EARTH MAT DESIGN DATA SHEET

The bidder shall submit:

- Soil resistivity survey data.
- Earth mat design calculations.
- Grid resistance calculation.
- GPR calculation.
- Touch voltage calculation.
- Step voltage calculation.
- Conductor sizing calculation.
- Earth electrode calculation.
- Earthing BOQ.
- Draft earth mat layout drawing.

The Annexure-I shall form an integral part of this specification and shall be submitted along with CAT-A approval documents to Plant Engineering Group, TPSODL before commencement of work.