

**BILL OF QUANTITY (Annexure-I)**

Name of Project: 1650ADC Shallow type Earth Electrode at Malegaon for Padghe HVDC terminal station pertaining to +/-500kV 1500MW					
Name of Work: CIVIL & ETC WORKS OF EARTH ELECTRODE STATION					
SR_NO	Description_of_Item	Quantity	UOM	Unit Rate	Amount
1	Mobilization & Demobilisation of necessary equipment, tools, plants, manpower, etc., for conducting soil investigation at a project site.	1	Lot	₹ 60,400.00	₹ 60,400.00
2	Drilling boreholes of 150mm dia, at specified locations including performing SPT, collecting disturbed and undisturbed samples, recording water table etc, all complete as per specification including backfilling of boreholes as per direction of Engineer-in- Charge.	75	RM	₹ 1,000.00	₹ 75,000.00
3	Add extra for rock drilling in boreholes where rock is encountered, all complete as per specification.	30	RM	₹ 1,800.00	₹ 54,000.00
4	Making trial pits of 2 mx 2 m in size extending to 4 m depths at specified locations and taking undisturbed samples as per specification including backfilling of pit as per direction of Engineer-In-Charge	5	Nos	₹ 3,300.00	₹ 16,500.00
5	Conducting laboratory tests on soil and water samples all complete as per specification.(Payment against this item shall be made based on the total no. of boreholes driven as per Item No 2 however, charges for laboratory testing of the samples collected from Trial Pits shall be deemed to be inclusive in the rate of this item). Note: The laboratory tests shall be carried out at any Govt Approved agencies/NABL accredited laboratories], Furnishing 2 copies of draft report and 4 copies of final report.	3	Per Bore-Hole	₹ 3,950.00	₹ 11,850.00
6	Earthwork in excavation & filling in all types of soil and soft/disintegrated rock in open areas/nallas/channels, to the required slopes, shapes, levels, elevations and profile, including trimming of bottom and slopes of excavation, bailing out rain (dewatering), pumping, removal of slush, preparing embankments/marginal banks, loosening, dressing, spreading material in layers not exceeding 200mm, as per direction of Engineer-in- Charge, water flooding, compacting to achieve 95% consolidation at optimum moisture content, finishing etc. all complete, for all leads and lifts within leveling boundary, including disposal of surplus earth and stacking of unsuitable material within a lead of 2.0 Km beyond substation boundary, with all labour, material, tools, tackles and equipment, safeguards and incidentals, Royalty,taxes etc. as necessary, as per drawings, specification and directions of the Engineer-in-Charge. Clearing of jungle is included in this item. (Only excavation/cutting will be measured for payment purpose.)	96000	Cu.Mtr.	₹ 87.50	₹ 8,400,000.00
7	Earthwork in excavation by mechanical means(Hydraulic excavator)/manual means over areas (exceeding 30cm in depth 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and disposal of excavated earth upto 100m and lift upto 4m, disposed earth to be levelled and neatly dressed. All kinds of soil .	3100	Cu.Mtr.	₹ 125.95	₹ 390,445.00
8	Earthwork in excavation by mechanical means(Hydraulic excavator)/manual means over areas (exceeding 30cm in depth 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and disposal of excavated earth upto 100m and lift upto 4m, disposed earth to be levelled and neatly dressed. Ordinary Rock.	1350	Cu.Mtr.	₹ 221.05	₹ 298,417.50
9	Earthwork in excavation by mechanical means (Hydraulic excavator )/manual means in foundation trenches or drains (not exceeding 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and dressing of sides and ramming of bottoms, lift upto 3.5m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 100m. All kinds of soil .	18200	Cu.Mtr.	₹ 166.40	₹ 3,028,480.00
10	Earthwork in excavation by mechanical means (Hydraulic excavator )/manual means in foundation trenches or drains (not exceeding 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and dressing of sides and ramming of bottoms, lift upto 3.5m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 100m. Ordinary Rock.	5200	Cu.Mtr.	₹ 275.85	₹ 1,434,420.00
11	Filling available excavated earth (including rock) in trenches, plinth, sides of foundations, etc., in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead upto 100m and lift upto 3.5m.	23000	Cu.Mtr.	₹ 125.75	₹ 2,892,250.00
12	Carriage & disposal of surplus excavated earth/rock beyond initial lead by mechanical means not necessarily all the times on pucca roads, including loading, unloading, dressing of excavated material, etc., complete as per specifications Lead upto 2 km.	2000	Cu.Mtr.	₹ 111.50	₹ 223,000.00
13	Providing and laying in position cement concrete of 1:4:8(1 cement : 4 fine sand : 8 stone aggregate, 40mm nominal size) grade including the cost of centering and shuttering - all complete	160	Cu.Mtr.	₹ 4,226.00	₹ 676,160.00

SR_NO	Description_of_Item	Quantity	UOM	Unit Rate	Amount
14	Providing and laying in position cement concrete of 1:2:4(1 cement : 2 fine sand : 4 coarse aggregate 20 mm nominal size) grade including the cost of centering and shuttering - all complete	39	Cu.Mtr.	₹ 5,021.38	₹ 195,833.82
15	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying, centering and shuttering, but excluding reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/cum. "Excess/ less cement used as per design mix is payable/recoverable separately).	1048	Cu.Mtr.	₹ 5,965.00	₹ 6,251,320.00
16	Add for using extra cement in the items of design mix over and above the specified cement content therein	1048	quintal	₹ 533.82	₹ 559,443.36
17	Steel reinforcement -Cold twisted bars /TMT- Fe 500/Fe 500D conforming to IS: 1786 of approved make of Mahatransco Including supply, straightening, cutting, bending, binding, (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	73.36	MT	₹ 79,120.00	₹ 5,804,243.20
18	Steel reinforcement -Cold twisted bars /TMT- Fe 500/Fe 500D conforming to IS: 1786. excluding supply, straightening, cutting, bending, binding, (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	10000	kg	₹ 11.00	₹ 110,000.00
19	Structural steelwork welded in built up sections like edge protection angles, pipes, insert plates with lugs gratings, frames, ladders, stair railings, framed work and similar works including providing, cutting, hoisting, fixing in position/ embedding in concrete and applying a priming coat of approved steel primer all complete.	15	MT	₹ 79,000.00	₹ 1,185,000.00
20	Grouting of block outs, pockets, foundations, bolts holes and underside of base plates with cement, sand aggregate ( of size 6 mm and down) grout 1:1:2 with non-shrink additive and shall be of strength not less than M30 including placing, curing, cleaning, surface preparation, testing, etc. complete with labour, materials, equipment, handling, testing, etc. all complete as per specifications, drawings and instructions of the Engineer.	2	cum	₹ 11,197.67	₹ 22,395.34
21	Supplying & fixing (all dia & length) foundation bolts in position with help of proper templates (to be supplied by contractor) including nuts, washers(Mass of Zinc Coating= 610 gm/ sqm) and template all complete as per drawings & directions of Engr-in-Charge. Weight of the template shall not be measured for payment purpose.	500	kg	₹ 118.00	₹ 59,000.00
22	Overhead Water Tank with staircase- All civil works as per drawing and Technical Specification including finishing (internal and external) etc complete in all respect. However, excavation, PCC, RCC and reinforcement shall be paid separately as per items available in this schedule.	1	Nos.	₹ 150,000.00	₹ 150,000.00
23	Boundary wall including gate as per drawing and Technical Specification including barbed wire fencing and concentrina coil. However, excavation, PCC, RCC and reinforcement shall be paid separately as per items available in this schedule.	1588	M	₹ 9,259.00	₹ 14,703,292.00
24	Supplying and filling in with Fine sand in trenches/floors including watering, ramming, consolidating and dressing complete	670	Cu.Mtr.	₹ 810.82	₹ 543,249.40
25	Seeping well concrete curb - Precast or cast in place concrete circular ring without steel reinforcing- 1m diameter 300 mm high 100mm thick	5	Cu.Mtr.	₹ 15,000.00	₹ 75,000.00
26	Supplying and laying of round river rock 50 to 100mm size or clean, silt free, crushed rock	90	Cu.Mtr.	₹ 797.16	₹ 71,744.40
27	Supplying and laying of Pea gravel fill of size less than 50mm for use as filter in seeping wells	5	Cu.Mtr.	₹ 895.49	₹ 4,477.45
28	Security Hut - All civil works as per drawing and specifications complete, including - brickwork, finishing (external and internal), windows etc. However, excavation, PCC, RCC and reinforcement shall be paid separately as per items available in this schedule.	20	Sq.m.	₹ 20,600.00	₹ 412,000.00
29	SEPTIC TANK & SOAKPIT FOR SECURITY ROOM as per drawing and technical specification	1	Nos.	₹ 125,000.00	₹ 125,000.00
30	Supplying and laying CPVC pipe for external water supply system - 50 mm dia pipe as per technical specification	200	M	₹ 422.00	₹ 84,400.00
31	Supplying and laying CPVC pipe for external water supply system - 25 mm dia pipe as per technical specification	100	M	₹ 173.60	₹ 17,360.00
32	Providing & Laying of SW pipes for external sewerage system as per technical specification 150mm diameter pipe	20	M	₹ 296.56	₹ 5,931.20
33	Providing & Laying of SW pipes for external sewerage system as per technical specification 250mm diameter pipe	20	M	₹ 615.02	₹ 12,300.40
34	High Silicon Chromium Iron Electrode element (2.5m long) fitted with jumper cables : Laying of Sub-Electrode elements (anodes with pre-fabricated cables of different lengths) in centre of coke trench complete with Cabling (1Cx8 sq.mm. or 1Cx10 sq.mm.) as specified in technical specification. Dimension of anodes- 65mm diameter, 2500mm long.	495	No	₹ 743.49	₹ 368,026.66

SR_NO	Description_of_Item	Quantity	UOM	Unit Rate	Amount
35	Calcined petroleum coke of high conductivity : Coke Backfill inside coke trench of cross-section size 0.8m x 0.8m along complete length as specified in technical specification.	1650	Cubic meter	₹ 198.58	₹ 327,659.06
36	6.6/11 kv Feeder cable 150 Sq.mm (copper): Cable preparation & laying: includes laying, dressing , and fitting termination kit of cables - laying can be either on supports, underground (in buried trench), over ground, in conduits, in wall etc. All other erection materials viz. ferrules, lugs, cable ties/ straps, markers etc. to be included ,where ever applicable, in the quoted rates.	3850	M	₹ 65.02	₹ 250,324.44
37	3.8/6.6kV Distribution cable (copper) : Cable preparation & laying: includes laying, dressing , termination of cables - laying can be either on supports, underground (in buried trench), over ground, in conduits, in wall etc. All other erection materials viz. ferrules, lugs, cable ties/ straps, markers etc. to be included,where ever applicable, in the quoted rates.	2250	M	₹ 65.02	₹ 146,293.50
38	PVC conduit with bend and support strap, 63 mm diameter,2.5 mm thickness to protect feeder cables (Supply & Laying of PVC pipe including bends & support strap)	100	M	₹ 296.14	₹ 29,614.20
39	Galvanised steel Pipe type Structure erection complete with fixing harware for equipments support	7	MT	₹ 6,115.92	₹ 42,811.42
40	Double break disconnecter Manually operated > 600 A (without support structure): HDB single phase Disconnecter with Insulators,MOM Box,terminal connectors, laying of Aux earthmat for MOM box complete with terminal connector and accesories (without support structure)	10	No	₹ 3,473.05	₹ 34,730.55
41	Electrode line impedance supervision Reactor 0.5mH, 2000A, 130kV BIL, 10kA thermal current 1 sec, air core, Class F insulation complete with terminal connector and accesories (without support structure)	1	No	₹ 7,943.25	₹ 7,943.25
42	Electrode line impedance supervision Blocking Filter Capacitor 0.52uF, 4.652kV complete with terminal connector and accessories (without support structure)	2	No	₹ 3,177.30	₹ 6,354.60
43	Electrode line impedance supervision Arrester Uc=1kV (min), Discharge class 3, Residual voltage 12kVp @5kA Lightning Impulse complete with terminal connector and accessories (without support structure)	1	No	₹ 1,111.07	₹ 1,111.07
44	Bus Post insulators complete with terminal connector and accessories (without support structure)	4	No	₹ 760.54	₹ 3,042.17
45	3" Al Tube (ETC of Al.Tube includes cutting, Aluminum welding, testing, bending & installation of Al. Tube).	15	M	₹ 1,270.92	₹ 19,063.80
46	AAC/ACSR Conductor complete with Tee connectors for droppers to equipment connections, PG clamps for Busbar jumpering, Twin/Quad bundle rigid/flexible spacers etc	200	M	₹ 198.58	₹ 39,716.25
47	Supply of 120 Sq.mm bare copper conductor	300	M	₹ 917.89	₹ 275,366.70
48	Supply of 40mm dia. MS rod	300	M	₹ 569.42	₹ 170,824.50
49	Supply of 75x12 GI flat	100	M	₹ 603.33	₹ 60,332.63
50	Supply of 40mm dia Rod electrode for surge arrester (3 meter each)	2	No	₹ 1,708.25	₹ 3,416.49
51	Unloading, storing and laying of 40 mm dia MS Rods/ 120 sqmm bare copper conductor at a depth of 600 mm measured from the top of Finished Ground Level and bringing out risers 300 mm above ground level to the nearest point of the equipment foundations as per requirement including following works: - excavation of trenches - laying of MS rod /bare copper conductor - welding/ brazing - backfilling of soil for bringing out pig tail risers of 40 dia MS rod/ bare copper conductor (approximately 60 nos.) for equipments. Risers shall be raised from the earthmat (at 600 mm depth) to 300 mm above ground level to the nearest point of the equipment. This shall include all cutting, bending, welding/brazing, fixing, application of paint on cutting & welded/brazed surface, etc to the main earthmat as per attached specification for underground earthing and electrodes and equipment earthing details notes . - any other work necessary to complete the laying of earthmat	300	M	₹ 86.97	₹ 26,090.04
52	Fabrication (as per technical specification) & laying of Auxiliary Mat of 40 mm Dia MS Rods at a depth of 300 mm from top of FGL including excavation & backfilling - any other work necessary to complete the laying of earthmat	10	No	₹ 3,842.85	₹ 38,428.50
53	Earthing work with 75X12 GI Flat - Installation of GI Flat including cutting, bending, welding with GI Flat / MS Rod, supply and application of paint, clamping to structure/building wall etc. to complete in all respect. All arc welding shall be done with low hydrogen content electrodes. the welds should be treated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminum paint. The red oxide and zinc chromate shall conform to IS:2074.	100	M	₹ 102.18	₹ 10,218.07

SR_NO	Description_of_Item	Quantity	UOM	Unit Rate	Amount
54	Installing of 40 mm diameter Rod Electrode without test pit (LA) including following works: - excavation/hammering of rod in earth - installing the rode electrode - backfilling and compaction - any other work necessary to complete the work	2	No	₹ 5,535.01	₹ 11,070.02
55	Electrode watering system comprising of pump, borewell, DG set, watering pipes, seeping well, valves, joints and connectors of various sizes as per Technical Specification (Design, supply & ETC): 1. Supply & ETC of Piping (consists of Tough hose-Twin-liner drip polytube as per IS: 12786, Power-loc Tee fitting, Power-loc 90 Degree) for watering electrode trenches from the water tank (pipe dia should be selected by vendor suitably as per design/requirement and to maintain adequate continuous flow of water through out the electrode trench) 2. Supply & ETC of submersible pump (5 HP)-2 No. 3. Supply & ETC starter panel/ distribution board of submersible pump 4. Supply & ETC of 7.5 KVA DG SET (1 no.) 5. Supply & ETC of cable (from DG to starter panel/distribution board and starter panel/distribution board to pump with cable glands for above items	1	Set	₹ 828,975.00	₹ 828,975.00
56	Boring/drilling bore well of required dia for casing/strainer pipe, by suitable method prescribed in IS:2800 (part I), including collecting samples from different strata, preparing and submitting strata chart/bore log, including hire & running charges of all equipments, tools, plants & machineries required for the job, all complete as per direction of Engineer-in -charge, upto 90 metre depth below ground level	50	Meter	₹ 389.24	₹ 19,462.00
57	Water permeable Geotextile cloth (supply & laying) Supply & Laying of Geo Textile Fabric on top of coke bed as specified in technical specification (400 Sqmm)	400	Sq. Meter	₹ 80.48	₹ 32,193.00
58	SACRIFICIAL paper form (supply & laying) Supply & Laying of SACRIFICIAL paper form for seeping wells (400 Sqmm)	400	Sq. Meter	₹ 40.24	₹ 16,096.50
59	RTD Temperature Measurement Sensor along with conduits : 1. supply of PVC conduit and fittings, plexiglass as specified in technical specification. 2. Laying of Soil temperture & moisture sensor with PVC conduits and fittings, Plexiglass.	20	No	₹ 6,071.10	₹ 121,422.00
60	Joints, welds and resin material (supply and installation) 1. joining of Feeder cable with distribution cable by CAD welding joints including material supply (20 joints) 2. joining of jumper cable with distribution cable by CAD welding joints including material supply (460 joints)	1	LOT	₹ 989,782.50	₹ 989,782.50
61	Joints, welds and resin material (supply and installation) Exothermic cad welding (T joint= 30 nos, 120 sqmm bare copper conductor)	30	NO OF JOINTS	₹ 1,820.70	₹ 54,621.00
62	Warning tape -Caution Electric Cable Below" roll of 300 m (1000ft) (supply & laying)	20	ROLLS	₹ 630.00	₹ 12,600.00
63	Power cables, junction boxes and other accessories required for illumination system & power supply in line with Technical Specifications (supply & ETC): Supply & ETC of CFL lamp fitting, exhaust fan, ceiling fan, Switchboard with 2 5/15A sockets and 4 switches, Electric lamp for main gate, Cabling, PVC conduits, MCB box(1no)	1	Set	₹ 34,650.00	₹ 34,650.00
64	Supply & ETC of Equipment Fixing Hardware - Full Threaded bolts with nut and two Plane Washer and one Spring Washer	15	KG	₹ 137.94	₹ 2,069.03
65	Open store of size of 900 Sqm as per standard specification of NIT	900	sqm	₹ 488.00	₹ 439,200.00
66	1 No. covered store of 100 Sqm size as per standard specification of NIT.	1	Nos.	₹ 766,633.00	₹ 766,633.00
<b>Total Amount (in Rs.) excluding GST</b>					<b>₹ 53,143,055.03</b>

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**Percentage BoQ**

Tender Inviting Authority: BHEL, TBG- SubContracting Department, Sector 16A Noida, UP

Name of Work: Execution and handing over of Civil works, Erection, Testing & Commissioning of 1650ADC Shallow type Earth Electrode including stores works for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link at Malegaon in Maharashtra

Contract No: TBSM/MALEGAON/GES/CIVIL-ETC/TENDER/23-24 DATE 10.11.2023

Name of the Bidder/ Bidding Firm / Company :						
<b>PRICE SCHEDULE</b>						
<b>(This BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevent columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the Bidder Name and Values only )</b>						
NUMBER #	TEXT #	NUMBER #	TEXT #	NUMBER	NUMBER #	TEXT #
Sl. No.	Item Description	Quantity	Units	Estimated Rate in Rs. P	TOTAL AMOUNT Without Taxes in Rs. P	TOTAL AMOUNT In Words
1	2	4	5	6	53	55
1	Total amount as per rates in BOQ (as per Annexure-I) for "Execution and handing over of Civil works, Erection, Testing & Commissioning of 1650ADC Shallow type Earth Electrode including stores works for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link at Malegaon in Maharashtra."- Excluding GST	1.000	Nos	53143055.00	<b>53143055.00</b>	INR Five Crore Thirty One Lakh Forty Three Thousand & Fifty Five Only
<b>Total in Figures</b>					<b>53143055.00</b>	INR Five Crore Thirty One Lakh Forty Three Thousand & Fifty Five Only
<b>Quoted Rate in Figures</b>			<b>Select</b>		<b>0.000</b>	INR Zero Only
<b>Quoted Rate in Words</b>			<b>INR Zero Only</b>			





SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE  
TERMINAL) ASSOCIATED WITH  $\pm 500$ KV 1500MW CHANDRAPUR-PADGHE HVDC  
BIPOLE LINK

*Guide Lines for Civil Works, Erection, Testing and Commissioning of  
MALEGAON Ground Electrode Station*

Doc. No. : TB-422-316-01 Rev 00

## SECTION-1

### 1.0 Introduction

The Malegaon ground electrode (Approximately 40 km from Padghe) is designed as a trench type land electrode with double rings with approximately circular shape adapted to the available site. The dimensions of the rings are approximately 190 m radius for the outer ring and 150 m radius for the inner ring. The depth of the trenches is 3.4 m. In the trenches there is a bed of coke with a 0.8 x 0.8 m section. In the center of the coke bed there are silicon iron rods with cables laid in a row, 460 units (200 in inner ring & 260 in outer ring), end to end along the trenches.

The cables from the silicon iron rods are connected with distribution cable and distribution cables to Feeder cables by exothermic Cad welding joint which are leading to the electrode line end tower placed in the center of the electrode station. There are 20 feeder cables which are connected with Disconnectors. At the centre station there are switching equipment, a surge arrester, a reactor and two series capacitor for electrode line impedance supervision (ELIS).

### 2.0 Scope

**These are the basic guidelines for ETC work and the scope of work shall not be limited by this. The quantity and sizes of the equipment/structures/buildings etc .if mentioned in this document are only indicative and the final quantity is as per the BOQ. The contractor shall be required to do all the activities to complete the work as per the guidelines/ instructions of Engineer-in-charge.**

The scope of the work is but not limited to supply (as per BOQ), receipt, un loading, storage, verification, watch & ward during storage, transport from storage area to erection site, erection, pre-commissioning testing, commissioning testing, energization and Handling over of all the equipment as per BOQ under the supervision of BHEL/MSETCL. The contractor shall arrange all equipment, test instruments, tools/ tackles, lifting jacks, pulling equipment, crane, jigs, fixtures, high capacity mobile oil tanker, consumables etc. as required to complete the complete erection & commissioning work, however some special T&P will be supplied by BHEL as stated in the relevant clauses in this document. All equipment structures, support structures, Towers etc. shall be grounded as per the relevant drawings and standard practices. Complete Watch & Ward for the entire material and proper store keeping both indoor and outdoor shall be provided by ETC contractor.

Skilled work force shall be kept at site by the ETC Contractor till the Trial operation is completed.



SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE  
TERMINAL) ASSOCIATED WITH  $\pm 500$ KV 1500MW CHANDRAPUR-PADGHE HVDC  
BIPOLE LINK

*Guide Lines for Civil Works, Erection, Testing and Commissioning of  
MALEGAON Ground Electrode Station*

Doc. No. : TB-422-316-01 Rev 00

**The ETC contractor or his associate should have a valid Govt. Electrical Contractor's License.**

The BOQ of Erection, Testing and commissioning is as per Annexure- 1.

The scope of civil works is indicated in the document TB-422-607-001-PKG-1 Rev No. 00. The civil works shall generally include, but not limited to- trench excavation and back filling, connection pits and connection trenches, tower and equipment foundations, antiweed and gravelling, fence, gate and drains etc, guard hut, surface dressing, building of indoor and outdoor storage etc.

### 3.0 SUPPLY ITEMS BY ETC CONTRACTOR

The contractor shall take dispatch clearance from BHEL before dispatch of Supply item as mentioned in BOQ.

The contractor shall submit Datasheet, drawing, catalogue, type test (as applicable) for obtaining technical approval and test certificate/ inspection call for arranging dispatch clearance by BHEL. In case of inspection, the contractor shall intimate BHEL two weeks in advance.

The contractor shall submit the following documents to BHEL for billing of supply items:

1. GST invoice.
2. Delivery challan/Packing list.
3. LR copy
4. Pre-dispatch inspection report/ Test certificate (whichever is applicable)

### 4.1 ERECTION

The Contractor shall unpack, place accurately in position and make ready for service all the equipment required by the Specification. All installations, assembly operations and adjustments shall be done in a neat and professional manner and in accordance with the seismic withstand requirements specified in the Specification, the applicable Indian electrical codes and in accordance with the manufacturer's instructions.

All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits.

The Contractor shall supply and use all lubricants and other consumables as required. Lubricants used for installation purposes shall be drained out, flushed where necessary, and replaced with the lubricant required for operation. All these consumables shall be supplied by the Contractor till completion of successful trial operation.



**SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE  
TERMINAL) ASSOCIATED WITH  $\pm 500$ KV 1500MW CHANDRAPUR-PADGHE HVDC  
BIPOLE LINK**

***Guide Lines for Civil Works, Erection, Testing and Commissioning of  
MALEGAON Ground Electrode Station***

Doc. No. : TB-422-316-01 Rev 00

All support insulators, reactors, capacitors, Surge arrester and other fragile equipment shall be handled with cranes with suitable beams and handling capacity. The slings shall be of sufficient length to avoid any damage to the equipment due to excessive swing, scratching by sling ropes etc. All handling equipment, sling ropes etc. shall be tested before erection and periodically for strength.

High silicon chromium iron electrode being fragile material shall be handled very carefully.

Bending of the AL tubes shall be done with suitable bending machine through cold bending only & in such a manner that inner diameter of pipe is not reduced. Cutting of the pipes shall be done with proper cutting tool.

The Contractor shall arrange all the equipment, instruments, accessories, tools & tackles, auxiliaries, cranes etc. required for the successful erection of Works.

The supply of cable ferrules, tags, ties cable sealing putti, zinc rich paint and other consumables are in the scope of contractor.

The contractor shall follow the safety norms and prevailing rules and regulations. The contractor has to strictly ensure safety of man and machine prior to execution of work in substation area.

## **4.2 SITE TESTING**

### **4.2.1 GENERAL**

After the installation and preliminary adjustments of equipment, the Site tests, shall be performed in the following stages:

Erection checks

Pre commissioning & Commissioning tests

The site testing has been categorized in above stages for the sake of convenience only. There may be overlapping of two or more stages for particular tests. The Contractor shall facilitate in performing the site testing with complete responsibility.

The Contractor shall provide all instruments, equipment and facilities required to perform these site tests. Calibration certificates for the test equipment shall be available at site for review by the BHEL/Employer prior to the start of the testing all special & test equipment necessary to simulate devices or switching sequences and required for commissioning shall be provided by the BHEL. Results of the site tests shall be well documented and shall form a part of plant documentation.



#### **4.2.2 ERECTION CHECKS**

The checks shall be carried out on all equipment after completion of erection /installation, in accordance with the relevant approved commissioning procedures to be given under BHEL supervision. These checks shall ensure that the equipment has sustained no damage in transit, has been properly erected/ installed, is correctly set, and is ready for energization or start-up. These checks shall be carried on all equipment after completion of erection according to the approved field quality plan/installation manual of individual equipment. The checks shall include, but not be limited to, the following:

- a) Visual examination of
  - Physical damage
  - Paint/zinc coating
  - Corona ring surface
  - Ground connection
  - Electrical connections
  - Cleanliness, specially for insulators
  - Oil leakage
  - Welded joints/application of Zinc rich paint over them
  - Moving parts for proper lubrication
- b) Checking of nameplates
- c) Torque check of electrical connections and mechanical joints
- d) Check of tightness of cable terminations, cable tags and cable glands
- e) Check of cabling i.e. cable trenches ladders and cable dressing
- f) Electrical clearance measurement.

#### **4.2.3 COMMISSIONING TESTS**

After completion of erection finalization checks, equipment tests shall be conducted. These tests shall verify the proper function and healthiness of individual equipment. The tests shall conform to the approved field quality plan/procedures. The Contractor shall, in the quality plans, specify the tests required for each equipment in the station.

The equipment (pre-commissioning) tests shall be in accordance with the standards, practices, codes & Specifications, as applicable, as well as specified below.

##### **4.2.3.1 GENERAL CHECKS**

The following general checks/tests shall be carried out on all equipment, wherever applicable:

- a) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant field quality plan (FQP).



**SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE  
TERMINAL) ASSOCIATED WITH  $\pm 500$ KV 1500MW CHANDRAPUR-PADGHE HVDC  
BIPOLE LINK**

***Guide Lines for Civil Works, Erection, Testing and Commissioning of  
MALEGAON Ground Electrode Station***

Doc. No. : TB-422-316-01 Rev 00

- b) Insulation resistance checks on primary equipment consisting of power factor tests and hi- pot tests.
- c) Insulation resistance check of control cables, motor etc.
- d) Resistance measurements of reactors.
- e) Wiring continuity and insulation resistance tests, including checks for cables emanating from the Employer's facilities.

#### **4.2.3.2 ISOLATORS/DISCONNECTS**

- a) Insulation resistance of each pole.
- b) Manual and electrical operation
- c) Mechanical and electrical interlocks.
- d) Contact resistance
- e) Alignment.
- f) Resistance of operating and interlocking coils.

#### **4.2.3.3 LIGHTNING ARRESTER**

- a) Resistance of ground connection.
- b) Reading of surge counters before and immediately after installation.

#### **4.2.3.4 MOTORS**

- a) Insulation resistance
- b) Phase sequence and proper direction of rotation.

#### **4.2.3.5 ELECTRICAL AUXILIARY SYSTEM**

The phase sequence and auto changeover of all supplies in the station system shall be carried out.

#### **4.2.3.6 STATION EARTHING**

- a) Check continuity of earthing grid interconnections.
- b) Check earth resistance of the entire grid.
- c) Check for weld joint and application of zinc rich paint on galvanized surfaces.

#### **4.2.3.7 CONDUCTOR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS.**

- a) Visual check for finish & welding.
- b) Electrical clearance check; especially at opened disconnector positions.
- c) Torque check on all bus bar power connectors and other accessories.



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- d) Sag and tension check on conductors.
- e) Contact resistance check or Milli volt drop test on all joints.
- f) Dye penetration test/radiography test on 10% sample basis on weld joints.
- g) Test check on 5% sample (weld) joints after cutting the weld piece to observe any voids, etc.

#### **4.2.4 SUB-SYSTEM, PRE-COMMISSIONING & COMMISSIONING TESTS**

##### **19.1 General**

This procedure is prepared for commissioning and testing the Malegaon electrode which will replace the original Anjur electrode of the Chandrapur-Padghe Project. A single line diagram of the Malegaon is shown in Figure 19-1 and a general arrangement is shown in Figure 19-2. The electrode is designed two concentric rings with the inner ring being 320m in diameter and the outer ring being 380m in diameter. The electrode is divided into 10 sections and may operate with up to 3 sections out of service in the event that maintenance is needed.

The testing and commissioning is divided into the following activities:

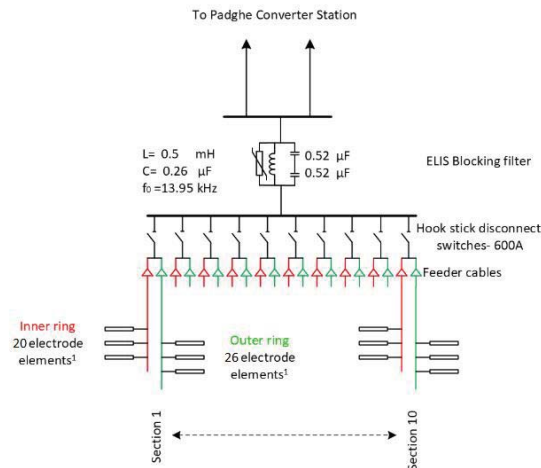
- a) Pre-Commissioning Inspection and Measurements
  - \_ Post Construction Inspection
  - \_ Measurement of ambient soil temperature and moisture levels at all measurement locations
- b) Commissioning Tests and Measurements

The commissioning and test program defines the required measurement and tests to be carried out during the electrode commissioning to verify the

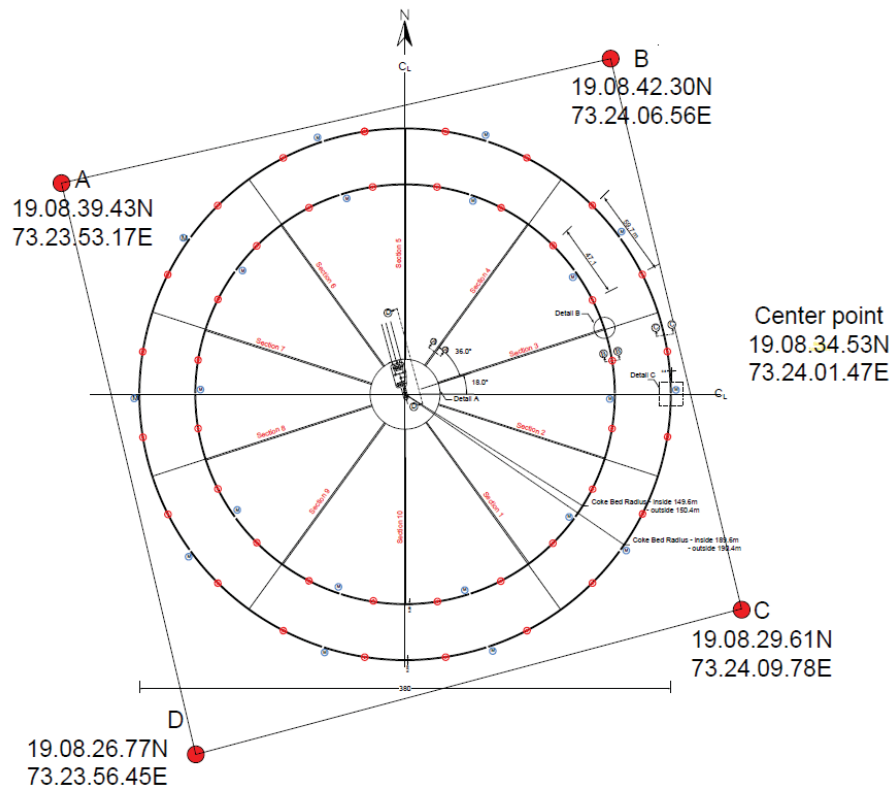
electrode has been constructed in accordance with the design specification, to evaluate the electrode performance and ensure it meets the specified criteria and requirements.

### c) Performance Evaluation of Electrode

This section describes preliminary evaluation of design and performance of electrode based on the measurement and test results.



**Figure 19-1 – Single line Diagram of Malegaon Electrode**



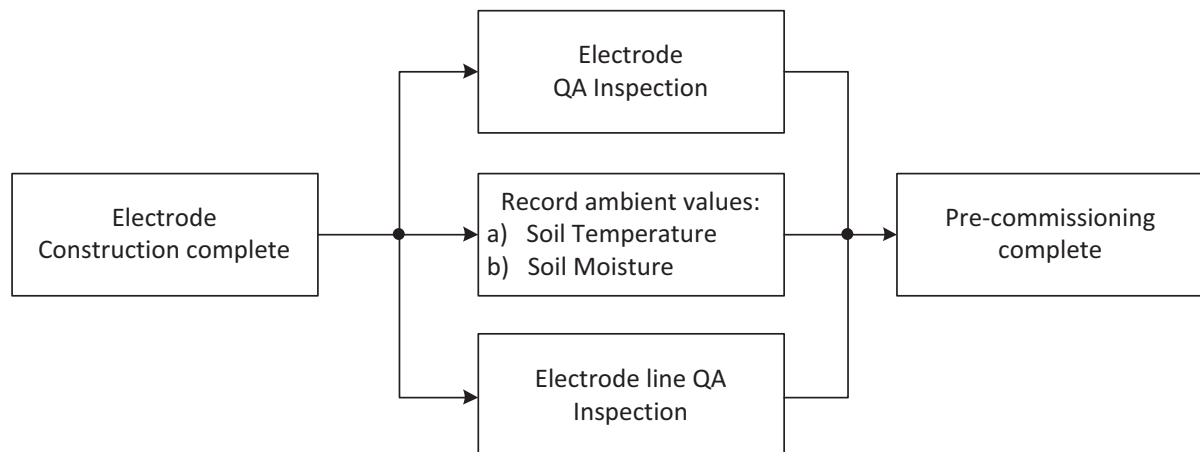
**Figure 19-2 – General Arrangement of the Electrode**

## 19.2 Pre-Commissioning Tests

The commissioning of electrode shall be performed in two stages, pre-commissioning and commissioning.

### Overview of Pre-Commissioning Tests

Pre-commissioning tests are necessary to ensure that electrode construction is complete, temporary grounds are removed, the electrode is constructed in accordance with the design and thus can be safely put into service. Figure 19-3 shows an overview of the tests.



**Figure 19-3 - Electrode Pre-Commissioning Tests**

### Pre-Commissioning Inspection

Prior to electrode energization, the electrode station shall be inspected to ensure that the electrode has been constructed as specified and all the temporary construction grounds have been removed.

#### **Required Test Equipment:**

- Inspection check sheet
- Torque wrench (1/2-inch drive click type) and sockets
- Micro-Ohmmeter (rental or provided by Customer)

#### **Procedure:**

- a) Electrode QA Inspection - The pre-commissioning inspection is to verify the construction is completed in accordance with the design. Each item on the check sheet provided in Table A-1 of Sample tables shall be verified.
- b) Verify that all connections are torqued to specification for the type/size of bolt and marked.
- c) Measurement of contact resistances of clamps to bus, arrester, reactor and capacitor connections and contact resistances of hook stick switches

### Measurement and Recording Soil Ambient Temperature and Moisture

#### **Required Test Equipment:**

---

*Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with  $\pm 500kV$  1500MW Chandrapur-Padghe HVDC Bipole link.*

- Multimeter with Ohmmeter function with cable for measuring the resistance of RTD in temperature measuring station. Temperature is determined from the measured value of the resistance of the RTD. The RTD is a PT100 with temperature coefficient of 0.00385 Ohms/degree C.
- Soil moisture test kit. The instrument reads the soil moisture directly when the probe is inserted to the bottom of the temperature measuring pipe.

**Procedure:**

Soil temperature and moisture measurements shall be performed manually at the measuring wells prior to any ground return mode operation using the specified portable instruments. The results shall be recorded in sheets based on Table A-2 of Sample tables.

Electrode Line QA inspection

Although the Electrode line is not within the scope of this work the following items should be checked prior to the electrode tests:

- a) The line conductors are complete with no missing sections, insulators are clean and arcing gaps ( if included in the line design) are installed.
- b) The shield wires are sectionalized and single point grounded for the specified distance from the electrode.
- c) All working grounds are removed
- d) There are no clearance violations to any items under the electrode line conductors.

19.3 Commissioning Tests

Overview of Commissioning Tests

The energization of electrode will be performed using the converters at Padghe. Measurements will be taken at the Padghe converter station and at the Malegaon electrode station. If any items have been identified for mitigation in the design report measurements would be required at these facilities as well.

Tests and measurements performed during commissioning include:

Group 1 Tests:

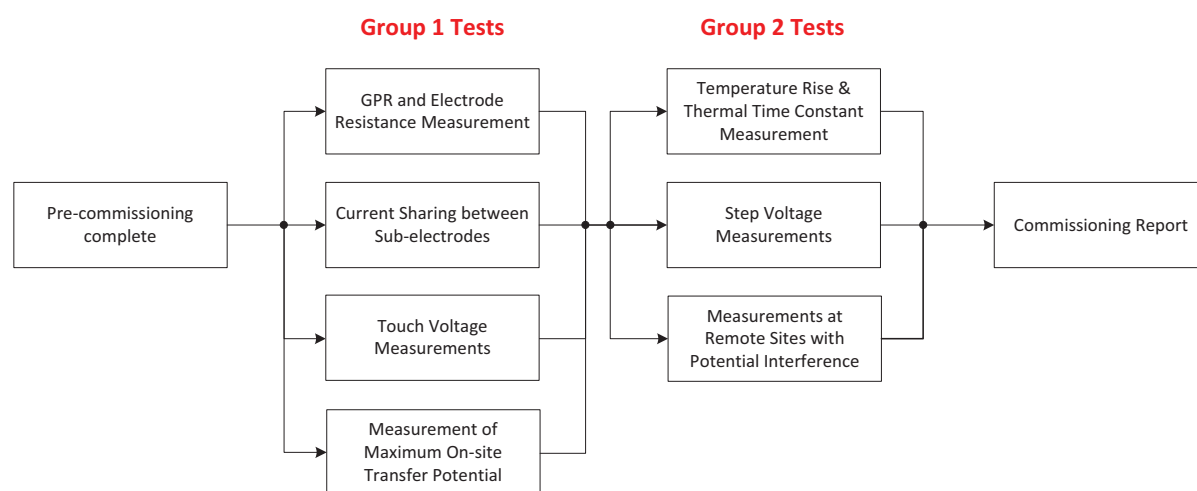
- a) Measurement of electrode potential rise
- b) Calculation of dc resistance of electrode to remote earth without any outage and with outage of 30% of sub-electrodes
- c) Measurement of current sharing between electrode sections of inner and outer rings without any outage and with outage of 30% of sub-electrodes
- d) Measurements of touch voltages
- e) Measurement of maximum transfer potential within the electrode substation.

Group 2 tests:

- a) Measurements of temperature rise and calculation of temperature rise time constant of the electrode

- b) Measurements of step voltages
- c) Measurements of possible interference at offsite locations.

An overview of the commissioning tests is shown in Figure 19-4. Note that the tests can be conveniently carried out in two groups. The Group 1 Tests will include the measurement of GPR, electrode resistance to remote earth, touch voltage and maximum on-site transfer potential. The Group 2 Tests will include the electrode thermal verification, measurement of step voltages and measurements at facilities which could be subject to interference (if required). Group 2 Tests are separated from Group 1 because these measurements require relatively long periods of operation at constant current.



**Figure 19-4 - Overview of Electrode Commissioning Tests**

### Measurement of Electrode Potential Rise and Resistance to Remote Earth

A good estimate of the ground potential rise at the electrode station can be obtained by injecting a known amount of current into the ground electrode through one of the electrode line conductors. The other conductor of the electrode line is open circuited at the converter station end and is used to measure the voltage change of the electrode with respect to remote earth. The open circuited electrode line conductor would be used to measure the electrode voltage at the Padghe converter station which represents remote earth. The open conductor ensures that the dc resistance of the electrode line is not included in the measurement of electrode resistance.

The voltage between the converter station ground and the open circuited electrode line conductor is the ground potential rise (GPR). The electrode resistance to remote earth is calculating the ratio of voltage over current. Current may be measured using the electrode line current transducer. Refer to Figure 19-4.

This method assumes that the ground potential rise at the converter station is negligible. The potential rise at any other electrode current can be determined by linear extrapolation of the measured value.

### **Test Equipment Required at Padghe:**

- Voltmeter suitable for measurement up to 1kV with accuracy of < 1%.

- Current transducer (the existing electrode line current transformer may be used)

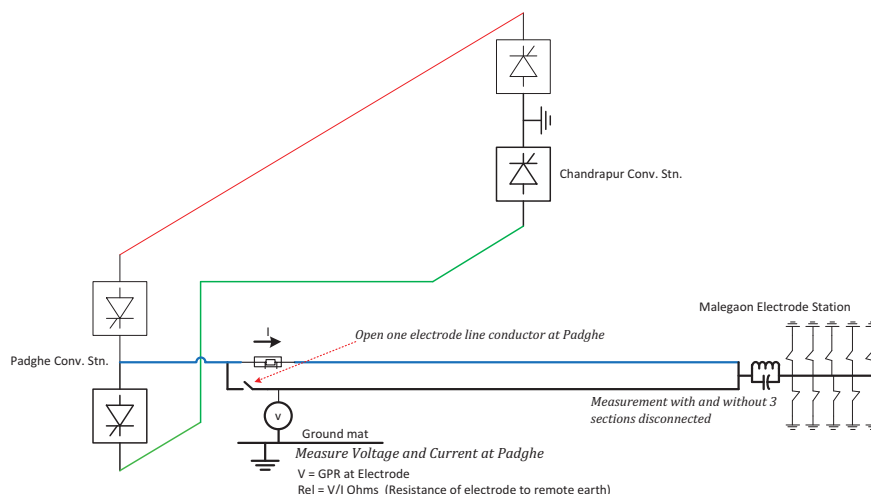
### Procedure:

The following is the sequence of steps to be followed

1. Inject dc current into one electrode line conductor **at Padghe** at the indicated measuring locations with magnitude of 0, 150, 1000, -150 and without outages and with outage of any 3 sub-electrodes. Both polarities of current are tested to detect possible polarization effects (if any). It should be verified that a single electrode line conductor can be thermally capable of carrying 1000A for up to 1 hour.
2. Maintain current at a constant value at each current test level until measurements at Padghe and at Malegaon are complete.
3. At each current step perform the following:
  - a) At Padghe, record the voltage (GPR) and calculate the electrode resistance ( $Rel = V/I$ ). (Table A-3)
  - b) At Malegaon, measure and record current in inner and outer sub-electrodes in accordance with Section-Measurements of Current Sharing between Sub-electrodes.
  - c) Stop HVDC system and connect both electrode line conductors
  - d) Increase electrode line current to rated current (1500 A)
  - e) At Malegaon, measure and record currents in each sub-electrode (Table A-4) in accordance with Section-Measurements of Current Sharing between Sub-electrodes.
  - f) Increase electrode line current to rated current (1650 A)
  - g) At Malegaon, measure and record currents in each sub-electrode (Table A-4) in accordance with Section-Measurements of Current Sharing between Sub-electrodes.

### Safety precautions:

It is expected that the electrode resistance will be within the range between 0.6 to 0.7 Ohms. Thus, the GPR may reach 600V to 700V at current of 1000A. A safety officer should be assigned at Padghe and at Malegaon by the Contractor to ensure that test equipment is adequate for the purpose and that safe practices and working procedures are followed throughout the tests.



**Figure 19-4 –Arrangement for Measuring Ground Potential Rise and Electrode Resistance**

### Measurements of Current Sharing between Sub-electrodes

This test will confirm the continuity of each sub electrode (feeder cables, distribution cables, individual sub-electrodes). Note that there is a large variation in soil resistivity over the site area and thus equal currents are not expected when comparing sub-electrodes. Inner ring sub-electrodes are expected to have lower current than outer ring sub-electrode. Currents shall be measured and recorded in each sub-electrode using the dc clip-on ammeter at the feeder cables below the disconnect switches. Acceptability of current sharing will be assessed after completing the measurements.

#### **Test equipment required at Malegaon**

- Clamp-on dc ammeter 0-600A (calibrated)

#### **Procedure:**

- a) At Malegaon, for each electrode current test level, measure and record the current in each of the 20 feeder cables to the sub-electrodes with no outage of electrodes sections similar to Table A-4 of Sample tables.
- b) Open hook stick switch of the three electrode sections selected for outage
- c) Repeat the measurements in a) above
- d) Reclose the hook stick switches

### Measurements of Touch Voltages

Touch voltages shall be measured and recorded at all structures on the site at test level of rated current (1500A) and, if possible, at the short time overload rating (1650A).

#### **Test equipment required at Malegaon**

- DC voltmeter with 2m test leads
- 200mm long steel rods driven into ground 150mm from all structures on the site.

#### **Procedure:**

- a) Drive the metal rods into the ground to a depth of about 100mm at a distance of about 1.2m from the structure. Leave them in place until the measurements are complete.
- b) Verify that the current injected is at one of the specified test levels (1500A, 1650A)
- c) Measure and record the voltage between the all structure and their associated metal rod. (Table A-5)
- d) Adjust the electrode current to the next test level and repeat the measurements.

Note: If the grounding of structures is correctly implemented then the touch voltages are expected to be nearly zero.

### Measurement of the maximum touch voltage that can occur on the site

The maximum touch voltage that can occur within the site is the voltage between the center of the inner ring (which has the highest potential rise) and the centre of the electrode which has the lowest potential rise. Due to unbalance of currents between the sub-electrodes of the outer ring, the GPR of the outer ring sub electrodes is not equal. The maximum GPR will occur on the sub-electrode with the lowest current. It is this sub-electrode that will be selected for measurement.

Slightly higher maximum touch voltages may be encountered during outages of three electrode sections. This may result in another different electrode section having lowest current and the measuring point would need to be moved.

### **Test equipment required at Malegaon**

- DC voltmeter with test leads
- Measuring leads or wire of 160m length stretching from centre of electrode to a point immediately above the inner ring near the middle of the sub-electrode. (Quantity 2)
- 20 cm metal rod to ensure contact with the soil. (Quantity 2)

Procedure:

- a) Identify the inner ring sub electrodes that have minimum current for the no-outage condition and for the case which has outage of three electrode sections
- b) Drive the metal rods at the center of the identified inner ring sub-electrode sections stretch out the 160m test leads from the centre of the electrode to the driven metal rods and fasten (or clip) the lead to the metal rod
- c) The other end of the 160m leads near the centre of the electrode may reach relatively high voltage and should not be handled during the test although it should be accessible for measuring using the insulated test leads of the multimeter.
- d) At each of the test currents (1500A and 1650A) and for outage and no-outage conditions record the voltage between the 160m test lead and one of the ground leads of the structures supporting the hook stick switches. Record the results in Table A-5.

### Measurement of temperature rise and calculation of temperature rise time constant

As the soil temperature increases slowly with large time constant, temperature measurements should be made over a duration of ideally up to one week one week of operation at constant dc ground current, ideally at maximum continuous current. If operation at maximum current cannot be arranged for one week, then a lower current which can be maintained at a constant value for at least three days (72 hours) should be selected.

Measurements of soil moisture and soil temperature at each of the electrode monitoring locations on the inner and outer rings shall be recorded. Measurements should be taken once per day at about the same time each day and recorded in Table A-6.

### **Safety Precautions:**

As the measurement of soil moisture will be carried out very near the coke bed of the electrode there is a risk of transfer potential from the electrode to the surface on the instrument leads or any metallic conductor. Suitable safety precautions need to be taken to avoid risk to personnel during measuring operations in monopolar operation. Also, all dip sticks used for water level measurement shall be non-conducting.

#### **Test equipment required at Malegaon**

- DC voltmeter with banana plug test leads for measuring resistance of temperature sensor RTDs.
- Soil moisture meter.

#### **Procedure:**

- a) Perform an initial set of temperature and soil moisture readings at all measuring locations and note the time
- b) Raise the electrode ground current to the rated value and hold it constant for the permitted test duration. A duration of 1 week is desirable but a minimum of 3 days
- c) Perform a set of soil moisture and temperature measurements every 24 hours at about the same time of day.
- d) Analyze the results to determine the thermal time constant and permitted time to maximum soil temperature of 90°C.

#### Measurement of Step Voltages

Step voltages shall be measured in the radial direction on at least 3 electrode sections (for instance 1, 4 and 7) and shall extend from at least 10 m inside the inner ring to 10m outside the outer ring. Step voltages would be measured at electrode currents of  $\pm 1500\text{A}$  and  $\pm 1650\text{A}$ .

#### **Test equipment required at Malegaon:**

- DC voltmeter with 2m test leads
- Measuring jig with 1m spacing to make it easier to measure profiles of voltage gradient  
(similar to Figure 19-5)

#### **Procedure:**

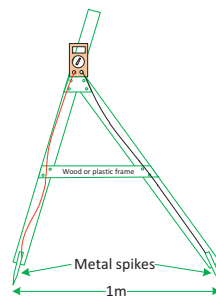
- a) Select the electrode sections that will be used to measure the step voltages and mark the tracks of the of the measurements on the ground using a temporary marking method such as stakes and string.
- b) Adjust the electrode current to the test level (1500A).
- c) On each of the selected electrode sections, measure a series of step voltages along a radial line taken near the middle of the section and a second profile should be measured near one end of the sub-electrodes. Record the results in Table A-7.

Profiles can be conveniently measured by constructing a measuring jig as shown in Figure 19-5. The jig can be walked along the profile by "walking" the jig by lifting the trailing edge and rotating it forward 180 degrees around the

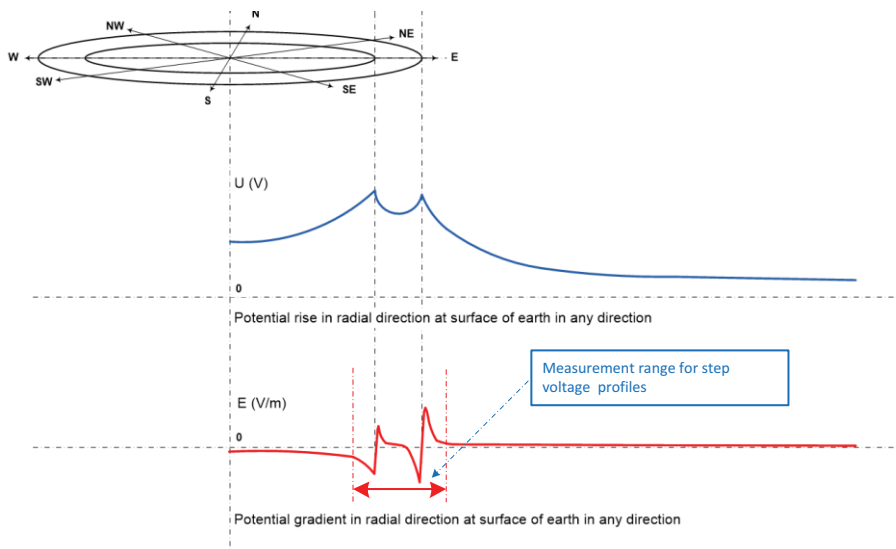
leading edge. A reading should be taken at each step. Note that the meter is reversed every "step" and thus polarity of meter readings need to be observed and adjusted.

The measurement shall be done radially along a line that passes through the centre of the electrode as shown in Figure 19-6. The voltage difference between each successive 1m step on the soil surface would be measured in the indicated range. The maximum step potential would be expected 2.5 to 3.5m outside each electrode ring.

- d) Perform a second set of measurements with an outage of three electrode sections. In this case, the measurements should be carried out on in-service electrode sections only.
- e) Repeat the step voltage profiles for a test current of 1650A and record results in Table A-7a.



**Figure 19-5 - Measuring Jig to Facilitate Step Voltage Profile Measurement**



**Figure 19-6 - Potential Gradient Measurements**

### Off-Site Measurements

Facilities that may be subject to interference from the Malegaon electrode have not been identified at this time. If necessary procedures for performing

measurements will be developed for each at-risk facility and will be described in a separate report.

## 19.4 Sample Tables for Recording Test Measurements

Table A-1 - Precommissioning Checklists Malegaon Electrode Station		
Item	Description	Verified
1	Constuction is complete	
2	Electrode Line is connected	
3	Electrode circuit matches single line diagram	
4	All structures are grounded at one point	
5	Cable Screens grounded (if screens are provided)	
6	Line shield wire is isolated at station (not grounded)	
7	All hookstick switches are closed	
8	Temperature and moisture measuring points installed and complete	
9	Site fences are in place (if applicable)	
10	Watering pipes installed and capped to	
11	Seepage wells installed in accodace with drawings	
12	connections are prepared with connection paste	
13	Cu/Al transition plates are installed at Hook switch top connections	
14	Bus supports include 1 sliding and one fixed fixing point.	
15	Structures ar level and anchor bolts are toqued and marked	
16	Insulators are in good condition and clean	
17	All working grounds removed	
	<b>Clamp Bolt Torque Checks</b>	<b>Verified</b>
1	incoming line conector west side	
2	Incoming line conector east side	
3	Bus connector to arrester leads	
4	Connections at at arrester	
5	Connections at at Reactor	
6	Connections at capacitor	
7	Connectors at electrode distribution bus	
8	Connectors at top of Hook switches	
9	Connectors at bottom of Hook switches	
	<b>Connector Resistance measurements</b>	<b>Value (<math>\mu\Omega</math>)</b>
1	incoming line conector west side	
2	Incoming line conector east side	
3	Bus connector going to reactor	
4	Reactor incoming conector (line side)	
5	Reactor ooutgoing connector (electrode side)	
6	reactor connection to capacitor (top)	
7	Reactor connection to capacitor (bottom)	
8	Capacitor connection to reator(top)	
9	Capacitor to reactor (bottom)	
10	bus connector going to reactor(electrode side)	
11	Bus connector to Hookstick switch 1	
12	Bus connector to Hookstick switch 2	
13	Bus connector to Hookstick switch 3	
14	Bus connector to Hookstick switch 4	
15	Bus connector to Hookstick switch 5	
16	Bus connector to Hookstick switch 6	
17	Bus connector to Hookstick switch 7	
18	Bus connector to Hookstick switch 8	
19	Bus connector to Hookstick switch 9	
20	Bus connector to Hookstick switch 10	
21	hookstick switch 1 connection to bus	
22	hookstick switch 2 connection to bus	
23	hookstick switch 3 connection to bus	
24	hookstick switch 4 connection to bus	
25	hookstick switch 5 connection to bus	
26	hookstick switch 6 connection to bus	
27	hookstick switch 7 connection to bus	
28	hookstick switch 8 connection to bus	
29	hookstick switch 9 connection to bus	
30	hookstick switch 10 connection to bus	
31	Hook stick Switch 1 switch top to bottom	
32	Hook stick Switch 2 switch top to bottom	
33	Hook stick Switch 3 switch top to bottom	
34	Hook stick Switch 4 switch top to bottom	
35	Hook stick Switch 5 switch top to bottom	
36	Hook stick Switch 6 switch top to bottom	
37	Hook stick Switch 7 switch top to bottom	
38	Hook stick Switch 8 switch top to bottom	
39	Hook stick Switch 9 switch top to bottom	
40	Hook stick Switch 10 switch top to bottom	
41	Hook stick Switch 1 to Feeder cable	
42	Hook stick Switch 2 to Feeder cable	
43	Hook stick Switch 3 to Feeder cable	
44	Hook stick Switch 4 to Feeder cable	
45	Hook stick Switch 5 to Feeder cable	
46	Hook stick Switch 3 to Feeder cable	
47	Hook stick Switch 6 to Feeder cable	
48	Hook stick Switch 7 to Feeder cable	
49	Hook stick Switch 8 to Feeder cable	
50	Hook stick Switch 9 to Feeder cable	
51	Hook stick Switch 10 to Feeder cable	
52	Connector at top of arrester	
53	Connector at botom of arrester	

Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with  $\pm 500kV$  1500MW Chandrapur-Padghe HVDC Bipole link.

Precommissioning Measurements Malegaon Electrode Station				
Table A-2 - Ambient Soil temperature and Moisture levels				
	Soil Ambient Temperature and Moisture Levels	RTD Resistance( $\Omega$ )	Temperature( $^{\circ}$ C)	Soil Moisture (%)
	Electrode Section 1 Inner ring	105.1	13.2	
	Electrode Section 1 Outer ring	100	0.0	
	Electrode Section 2 Inner ring	100	0.0	
	Electrode Section 2 Outer ring	100	0.0	
	Electrode Section 3 Inner ring	100	0.0	
	Electrode Section 3 Outer ring	100	0.0	
	Electrode Section 4 Inner ring	100	0.0	
	Electrode Section 4 Outer ring	100	0.0	
	Electrode Section 5 Inner ring	100	0.0	
	Electrode Section 5 Outer ring	100	0.0	
	Electrode Section 6 Inner ring	100	0.0	
	Electrode Section 6 Outer ring	100	0.0	
	Electrode Section 7 Inner ring	100	0.0	
	Electrode Section 7 Outer ring	100	0.0	
	Electrode Section 8 Inner ring	100	0.0	
	Electrode Section 8 Outer ring	100	0.0	
	Electrode Section 9 Inner ring	100	0.0	
	Electrode Section 9 Outer ring	100	0.0	
	Electrode Section 10 Inner ring	100	0.0	
	Electrode Section 10 Outer ring	100	0.0	

Table A-3 - Electrode GPR and Resistance to Remote Earth			
	Decription	GPR	Electrode Resistance( $\Omega$ )
Item	Measurement of GPR and Resistance	Voltage (V)	
1	GPR at Iel = 0 A ( at Padghe)		--
2	GPR at Iel = 150 ( at Padghe)		0
3	GPR at Iel = 500 ( at Padghe)		0
4	GPR at Iel = 1000 ( at Padghe)		0
5	GPR at Iel = -150 ( at Padghe)		0
6	GPR at Iel = -500 ( at Padghe)		0
7	GPR at Iel = -1000 ( at Padghe)		0

**Commissioning Tests - Group 1  
Malegaon Electrode Station**

Table A-4 - Current Distribution between Electrode Sections				
<b>1</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel =150A, No outage</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>2</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = -150A, No outage</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>3</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel =1000A, No outage</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>4</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel =1500A, No outage (2 conductors on line)</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>5</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1500A, 3 outages</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>6</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel =1650A, No outage (2 conductors on line)</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>7</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1650A, 3 outages</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	

**Commissioning Tests - Group 1  
Malegaon Electrode Station**

**Table A-5 - Touch Voltage at Maximum Current**

	<b>Touch voltage Measurements @ Iel=1650A</b>	<b>Touch voltage(V)</b>
	incoming tower	
	incoming bus structure 1 west	
	Incoming bus structure 2 east	
	Arrester structure	
	Reactor structure	
	Capacitor structure	
	Electrode distribution Bus structure 1	
	Electrode distribution Bus structure 2	

**Table A-5a - Maximum Possible Transfer Potential on Site**

	<b>Maximum Transfer Potential on site @1650A</b>	<b>Transfer Voltage(V)</b>
	First electrode section (center) no outage	
	First electrode section (edge) no outage	
	Second electrode section (center) no outage	
	Second electrode section (edge) no outage	
	First electrode section (center) outage 3 sections	
	First electrode section (edge) outage 3 sections	
	Second electrode section (center) outage 3 sections	
	Second electrode section (edge) outage 3 sections	

**Commissioning Tests Group 2  
Malegaon Electrode Station**

**Table A-6 - Soil Temperature Rise and Moisture levels**

Soil Ambient Temperature and Moisture Levels	Day 0 - 9:00am Initial Cond			Day 1 - 9:00am		
	RTD Resistance(Ω)	Temperature(°C)	Soil Moisture (%)	RTD Resistance(Ω)	Temperature(°C)	Soil Moisture (%)
Electrode Section 1 Inner ring	105.1	13.2		105.1	13.2	
Electrode Section 1 Outer ring	100	0.0		100	0.0	
Electrode Section 2 Inner ring	100	0.0		100	0.0	
Electrode Section 2 Outer ring	100	0.0		100	0.0	
Electrode Section 3 Inner ring	100	0.0		100	0.0	
Electrode Section 3 Outer ring	100	0.0		100	0.0	
Electrode Section 4 Inner ring	100	0.0		100	0.0	
Electrode Section 4 Outer ring	100	0.0		100	0.0	
Electrode Section 5 Inner ring	100	0.0		100	0.0	
Electrode Section 5 Outer ring	100	0.0		100	0.0	
Electrode Section 6 Inner ring	100	0.0		100	0.0	
Electrode Section 6 Outer ring	100	0.0		100	0.0	
Electrode Section 7 Inner ring	100	0.0		100	0.0	
Electrode Section 7 Outer ring	100	0.0		100	0.0	
Electrode Section 8 Inner ring	100	0.0		100	0.0	
Electrode Section 8 Outer ring	100	0.0		100	0.0	
Electrode Section 9 Inner ring	100	0.0		100	0.0	
Electrode Section 9 Outer ring	100	0.0		100	0.0	
Electrode Section 10 Inner ring	100	0.0		100	0.0	
Electrode Section 10 Outer ring	100	0.0		100	0.0	

Table A-7 -Step Voltage Profiles (1500A)						
Distance from center (m)	no outage	no outage	no outage	3 outages	3 outages	3 outages
	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)
150						
151						
152						
153						
154						
155						
156						
157						
158						
159						
160						
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162						
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165						
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200						

Table A-7a -Step Voltage Profiles (1650A)						
Distance from center (m)	no outage	no outage	no outage	3 outages	3 outages	3 outages
	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)
150						
151						
152						
153						
154						
155						
156						
157						
158						
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## ETC BOQ

## Annexure-1

Sr. No.	Item Details	Unit	Quantity
1	<b>High Silicon Chromium Iron Electrode element (2.5m long) fitted with jumper cables :</b> Laying of Sub-Electrode elements (anodes with pre-fabricated cables of different lengths) in centre of coke trench complete with Cabling (1Cx8 sq.mm. or 1Cx10 sq.mm.) as specified in technical specification. Dimension of anodes- 65mm diameter, 2500mm long.	No	495
2	<b>Calcined petroleum coke of high conductivity :</b> Coke Backfill inside coke trench of cross-section size 0.8m x 0.8m along complete length as specified in technical specification.	Cubic meter	1650
3	<b>6.6/11 kv Feeder cable 150 Sq.mm (copper):</b> Cable preparation & laying: includes laying, dressing , and fitting termination kit of cables - laying can be either on supports, underground (in buried trench), over ground, in conduits, in wall etc. All other erection materials viz. ferrules, lugs, cable ties/ straps, markers etc. to be included ,where ever applicable, in the quoted rates.	M	3850
4	<b>3.8/6.6kV Distribution cable (copper) :</b> Cable preparation & laying: includes laying, dressing , termination of cables - laying can be either on supports, underground (in buried trench), over ground, in conduits, in wall etc. All other erection materials viz. ferrules, lugs, cable ties/ straps, markers etc. to be included,where ever applicable, in the quoted rates.	Meter	2250
5	<b>PVC conduit with bend and support strap, 63 mm diameter,2.5 mm thickness to protect feeder cables</b> (Supply & Laying of PVC pipe including bends & support strap)	Meter	100
6	<b>Galvanised steel Pipe type Structure erection complete with fixing harware for equipments support</b>	MT	7
7	<b>Double break disconnecter Manually operated &gt; 600 A</b> (without support structure): HDB single phase Disconnecter with Insulators,MOM Box,terminal connectors, laying of Aux earthmat for MOM box complete with terminal connector and accesories (without support structure)	No	10
8	<b>Electrode line impedance supervision Reactor 0.5mH, 2000A, 130kV BIL, 10kA thermal current 1 sec, air core, Class F insulation complete with terminal connector and accesories (without support structure)</b>	No	1
9	<b>Electrode line impedance supervision Blocking Filter Capacitor 0.52uF, 4.652kV complete with terminal connector and accessories (without support structure)</b>	No	2
10	<b>Electrode line impedance supervision Arrester Uc=1kV (min), Discharge class 3, Residual voltage 12kVp @5kA Lightning Impulse complete with terminal connector and accessories (without support structure)</b>	No	1
11	<b>Bus Post insulators complete with terminal connector and accessories (without support structure)</b>	No	4
12	<b>3" Al Tube (ETC of Al.Tube includes cutting, Aluminum welding, testing, bending &amp; installation of Al. Tube).</b>	Meter	15
13	<b>AAC/ACSR Conductor complete with Tee connectors for droppers to equipment connections, PG clamps for Busbar jumpering, Twin/Quad bundle rigid/flexible spacers etc</b>	Meter	200
14	<b>Supply of 120 Sq.mm bare copper conductor</b>	Meter	300
15	<b>Supply of 40mm dia. MS rod</b>	Meter	300
16	<b>Supply of 75x12 GI flat</b>	Meter	100
17	<b>Supply of 40mm dia Rod electrode for surge arrester (3 meter each)</b>	No	2
18	<b>Unloading, storing and laying of 40 mm dia MS Rods/ 120 sqmm bare copper conductor at a depth of 600 mm measured from the top of Finished Ground Level and bringing out risers 300 mm above ground level to the nearest point of the equipment foundations as per requirement including following works:</b> - excavation of trenches - laying of MS rod /bare copper conductor - welding/ brazing - backfilling of soil for bringing out pig tail risers of 40 dia MS rod/ bare copper conductor (aproximately 60 nos.) for equipments. Risers shall be raised from the earthmat (at 600 mm depth) to 300 mm above ground level to the nearest point of the equipment. This shall include all cutting, bending, welding/brazing, fixing, application of paint on cutting & welded/brazed surface, etc to the main earthmat as per attached specification for underground earthing and electrodes and equipment earthing details notes . - any other work necessary to complete the laying of earthmat	Meter	300
19	<b>Fabrication (as per technical specification) &amp; laying of Auxiliary Mat of 40 mm Dia MS Rods at a depth of 300 mm from top of FGL including excavation &amp; backfilling</b> - any other work necessary to complete the laying of earthmat	No	10

20	Earthing work with 75X12 GI Flat - Installation of GI Flat including cutting, bending, welding with GI Flat / MS Rod, supply and application of paint, clamping to structure/building wall etc. to complete in all respect. All arc welding shall be done with low hydrogen content electrodes. the welds should be treated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminum paint. The red oxide and zinc chromate shall conform to IS:2074.	Meter	100
21	<b>Installing of 40 mm diameter Rod Electrode without test pit (LA) including following works:</b> - excavation/hammering of rod in earth - installing the rode electrode - backfilling and compaction - any other work necessary to complete the work	No	2
22	<b>Electrode watering system comprising of pump, borewell, DG set, watering pipes, seeping well, valves, joints and connectors of various sizes as per Technical Specification (Design, supply &amp; ETC):</b> 1. Supply & ETC of Piping (consists of Tough hose-Twin-liner drip polytube as per IS: 12786, Power-loc Tee fitting, Power-loc 90 Degree) for watering electrode trenches from the water tank (pipe dia should be selected by vendor suitably as per design/requirement and to maintain adequate continuous flow of water through out the electrode trench) 2. Supply & ETC of submersible pump (5 HP)-2 No. 3. Supply & ETC starter panel/ distribution board of submersible pump 4. Supply & ETC of 7.5 KVA DG SET (1 no.) 5. Supply & ETC of cable (from DG to starter panel/distribution board and starter panel/distribution board to pump with cable glands for above items	Set	1
23	<b>Boring/drilling bore well of required dia for casing/strainer pipe, by suitable method prescribed in IS:2800 (part I), including collecting samples from different strata, preparing and submitting strata chart/bore log, including hire &amp; running charges of all equipments, tools, plants &amp; machineries required for the job, all complete as per direction of Engineer-in -charge, upto 90 metre depth below ground level</b>	Meter	50
24	<b>Water permeable Geotextile cloth (supply &amp; laying)</b> Supply & Laying of Geo Textile Fabric on top of coke bed as specified in technical specification (400 Sqmm)	Sq. Meter	400
25	<b>SACRIFICIAL paper form (supply &amp; laying)</b> Supply & Laying of SACRIFICIAL paper form for seeping wells (400 Sqmm)	Sq. Meter	400
26	<b>RTD Temperature Measurement Sensor along with conduits :</b> 1. supply of PVC conduit and fittings, plexiglass as specified in technical specification. 2. Laying of Soil temperture & moisture sensor with PVC conduits and fittings, Plexiglass.	No	20
27	<b>Joints, welds and resin material (supply and installation)</b> 1. joining of Feeder cable with distribution cable by CAD welding joints including material supply (20 joints) 2. joining of jumper cable with distribution cable by CAD welding joints including material supply (460 joints)	lot	1
28	<b>Joints, welds and resin material (supply and installation)</b> Exothermic cad welding (T joint= 30 nos, 120 sqmm bare copper conductor)	no of joints	30
29	<b>Warning tape -Caution Electric Cable Below" roll of 300 m (1000ft) (supply &amp; laying)</b>	rolls	20
30	<b>Power cables, junction boxes and other accessories required for illumination system &amp; power supply in line with Technical Specifications (supply &amp; ETC):</b> Supply & ETC of CFL lamp fitting, exhaust fan, ceiling fan, Switchboard with 2 5/15A sockets and 4 switches, Electric lamp for main gate, Cabling, PVC conduits, MCB box(1no)	Set	1
31	<b>Supply &amp; ETC of Equipment Fixing Hardware - Full Threaded bolts with nut and two Plane Washer and one Spring Washer</b>	KG	15

Sl.No.	ETC BOQ_ANNEXURE_1: STANDARD & PROJECT SPECIFIC TECHNICAL NOTES & SCOPE
1	<p>Bidder Supplied Material - For approved make of supply items, please visit "MSETCL'S APPROVED VENDOR LIST" at following website address. <a href="http://www.mahatransco.in">www.mahatransco.in</a></p> <p>Bidder to offer items from MSETCL approved make only (as applicable). Bidder to supply material of proven design and make, which have already been extensively used and tested. Bidder to obtain approval from BHEL Engineer incharge / Customer prior to supply. Quantity of supply items are provisional and shall be finalised during contract stage. Qty of supply item may vary upto any extent and and even may get deleted. However overall contract value may vary +/- 30%. Variation will be valid up-to contract stage.</p>
2	Quoted rates are deemed to be inclusive of miscellaneous works viz erection of clamps and connectors.
3	Supply of all paint, welding electrodes, grease for clamps & connectors and other consumable required by ETC contractor shall be part of ETC works. Paint, welding electrode, grease make etc. is subject to BHEL/CUSTOMER approval.
4	Equipment erection (say Isolator ) means complete erection, metallics, post insulator, connectors (expansion/rigid tubular for Al.Tube / single/double/quadraple conductor), connection to the next in line (if connected to overhead busbar or droppers) including PG clamps/Tee connectors etc. This will be clear from the enclosed electrical layout drawings.
5	Equipment and tower erection would include supply and erection of miscellaneous items , viz labels of equipments ,danger plates , device number marking on the equipment etc as per site requirements. Supply & Mounting of Danger plates shall be as per IS-2551, latest ammendment.
6	The storage instructions of the equipment manufacturer/ Employer shall be strictly adhered to. MSETCL Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.
7	<p><b>ETC of Power Cable:</b> Scope includes Cable Laying tagging , dressing, ferruling, lugging, installation of cable gland, fitting of cable termination kit,soldering, tapping, jointing, crimping, termination, and drilling/ cutting holes in cable gland plates- laying can be either on trays, hanger, supports, underground, buried in ground or through GI/PVC pipe over/under ground, through wall etc. All erection materials viz. Cable Lug, ferrules, cable ties / straps, Al. tags, route markers, GI / PVC wall sleeves with rubber / nylon bushes etc shall be supplied by bidder. excluding supply of Cable Gland which are covered separately (as a separate BOQ item / free supply by BHEL). Machine ferruling shall be adopted.</p>
8	For Directly Buried Cable (as mentioned above) bidder to supply & install cable route marker. Location of cables laid directly underground shall be clearly indicated with <b>cable route marker</b> made of galvanised iron plate. The cable route marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction.
9	<p><b>CABLE LUG (as applicable):</b> Supply of cable lug is in bidders scope. cable lugs shall be tinned copper solderless crimping type conforming to IS-8309 &amp; 8394 for all control Cables and cables with copper wire.</p> <p>For Aluminium Bimetallic lugs for power cables as required shall beused depending upon type of cables and terminations. Solderless crimping of terminals shall be done by using corrosion inhibitory compound.</p> <p>The cable lugs shall suit the type of terminals provided. The bidder shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.</p> <p>Bidder to supply cable lug from manufacturer's authorisedrepresentative / dealer. Make of cable lug is to be approved by MSETCL.</p>

Sl.No.	ETC BOQ_ANNEXURE_1: STANDARD & PROJECT SPECIFIC TECHNICAL NOTES & SCOPE
10	<b>Cable TAGS &amp; Markers</b> - Bidder to supply and install cable tag & markers. The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables.
11	<b>Cable Gland:</b> Tin/ Nickel, Nichel/chromium - Plated (coating thickness not less than 10 microns) MSETCL approved make brass cable glands, double compression heavy-duty type complete with necessary armour clamp & tapered washer etc. Bidder to offer the gland from authorised representative of manufacturer. Cable gland shall be subject to customer approval prior to dispatch.
12	Power cables shall be securely fixed to the trays/supports with self locking type nylon ties with de-interlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.
13	All arc welding with shall be done with <b>low hydrogen content electrodes</b> for all earthing works i.e. MS Rod, GI Flat & MS Flat
14	All exothermic weld joint to be carried by skilled manpower. Bidder to offer checking of joints by BHEL/ customer site incharge.
15	The welds on 40MM MS Rod, MS Flat(existing), should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
16	Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red oxide primer and afterwards coated with two layers <b>bitumen compound</b> to prevent corrosion.
17	All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.
18	Compleete ETC package is under the scope of bidder. All T&P required to complete the job including cranes etc. required to complete the job shall be provided by bidder only.
19	Welding of Aluminium tubes (supply of welding sleeve excluded) as per 'Annexure-C: PROCEDURE FOR WELDING OF ALUMINIUM BUSES' is in ETC contractor's scope and joints shall be tested as per SECTION-SWITCHYARD ERECTION. Welding and Bending machines and any other equipment will be in ETC Contractor scope.
20	<b>Testing istruments</b> (dully calibrated) as mentioned in Technical specification (under clause:19 of section-2- Sub system and Pre-commissioning) shall be arranged by ETC Contractor at it's own cost till sucessful completion of ETC work . However, if any other instrument not mentioned in TS but required for sucessful completion of ETC work shall be in ETC contractor's scope. Bidder to submit valid calibration certificate during commencement of testing / commissioning works.



**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION BUSINESS ENGINEERING MANAGEMENT, NOIDA.**

DOCUMENT No.	TB-422-607-001-PKG-I	R0	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	[REDACTED]		
TITLE		SIGN	[REDACTED]		
TECHNICAL SPECIFICATION FOR CIVIL WORKS OF EARTH ELECTRODE STATION	DATE	26-10-2023	26-10-2023	26-10-2023	
	GROUP	TBEM	TBEM	TBEM	
CUSTOMER	MAHARASHTRA STATE ELECTRICITY TRANSMISSION CORPORATION				
PROJECT	1650ADC Shallow type Earth Electrode at Malegaon for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link				

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	(a) CUSTOMER TECHNICAL SPECIFICATION	99

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## SECTION - 1

### SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

#### 1.1.0 SCOPE

1.1.1 The scope of work under this specification is civil works of 1650ADC Shallow type Earth Electrode at Malegaon for Padghe HVDC terminal station pertaining to +/- 500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link end being executed by BHEL. The Customer is MAHATRANSCO.

The Civil Works shall generally include, *but not limited to*, following:

- (i) Soil investigation
- (ii) Equipment foundations
- (iii) Trench Excavation and back filling
- (iv) Boundary wall & Main gate
- (v) Guard (Security) hut with sanitation facilities
- (vi) Civil works associated with laying of Electrode elements, cables, water pipes, seeping wells and other accessories etc.
- (vii) Site Levelling including excavation, filling and Compaction of Electrode site.
- (viii) Overhead water tank (RCC) 2.5 meter height with staircase
- (ix) Any other work required for the project in Earth Electrode Station area

#### 1.1.2

The works to be performed in the above construction includes preparation of bar bending schedules, based on the drawings released for construction and getting the same approved by the Engineer-in-charge plus the execution of the work including providing of all labour, supervision, materials, scaffolding, power, fuel, construction equipments, tools and plants, supplies, transportation, all incidental items necessary for successful completion of the work including contractor's supervision and in strict accordance with the drawings and specifications and with inspection and testing standards. The nature of work shall generally involve excavation in all type of soil including dewatering, shoring, strutting, filling and compaction under and around structures, backfilling with available excavated earth around completed structures, cable trenches with covers, disposal of surplus soil, steel formwork, providing necessary steel embedment's and other inserts, drainage work, concreting, brickwork, flooring and finishing etc. and all other works in building all complete as per detailed specification, drawings and directions of Engineer-in-charge

**1.2.0 SPECIFIC TECHNICAL REQUIREMENT**

1.2.1 The specific technical requirements for the execution of civil works shall be as per Customer's specification (Section-3) /I.S Specification. In case of any conflict between these Customer's specification shall prevail.

**1.3.0 BILL OF QUANTITIES**

1.3.1 The Bill of Quantity cum price schedule shall be as per page 1.3 to page 1.5

1.3.2 The quantities indicated in the 'Bill of Quantity cum price schedule' are indicative and can vary to any extent. Contractor shall not be entitled for any claim for any such variation in the quantities.

1.3.3 The provision of Bill of Quantity cum price schedule, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, the clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding.

1.3.4 Method of measurement for payment purpose:

1.3.4.1 Excavation shall be measured in cubic meters. The lateral dimensions to be considered for working out excavation quantity shall be the PCC dimension below the footing as per approved drawing.  
Nothing extra shall be paid for slope cutting, etc. Backfilling & disposal quantities shall be worked out based on the above dimensions only. However the contractor shall maintain the required slope and working space as per the safety /statutory requirement and its cost is deemed to be included in the quoted rate.

1.3.4.2 Method of Measurement for Excavation in Trench Rings for Electrode station:

The excavation profile shown in tender drawing no. CHP-MEL-SD-280-01 (Sheet 2 of 5) is to be considered for payment purpose only for excavation and backfilling. However, the side slopes or terracing of trench to be decided at site as per soil conditions to maintain safety and working requirement.

Reference Tender drawings:

- 1) CHP-MEL-GA-280-01 (Sheet 1 of 1)
- 2) CHP-MEL-SD-280-01 (Sheet 1 to 5)

1.3.4.3 For other items, unless otherwise described the method of measurement as described in 'Method of Measurement of Building and Civil Engineering Works'-IS 1200(Part I to XXV) latest edition of BIS shall be followed.

1.3.4.4 Immediately after taking over of the site, the contractor shall carry out the topographical survey of the existing ground for the project site jointly with BHEL and customer before commencing any construction or levelling activity. The spot levels shall be taken as per the instructions of the Engineer-in-charge. Based on field observations, the bidder shall prepare and submit the survey map indicating spot levels to BHEL. The cost of the survey shall be deemed to be included in the scope and nothing extra shall be paid for the same.

## BILL OF QUANTITY

**Name of Project :** 1650ADC Shallow type Earth Electrode at Malegaon for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link

**Name of Work :** CIVIL WORKS OF EARTH ELECTRODE STATION

S.No.	Description of Item	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
1	Mobilization & Demobilisation of necessary equipment, tools, plants, manpower, etc., for conducting soil investigation at a project site.	Lot	1	60400	60400
2	Drilling boreholes of 150mm dia, at specified locations including performing SPT, collecting disturbed and undisturbed samples, recording water table etc, all complete as per specification including backfilling of boreholes as per direction of Engineer-in- Charge.	RM	75	1000	75000
3	Add extra for rock drilling in boreholes where rock is encountered, all complete as per specification.	RM	30	1800	54000
4	Making trial pits of 2 mx 2 m in size extending to 4 m depths at specified locations and taking undisturbed samples as per specification including backfilling of pit as per direction of Engineer-In-Charge	Nos	5	3300	16500
5	Conducting laboratory tests on soil and water samples all complete as per specification.(Payment against this item shall be made based on the total no. of boreholes driven as per Item No 2 however, charges for laboratory testing of the samples collected from Trial Pits shall be deemed to be inclusive in the rate of this item). Note: The laboratory tests shall be carried out at any Govt Approved agencies/NABL accredited laboratories], Furnishing 2 copies of draft report and 4 copies of final report.	Per Bore Hole	3	3950	11850
6	Earthwork in excavation & filling in all types of soil and soft/disintegrated rock in open areas/nallas/channels, to the required slopes, shapes, levels, elevations and profile, including trimming of bottom and slopes of excavation, bailing out rain (dewatering), pumping, removal of slush, preparing embankments/marginal banks, loosening, dressing, spreading material in layers not exceeding 200mm, as per direction of Engineer-in- Charge, water flooding, compacting to achieve 95% consolidation at optimum moisture content, finishing etc. all complete, for all leads and lifts within leveling boundary, including disposal of surplus earth and stacking of unsuitable material within a lead of 2.0 Km beyond substation boundary, with all labour, material, tools, tackles and equipment, safeguards and incidentals, Royalty,taxes etc. as necessary, as per drawings, specification and directions of the Engineer-in-Charge. Clearing of jungle is included in this item. (Only excavation/cutting will be measured for payment purpose.)	Cu.Mtr.	96000	87.5	8400000
7	Earthwork in excavation by mechanical means(Hydraulic excavator)/manual means over areas (exceeding 30cm in depth 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and disposal of excavated earth upto 100m and lift upto 4m, disposed earth to be levelled and neatly dressed. All kinds of soil .	Cu.Mtr.	3100	125.95	390445
8	Earthwork in excavation by mechanical means(Hydraulic excavator)/manual means over areas (exceeding 30cm in depth 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and disposal of excavated earth upto 100m and lift upto 4m, disposed earth to be levelled and neatly dressed. Ordinary Rock.	Cu.Mtr.	1350	221.05	298417.5
9	Earthwork in excavation by mechanical means (Hydraulic excavator )/manual means in foundation trenches or drains (not exceeding 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and dressing of sides and ramming of bottoms, lift upto 3.5m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 100m. All kinds of soil .	Cu.Mtr.	18200	166.4	3028480
10	Earthwork in excavation by mechanical means (Hydraulic excavator )/manual means in foundation trenches or drains (not exceeding 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and dressing of sides and ramming of bottoms, lift upto 3.5m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 100m. Ordinary Rock.	Cu.Mtr.	5200	275.85	1434420
11	Filling available excavated earth (including rock) in trenches, plinth, sides of foundations, etc., in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead upto 100m and lift upto 3.5m.	Cu.Mtr.	23000	125.75	2892250

**BILL OF QUANTITY**

**Name of Project :** 1650ADC Shallow type Earth Electrode at Malegaon for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link

**Name of Work :** CIVIL WORKS OF EARTH ELECTRODE STATION

S.No.	Description of Item	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
12	Carriage & disposal of surplus excavated earth/rock beyond initial lead by mechanical means not necessarily all the times on pucca roads, including loading, unloading, dressing of excavated material, etc., complete as per specifications Lead upto 2 km.	Cu.Mtr.	2000	111.5	223000
13	Providing and laying in position cement concrete of 1:4:8(1 cement : 4 fine sand : 8 stone aggregate, 40mm nominal size) grade including the cost of centering and shuttering - all complete	Cu.Mtr.	160	4226	676160
14	Providing and laying in position cement concrete of 1:2:4(1 cement : 2 fine sand : 4 coarse aggregate 20 mm nominal size) grade including the cost of centering and shuttering - all complete	Cu.Mtr.	39	5021.38	195833.82
15	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying, centering and shuttering, but excluding reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/cum. Excess/ less cement used as per design mix is payable/recoverable separately).	Cu.Mtr.	1048	5965	6251320
16	Add for using extra cement in the items of design mix over and above the specified cement content therein	quintal	1048	533.82	559443.36
17	Steel reinforcement -Cold twisted bars /TMT- Fe 500/Fe 500D conforming to IS: 1786 of approved make of Mahatransco Including supply, straightening, cutting, bending, binding, (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	MT	73.36	79120	5804243.2
18	Steel reinforcement -Cold twisted bars /TMT- Fe 500/Fe 500D conforming to IS: 1786. excluding supply, straightening, cutting, bending, binding, (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	kg	10000	11	110000
19	Structural steelwork welded in built up sections like edge protection angles, pipes, insert plates with lugs gratings, frames, ladders, stair railings, framed work and similar works including providing, cutting, hoisting, fixing in position/ embedding in concrete and applying a priming coat of approved steel primer all complete.	MT	15	79000	1185000
20	Grouting of block outs, pockets, foundations, bolts holes and underside of base plates with cement, sand aggregate ( of size 6 mm and down) grout 1:1:2 with non-shrink additive and shall be of strength not less than M30 including placing, curing, cleaning, surface preparation, testing, etc. complete with labour, materials, equipment, handling, testing, etc. all complete as per specifications, drawings and instructions of the Engineer.	cum	2	11197.67	22395.34
21	Supplying & fixing (all dia & length) foundation bolts in position with help of proper templates (to be supplied by contractor) including nuts, washers(Mass of Zinc Coating= 610 gm/ sqm) and template all complete as per drawings & directions of Engr-in-Charge. Weight of the template shall not be measured for payment purpose.	kg	500	118	59000
22	Overhead Water Tank with staircase- All civil works as per drawing and Technical Specification including finishing (internal and external) etc complete in all respect. However, excavation, PCC, RCC and reinforcement shall be paid separately as per items available in this schedule.	Nos.	1	150000	150000

## **BILL OF QUANTITY**

**Name of Project :** 1650ADC Shallow type Earth Electrode at Malegaon for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link

**Name of Work :** CIVIL WORKS OF EARTH ELECTRODE STATION

S.No.	Description of Item	Unit	Quantity	Unit Rate (Rs)	Amount (Rs)
23	Boundary wall including gate as per drawing and Technical Specification including barbed wire fencing and concentrina coil. However, excavation, PCC, RCC and reinforcement shall be paid separately as per items available in this schedule.	M	1588	9259	14703292
24	Supplying and filling in with Fine sand in trenches/floors including watering, ramming, consolidating and dressing complete	Cu.Mtr.	670	810.82	543249.4
25	Seeping well concrete curb - Precast or cast in place concrete circular ring without steel reinforcing- 1m diameter 300 mm high 100mm thick	Cu.Mtr.	5	15000	75000
26	Supplying and laying of round river rock 50 to 100mm size or clean, silt free, crushed rock	Cu.Mtr.	90	797.16	71744.4
27	Supplying and laying of Pea gravel fill of size less than 50mm for use as filter in seeping wells	Cu.Mtr.	5	895.49	4477.45
28	Security Hut - All civil works as per drawing and specifications complete, including - brickwork, finishing (external and internal), windows etc. However, excavation, PCC, RCC and reinforcement shall be paid separately as per items available in this schedule.	Sq.m.	20	20600	412000
29	SEPTIC TANK & SOAKPIT FOR SECURITY ROOM as per drawing and technical specification	Nos.	1	125000	125000
30	Supplying and laying CPVC pipe for external water supply system - 50 mm dia pipe as per technical specification	M	200	422	84400
31	Supplying and laying CPVC pipe for external water supply system - 25 mm dia pipe as per technical specification	M	100	173.6	17360
32	Providing & Laying of SW pipes for external sewerage system as per technical specification 150mm diameter pipe	M	20	296.56	5931.2
33	Providing & Laying of SW pipes for external sewerage system as per technical specification 250mm diameter pipe	M	20	615.02	12300.4
<b>Total</b>					<b>47952913.07</b>

## **STANDARD TECHNICAL SPECIFICATION FOR SOIL INVESTIGATION**

### **2.1.0 BORE HOLES**

Drilling of bore holes of 150 mm dia. in accordance with the provisions of IS: 1892, to 15m depth or to refusal whichever occurs earlier. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. In case of refusal within 3M depth, minimum depth of boring shall be 3 M. However, in case where deep pile foundations are envisaged, the depths have to be regulated as per codal provisions. In cases where rock is encountered, coring in bore holes shall be carried out to 3 M in bed rock and continuous core recovery is achieved.

Performing Standard Penetration Tests at approximately 1.5m intervals in the bore holes starting from 1.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.

Collecting undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5m and every change of stratum starting from 1.0m below ground level onwards in clayey strata.

The depth of water table shall be recorded for each bore hole.

All samples, both disturbed and undisturbed, shall be identified properly with the bore hole number and depth from which they have been taken.

The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the Contractor's laboratory without any damage or loss.

The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the borelog shall be handed over to the site representative of BHEL/Customer.

### **2.2.0 DYNAMIC CONE PENETRATION TEST**

Dynamic cone penetration tests shall be carried out with the circulation of bentonite slurry at specified locations and a continuous record of penetration resistance (NG) up to 15.00m from natural ground level or the refusal shall be maintained by the Contractor. IS: 4968 (Part-2) shall be followed for carrying out the test and for reporting of results. The driving system shall comprise of 65kg weight having a free fall of 75cm. The cone size shall be 65mm diameter and provided with vents for continuous flow of bentonite slurry.

The location for the tests shall be as directed by BHEL/Customer. On completion of the test, the results shall be presented as a continuous record as the numbers of blows required for every 300 mm penetration of the cone into the soil.

### **2.3.0 TRIAL PITS**

Trial pits shall be excavated at specified locations. The trial pits shall be 2m x 2m in size extending to 4m in depth, or as specified by BHEL/Customer. Undisturbed samples shall be taken from the trial pits as per the direction of the BHEL/Customer.

### **2.4.0 PLATE LOAD TEST**

Plate load test shall be conducted to determine the bearing capacity, modulus of subgrade reaction and load/settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs, The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to IS : 1888, Modulus of subgrade reaction shall be conducted as per IS: 9214. The location(s) and depth of the test shall be as specified by BHEL/Customer. (Depth shall be upto a maximum of 3.00m below the natural ground level).

Undisturbed tube samples shall be collected at 1.0 m and 2.5m depths from natural ground level for carrying out laboratory tests.

The size of the pit in plate load test shall not be less than five times the plate size and shall be taken upto the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate.

The load shall be increased in stages. Under each loading stage, record of Time vs Settlement shall be kept as specified in IS: 1888.

Backfilling of the pit shall be carried out as per the directions of the Owner. Unless otherwise specified the excavated soil shall be used for this purpose. In cases of gravel-boulder or rocky strata, respective relevant codes shall be followed for tests.

### **2.5.0 FIELD CALIFORNIA BEARING RATIO TEST**

This test shall be carried out to obtain the properties of soil required for the construction of roads. The equipments and accessories required for carrying out the test, test procedure, recording of observations and presentation of results shall conform to IS: 2720 part XXXI.

### **2.6.0 WATER SAMPLE**

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air-tight containers.

## **2.7.0 BACK FILLING OF BORE HOLES**

On completion of each hole, the Contractor shall backfill all bore holes as directed by the BHEL/Customer. The backfill material can be the excavated material.

## **2.8.0 LABORATORY TESTS**

**2.8.1** The laboratory tests shall be carried out progressively during the field work after sufficient number of samples have reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.

**2.8.2** All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid out in the relevant I.S. Codes.

The following laboratory tests shall be carried out:

- (i) Visual and Engineering Classification.
- (ii) Liquid limit, plastic limit and shrinkage limit for C- $\phi$  soils.
- (iii) Natural moisture content, bulk density and specific gravity.
- (iv) Grain size distribution.
- (v) Swell pressure and free swell index determination.
- (vi) California bearing ratio.
- (vii) Consolidated drained test with pore pressure measurement.
- (viii) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.
- (ix) Rock quality designation (RQD), RMR in case when rock is encountered.

## **2.9.0 ELECTRICAL RESISTIVITY TESTS**

**2.9.1** This test shall be conducted to determine the electrical resistivity of soil required for designing safety grounding system for the entire sub-station area. The specification for the equipment and other accessories required for performing the test, test procedure and report-ing of field observations shall conform to IS: 3043. The test shall be conducted using Wenner's four electrode method as specified in IS: 1892, Appendix-B2. Unless

otherwise specified, at each test location the test shall be conducted along two perpendicular lines parallel to the co-ordinate axes. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.5m upto a distance of 20m.

## **2.10.0 TEST RESULTS AND REPORTS**

**2.10.1** The Contractor shall submit the detailed report wherein information regarding the geological details of the site, summarized observations and test data, bore logs, and conclusions & recommendations on the type of foundations with supporting calculations for the recommendations are given. Initially, the report shall be submitted by the Contractor in draft form and after the draft report is approved, the final report in desired no. of copies shall be submitted. The test data shall bear the signatures of the contractor and site representative of BHEL/Customer.

**2.10.2** The report shall include, but not limited to the following :

- (i) A plan showing the locations of the exploration work i.e. bore holes, dynamic cone penetration tests, trial pits, plate load test, etc.
- (ii) Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.
- (iii) Test results of field and laboratory tests shall be summarized strata wise as well in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.
- (iv) Recommendations: The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from BHEL/Customer. The observations and recommendations shall include, but not limited to the following:
  - (a) Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.
  - (b) Recommended type of foundations for various structures. If piles are recommended, the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.
  - (c) Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement

characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 2.5/3.0(As advised by BHEL/Customer).

- (d) Recommendation regarding liquefaction characteristics of soil.
- (e) Recommendations regarding slope of excavations and dewatering schemes, if required.
- (f) Comments on the chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
- (g) If expansive soil is met with, recommendations on removal or retainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification or materials to be used, construction method, equipments to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.
- (h) Recommendations for additional investigations beyond the scope of the present work, if considered necessary.

# **SECTION-2**

# **PROJECT SPECIFICATION**

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## 1. General

Maharashtra State Electricity Transmission Company Limited (MSETCL) was incorporated in June, 2005 consequent to the restructuring of MSEB. This wholly owned corporate entity under Maharashtra Govt. commenced its operations in year 2005 as part of an initiative of the Government of Maharashtra to consolidate and organize Generation, Transmission and Distribution Segments as separate commercial entities. MSETCL, a Govt. of Maharashtra Enterprise is the premier organization in India incorporated with a view to achieve complete integration of regional transmission systems to form All India Grid.

MSETCL is operating the  $\pm 500\text{kV}$ , 1500 MW Chandrapur-Phadge HVDC Bipole Link. The link was commissioned by MSETCL in 1999. The HVDC system is a vital link which transfers the bulk power from generating stations located near Chandrapur area to Mumbai Region.

The present specification is framed to execute a new earth electrode station for  $\pm 500\text{kV}$  HVDC Chandrapur-Padghe link of Padghe end MSETCL. The present works has been warranted due to shifting of already operation earth electrode at Anjur site for Padghe terminal. The quality of works is intended to make the new electrode last for a minimum life of 25 years.

Contractor in this specification, shall mean the successful bidder who is carrying out the scope of works, Employer shall mean MSETCL and Consultant shall mean any third party appointed by MSETCL in this regard.

All other equipment, materials and services, whether explicitly stated or otherwise, that are necessary for the satisfactory operation of the HVDC electrode station under present scope as described in the Specification, shall be deemed to be included in the present scope of work.

The equipment and systems shall conform in all aspects to high standards of engineering, design and workmanship and shall be capable of continuous commercial operation in the specified manner and shall also be in line with the current practice for reliable and efficient functioning of the HVDC system. The Employer shall interpret the meaning of the Specifications, data & drawings etc., and shall have a right to reject or accept any work or material which in his assessment does not meet the requirements of this Specification and/or applicable National and International standards, codes, rules, etc. mentioned elsewhere in the Specification.

In the event of a conflict between requirements of any two clauses of the Specification/documents or requirements of different codes/standards specified, the more stringent requirement as per the interpretation of the Employer shall

apply, unless confirmed otherwise by the Employer in writing based on a written request from the Contractor.

The bidders/contractor shall offer only such equipment and from such works whose similar equipment have been in service for similar duties as on the date of bid opening and have been type tested as per relevant standards.

Whenever a material or equipment is specified herein by reference to a particular brand name, manufacturer or vendor, the Contractor may supply another manufacturer's equivalent product also.

All the items along with the quantities mentioned in the Bill of Quantity (BOQ) submitted along with the bid shall be considered as indicative only and the Contractor shall supply at no extra cost to the Employer any additional material /equipment /services not covered by these lists but which are found to be required for the fulfilment of the Specification.

## **2. Scope of works**

The scope of this specification includes overall Project management, Engineering, manufacture, factory testing, supply of all items, transportation, delivery to the sites, unloading, storing, handling, and moving into final position, installation, testing, commissioning and placing into successful operation of the Malegaon Electrode Station (400 m X 400 m) of Padghe end for  $\pm 500\text{kV}$  HVDC Chandrapur-Padghe HVDC Bipole.

### **2.1 Supply and Installation:**

The broad scope of supplies and installation in line with the Technical specification and Drawings shall be as follows:

- i. High Silicon Chromium Iron (HSCI) Electrode Element fitted with 1.1kV,  $8\text{mm}^2$  (min.) copper jumper cables
- ii. Calcined petroleum coke of high conductivity
- iii. Air core reactors for Electrode line impedance supervision
- iv. Capacitor Units for Electrode line impedance supervision
- v. Surge Arrester
- vi. Hook stick disconnecter  $>600\text{Amp}$  AC including one hook stick or Double Break disconnecter (manually operated)  $>600\text{Amp}$  AC or equivalent DC current
- vii. Geotextile cloth
- viii. Erection hardware such as Insulators, Post insulators, 3" aluminum bus, Clamp and connectors, Support structures, flexible conductors, Bare copper conductors for earthing, earthing flats/riser, PVC Conduits and other erection hardware in line with Employer's drawings and BoQ/ BOM.

- ix. Cable Joints, welds, resin materials, warning tape etc. as per Employer's drawings.
- x. 6.6kV Feeder cables (copper) & 6.6kV Distribution cables (copper).
- xi. Power cable, Junction box (plinth mounted or structure mounted) for power supply to submersible pump etc. from DG set.
- xii. Power cable, distribution box for power supply to guard hut.
- xiii. Complete Electrode watering system in line with drawings which includes 2 nos. of Submersible pump, 1 no. 7.5 kVA DG set (silent enclosure type), 1 no. 5kl RCC storage tank at 2.5m with staircase, watering pipes/hoses, valves, joints and connectors of various sizes etc. Location of DG set, submersible pump shall be proposed by contractor during detailed engineering.
- xiv. Sensor elements like temperature sensor and humidity sensor along with conduits in line with Employer's drawings.
- xv. Illumination system for Guard (Security) hut and Main-gate
- xvi. Supply of Testing equipment
- xvii. Supply of Mandatory spares as per Bill of Quantities or Bid Price Schedule
- xviii. Any other equipment/ supplies to complete the scope of work.

## 2.2 Civil works:

The scope of work shall include but not be limited to the following:

### A. Civil Works as per Drawing /Specifications provided by Employer:

- i. Boundary wall & Main gate for Electrode station
- ii. 1 no. Guard (Security) hut with sanitation facilities
- iii. Civil works associated with laying of Electrode elements, cables, water pipes, seeping wells and other accessories etc.

### B. Design, Engineering and civil work (as per Contractor supplied drawings) for the following :

- i. Soil investigation for civil foundation design.
- ii. Site Levelling including excavation, filling and Compaction of Electrode site.
- iii. Foundation and structure design for equipment, civil building/ structures under present scope. The design of foundation shall be based on the soil investigation report and other parameter as per relevant IS codes and technical specification.
- iv. 1 no. of Overhead water tank (RCC) 2.5 meter height with staircase
- v. 1 no. of Borewell
- vi. MS plates for marking the feeder cables, distribution cables, watering hoses, and sections of electrodes.
- vii. Any other civil works to complete the specified scope in line with technical specification shall be carried out by the contractor.

Any additional quantity/work required to complete the scope of work and put the electrode station into successful operation as per attached Drawings, documents

& this specification shall be deemed included in the scope of works. Contractors responsibility is to put the complete electrode station into successful operation after completion of all system tests.

The work to be done under this specification shall include all labour, plant, equipments, material and performance of all work necessary for the complete installation and commissioning of electrode station. All apparatus, appliances, material and labour etc. not specifically mentioned or included, but are necessary to complete the entire work or any portion of the work in compliance with the requirements implied in this specification is deemed to be included in the scope of contractor.

Before proceeding with the construction work, the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the Employer shall endeavour to provide the information, it shall not be binding for the Employer to provide the same. The bidders are advised to visit the Electrode site and acquaint themselves with the topography, infrastructure and also the design philosophy. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substation in all respects. All materials required for the Civil and construction/installation work including cement and steel shall be supplied by the Contractor.

### **3. Physical and other parameters**

#### **3.1 Location of the Substation**

The Malegaon Earth electrode terminal is located about 40km from Padghe HVDC terminal in Maharashtra. The nearest railway station is Padghe (approx. 40km) and nearest airport is Mumbai (approx. 100km). The coordinates of the site location is 19.08.34.53N, 73.24.01.47E. The size of the land is 400 m X 400m.

#### **3.2 Meteorological data**

Meteorological data shall be as follows:

Altitude	155m above MSL (approx.)
Snow fall	Nil
Seismic zone	As per IS 1893
Wind zone	As per IS 875 Part-3
Min./Max. Ambient Temperature	0-50 degree Celsius
Coastal Area consideration	Yes

#### 4. Schedule of Quantities

Bidder should include all such items in the bid proposal sheets which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful completion of the scope of work shall be included in the bid price and shall be provided at no extra cost to owner.

#### 5. Basic Reference drawings and documents

Employer has prepared Single line Diagram, Layout of Earth Electrode, Erection diagram of Earth Electrode, Detail EKD Material details, Testing procedure and Specification for Civil and Structural works. The details are part of Technical specifications as per following:

Description	Section no. of TS
SLD, Layout and Erection Key Diagram	Section-15
EKD (Erection key Diagram) - Material details (for reference only)	Section-16
Material specification	Section-17
Existing Equipment Details at Anjur Electrode Station	Section-18
Sub system and Pre-commissioning tests	Section-19
Section: Civil works	Section-20
Section: Structures	Section-21

In-case of any discrepancy between the drawings and text of specification, the requirements of text shall prevail in general. However, the Bidder is advised to get these clarified from Employer.

Contractor has to prepare Engineering drawings/ documents/ design which are not available above and shall submit for Employer's approval during detail engineering.

#### 6. Facilities to be provided by Employer

Approach road and access to the Electrode station site shall be provided by employer.

Dead End Electrode line tower shall be provided by Employer at the center of the Electrode station. The connection with dead end tower to the equipment shall be under Contractor's scope. Detail of Electrode Tower/ Line Conductor shall be provided during detail engineering.

#### 7. Construction Power and Water supplies:

Employer shall provide 415 Volt supply for construction power on chargeable basis at the perimeter of the site. The Contractor shall be responsible for the provision

of any switchgear, enclosures and transformation required for the construction power feeder line. The Contractor shall also be responsible for the provision of the extension and distribution of the 415 Volt power from the point at the perimeter of the site at which the said line terminates to the location at which said power is required. Such lines and equipment shall be considered Temporary Equipment.

The Employer shall neither be liable nor responsible for the delay in arrangement of power supply at site or interruption of power supply to the sites, and shall not be liable for any extra costs nor required to grant extension of time as a result of the said delay/ interruption. In such situation, Contractor shall make his own arrangement for provision of construction power supply . The Contractor shall indicate the requirement of construction power in KVA to the Employer within one month of the actual contract.

Construction water supply shall be in the scope of contractor and arranged accordingly.

## 8. Special tools and tackles

The bidder shall include in his proposal the deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. However a list of all such devices should be indicated in the relevant schedule provided in the Bid Price Schedule. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized. Any special tools and tackles/ hydraulic crane for erection, testing and commissioning of the electrode elements at site shall be arranged by the bidder.

## 9. Operation and Maintenance Test Equipment

The Contractor shall supply the following test equipments which shall be required by the Employer for the operation & maintenance of the stations :

Sl.	Test Equipment	Specification
1.	Digital Micro Ohm Meter for contact resistance measurement	Range : 0 to 200 m ohm Accuracy : + 1 % Resolution : 1 micro-ohm Test Current : 0-600A(dc) with 15 sec load time and 0-660 A (AC) with 2 sec load time. Test lead length of min 15 meter.
2.	Clamp on DC Ammeter	0-600A range Accuracy : 1% Resolution : 100 mA
3.	Portable Soil moisture test kit	Comprising of with Soil moisture sensor, Moisture meter, replacement sensor rods etc.

*Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with ±500kV 1500MW Chandrapur-Padghe HVDC Bipole link.*

4.	Voltmeter	Range: up to 1kV Accuracy : < 1%. Resolution : 100mV Can measure both AC & DC
5.	Torque wrench, sockets and ratchet box	Wrench of 1/2-inch drive click type

The equipment shall generally comply with the requirement of relevant Indian standard or equivalent International standards such as IEC, BS, ASTM, ISO, etc.

## 10. Technical parameters

The major technical parameters at Malegaon Earth Electrode station are as per following details:

Sl	Item	Technical Parameters
1	Site for work	Malegaon, Maharashtra
2	Ampere rating	1650ADC continuous
3	Target resistance	0.65-0.75 ohm (max)
4	Number of isolatable sections in electrode	10 nos.
5	Outage requirement	30% of the section
6	Touch Voltage	40V
7	Step voltage	5+0.03*p Volts where p= top layer local soil resistivity
8	Type of installation	Double ring shallow type

## 11. Specific requirement

- i. Jointing of feeder cable with distribution cable, distribution cable with jumper cable and installation of temperature and moisture sensors is detailed in the attached drawings of SLD & Layout, which shall be of high-quality work and to be executed by skilled manpower. The spacing between electrode elements as well the arrangement of inner ring and outer ring shall be as per the drawings and meet quality standards.
- ii. CAD Welding process shall be used for connecting HSCI electrode elements with jumper cables to the distribution cables, and distribution cables with feeder cables. The connections shall be proper and shall be carried out by highly skilled and experienced manpower.
- iii. The connections and joints shall be encapsulated in insulating resin to prevent the deterioration of the metal in the joints due to the electrolytic corrosion.
- iv. Detailed material specification for major equipments is attached as part of TS and shall be adhered to by the Contractor. **EKD- Material details as part of TS is for reference purpose only.** Contractor may propose similar/better items/equipments

to meet the functional requirement of TS subject to Employer's approval. Any item details, if not available in EKD-Material details and are required in line with scope of supply, same shall be supplied by Contractor under present scope.

- v. The Contractor shall design, supply and install complete arrangement for the watering system of the electrodes in line with TS including the supply of storage water pumps with diesel engine.
- vi. The central area of electrode where ELIS equipment are installed shall be grounded with bare copper conductor and HSCI elements as per drawing. All the Equipment and structures shall be earthed at least two (02) points.
- vii. The Item designation of equipment shall be as per Employer's existing drawings and the same shall be marked in the Rating Plate of the equipment.
- viii. The contractor shall submit three (3) sets each for drawings , reports and technical data sheet for approval of Employer during detail engineering. Further two (2) sets each of approved/as built drawings/documents and soft copies (in hard drive of suitable capacity) shall be handed over to Employer.
- ix. The supplied items shall be stored safely near/at execution site under covered store by contractor.

## 12. Quality Inspection and testing

All equipment being supplied shall conform to type tests as per technical specification/ relevant IEC/IS and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of similar equipment/ material already accepted by Employer shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) /representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within **10 years** from the date of Award. In case the test reports are of the test conducted earlier than the years specified below from the date of Award, the contractor shall repeat these test(s) at no extra cost to the Employer. Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all

type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

The Employer reserves the right to witness any or all the type tests. The Employer shall bear all expenses for deputation of Employer's representative(s) for witnessing the type tests except in the case of re-deputation if any, necessitated due to no fault of the Employer.

Routine tests shall however be done freshly on sample basis.

The Type test and Routine test report clearance procedure shall be as per the Employer's prevailing Quality management practice. However, the Type and Routine test reports clearance shall be subject to Employer's approval.

The following tests shall be covered at manufacturer works/ Other NABL accredited lab as minimum requirement for quality for supplied items:

(R= Routine test, T=Type test)

- i. **For ELIS air core reactor-** Generally as per IEC 60076-6
  - Measurement of winding resistance (R)
  - Measurement of inductance(R)
  - Measurement of Q-factor(R)
  - Measurement of loss(R)
  - Lightning impulse test(R)
  - Measurement of variation of inductance and resistance with frequency (T)
  - Temperature-rise test(T)
  - Lightning impulse test(T)
- ii. **For ELIS Capacitor-** Generally as per IEC 60871-1 and 4
  - All routine tests as specified in IEC 60871-1 along with discharge test of IEC 60871-4
  - AC voltage test between terminal sand container (T)
  - Short circuit discharge (T)
  - Thermal stability (T)
  - Variation of C with temperature and frequency (T)-(The capacitance of the unit shall be measured at 50/60 Hz and rated harmonic frequencies over a range of capacitor unit mean dielectric temperatures including, but not limited to, minimum ambient temperature with minimum capacitor bank

voltage excluding harmonics, and maximum ambient temperature and maximum load)

iii. **Disconnectors-**

- Routine tests as per IEC 62271-102
- Type tests as per IEC 62271-102 (RIV and EMC tests not applicable)

iv. **Surge Arrester-** Generally as per IEC 60099

For blocks:

- Residual voltage test (R)
- Energy withstand test (R)  
(The test shall be performed by subjecting all blocks to high-energy impulses with cooling to room temperature allowed between each)

For arrester units:

- Reference voltage test (R)
- Internal partial discharge (R) measured as per IEC 60270
- Leak test (R)-For units where gas is enclosed
- Residual voltage test (T)- for steep current impulse, lightning impulse, switching impulse
- Operating duty test (T)
- Long duration current impulse withstand test (T)
- Accelerated ageing procedure(T)
- Short-circuit test(T)
- Insulation withstand test of the arrester housing(T)

v. **High Silicon Chromium Iron elements-**

Silicon iron anodes:

- Visual inspection of casting and dimensions. (R)
- Verification of material certificate.  
Sample tests of Silicon iron anodes (sampling size as per Employer's practice)
- Chemical composition
- Specific gravity
- Compressive strength, to be done for information
- Tensile strength, to be done for information

Assembled anode:

- Pull-out strength of cable. The supplier shall suggest suitable test to verify the physical strength of the cable attachment. (T)
- Material certificate of silicon iron casting. (T)
- Visual inspection of cable attachment before sealing with resin. (R)
- Visual inspection of cable seal. (R)

- Verification of dimensions. (R)
- Verification of cable length and marking. The marking tag shall be securely attached to the cable or anode. (R)
- Resistance(R)

vi. **Jumper Cables fixed on HSCI element**

The cables shall be tested acc. to IS 7098-1 in applicable parts or according to test program suggested by supplier.

vii. **Feeder/distributor cables**

The cables shall be tested in applicable parts acc. to IS 7098-1 and -2.

viii. **Geotextile**

The requirements of the material shall be as specified in Indian Standard 15910 : 2010, Clause 5.3.

ix. **Balance supply items** shall be tested as per relevant IS/IEC standards.

### **13.Sub system and Pre-commissioning tests.**

After completion of the Electrode Installation work, Subsystem tests and Pre-commissioning test are to be performed under present scope of the Contractor. The detail list, procedures and test recording formats of these tests is attached as part of TS. Testing equipment needed for successful testing shall be arranged by the contractor.

### **14.Standards**

The Works covered by the Specification shall be designed, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India. The Equipment(s) shall also conform to the general requirements detailed in the following standards, which shall form an integral part of the Specification, in addition to meeting the specific requirements called for elsewhere in the Specification.

The Contractor shall note that the standards mentioned herein are not mutually exclusive or complete in themselves, but are intended to complement each other, with minimum repetition, to define the requirements of the Specification.

When specific requirements stipulated in the Specification exceed or change those required by the applicable standards, the stipulations of the Specification shall take precedence.

Unless specifically agreed to by the Employer prior to Award of Contract, the Work shall be in accordance with the standards indicated and the requirements of the Specification. The Contractor shall be held responsible for any deviation.

In case of conflict between the various standards, the decision of Employer shall be binding & final.

All equipment and materials, unless otherwise specifically required in the Specification, shall conform to latest revisions of the standards listed in the Specification, in force 15 days before the originally scheduled deadline for submission of bid at the time of signing of the contract for this project.

IEC/TS 62344	Design of earth electrode stations for high-voltage direct current (HVDC) links.
IS-1893	Criteria for Earthquake Resistant Design of Structures
IEC 60076-6	Air core reactors
IEC-60871	Shunt capacitors
IEC 62271-102	High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches
IEC-60099-9	Metal-oxide surge arresters without gaps for HVDC converter stations
IEC-60270	Partial Discharge measurements
IS-7098-Part 1,2,3	XLPE insulated cables
IS-8130	Conductors for Insulated cables
IS-1554(1)	PVC Insulated cables
IS-15910	Geotextiles
IS-5561	Clamp and connectors
IS-1892	Code of practice for subsurface investigation for foundations
IS-1080	Code of Practice For Design And Construction Of Shallow Foundations In Soils (Other Than Raft, Ring And Shell)
IS-9451	Guidelines for lining of canals in expansive soils
IS: 456	Plain and Reinforced Concrete
IS: 10262	Concrete Mix Proportioning — Guidelines
IS: 1786	High Strength Deformed Steel Bars and Wires for Concrete reinforcement
IS:875	Code of practice for design loads (Other than earthquake) for buildings and structures
IS: 1893	Criteria for Earthquake Resistant Design of structures
IS: 3370	Concrete structures for storage of liquids
IS: 1200	Methods of measurement of building and civil engineering works
IS:1489 or	IS: 269 or IS:8112 or IS: 12269 or IS: 455 Cement

IS: 4926 or IS: Concrete mix  
4925

IS: 3812 Pulverized fuel ash

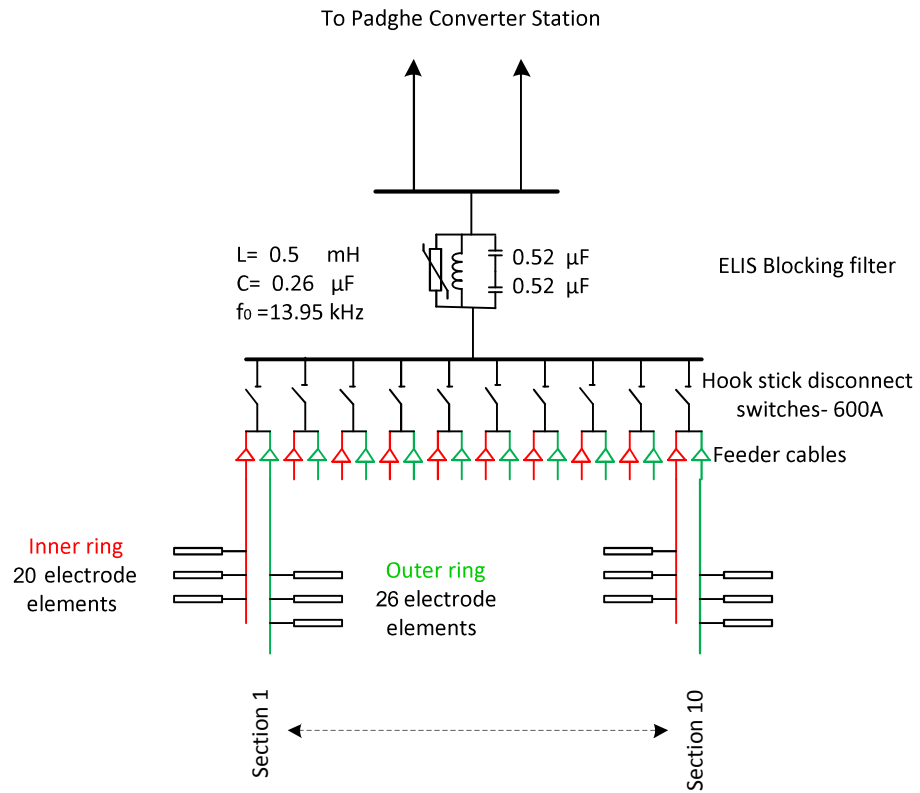
IS: 800 General construction in steel


IS: 2911 Design and construction of pile foundations

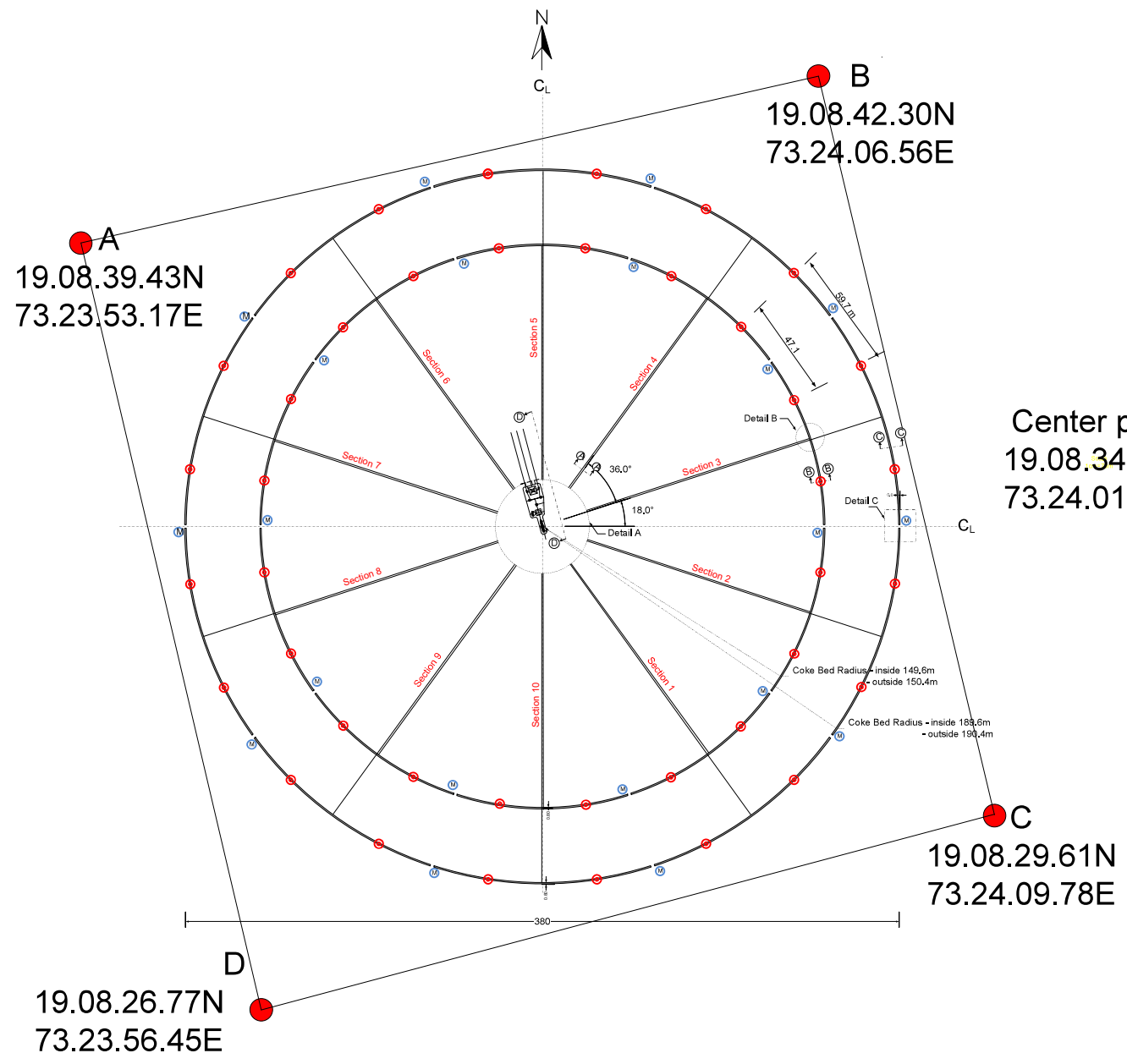
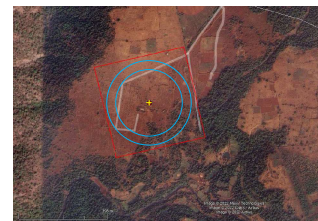
IS: 2720 Soil testing

## **15. Single line diagram (SLD), Layout and Erection Key Diagram**

The Single line diagram, layout and EKD is as shown below.



 Chandapur Padghe HVDC System			
21-Sept-2022			
Scale	<b>Malegaon Electrode Station</b> <b>Single line diagram</b>		
Designed			
Checked			
Approved	CHP-MEL-SD-280-02	Sheet 1 of 1	Rev. 0



Center point  
 19.08.34.53N  
 73.24.01.47E

- ⊙ Seeping Well Location
- ⊙ Measuring Point Location

Notes:

1. Distribution cables over coke beds and irrigation piping are not shown on this sheet in the interests of clarity. Also individual HSCI elements and jumper cables are not shown.
2. Site fencing is optional. Touch and step potentials on the site are within the safe range for humans and animals.
3. For details of seeping wells and measurement locations refer to sheet 3.
4. Each measuring location will have two tubes extending down to depth of the center of the coke bed. One tube is sealed at bottom end and contains a temperature sensor. The other tube is open at the bottom and is suitable for measuring soil moisture or temperature with suitable portable instruments.
5. Measurement of current in each electrode section will be by clamp-on ammeter at the dead-end structure.
6. All cable joints are made using the CADWeld process and are encapsulated to prevent corrosion.
7. Coke bed cross section is 0.8m x 0.8m for both inner ring and outer rings. The depth to center of the coke bed is 3.0m for inner ring and 3.5m for outer ring.
8. Spacing between adjacent sections is 2.0 m for both inner and outer rings.
9. Refer to 280-10200-2 for material specifications and quantities.

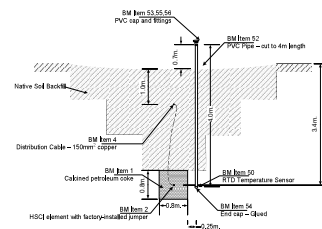
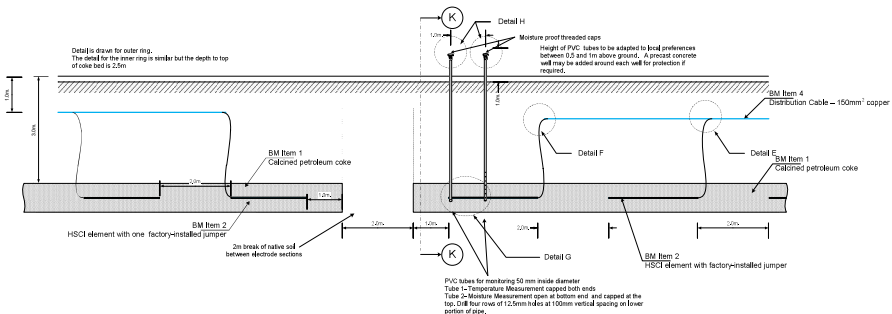
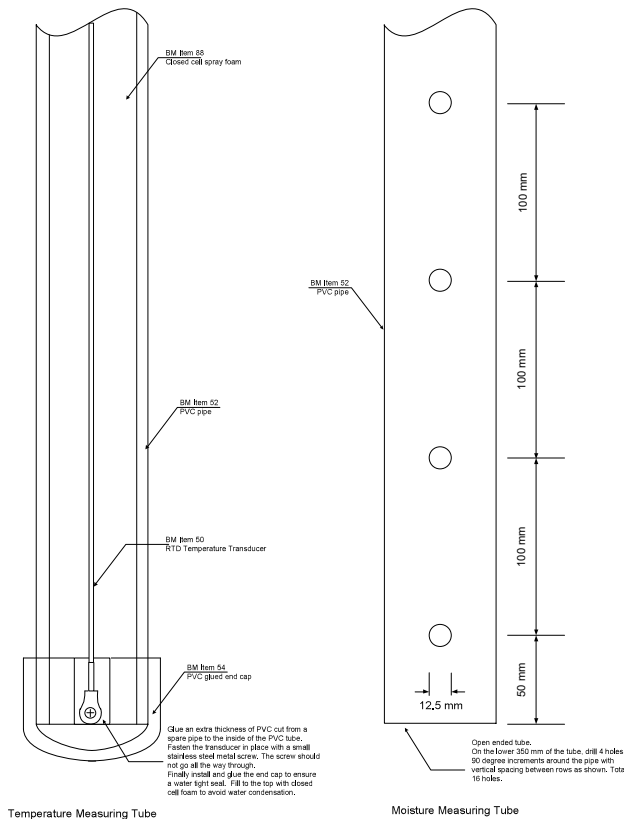
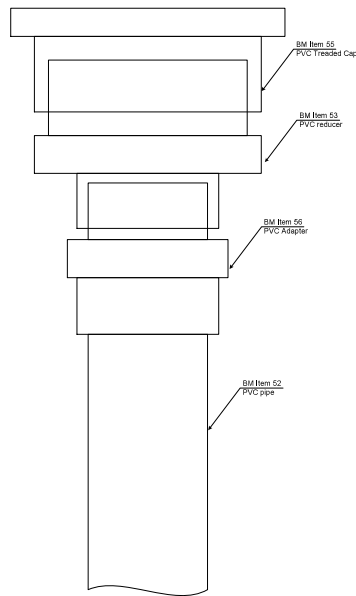
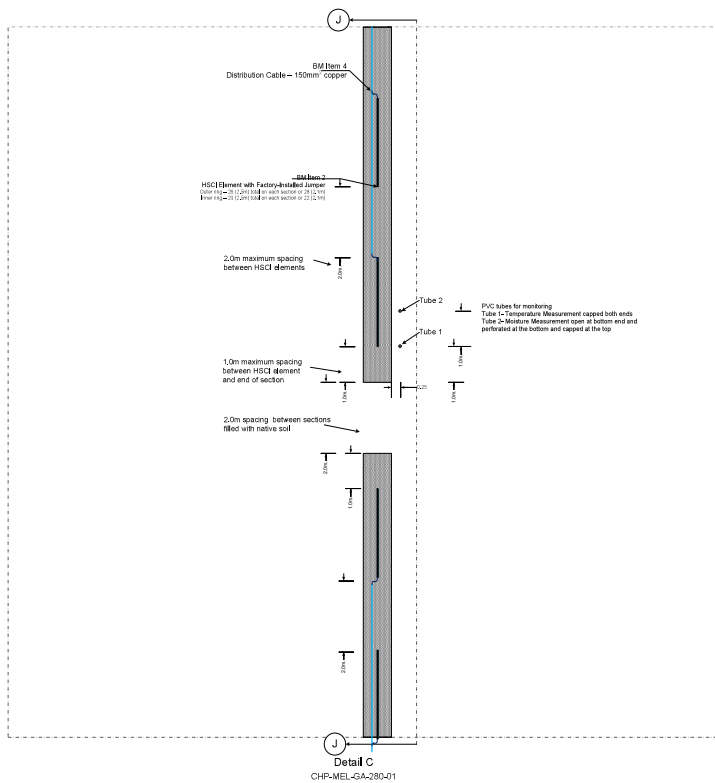
<b>Chandapur Padghe HVDC System</b>	
21-Sept-2022	
Malegaon Electrode Site General Arrangement and Site Plan	
Scale: 1cm = 8.0 m Drawn by: BJB Checked by: JH Approved by: BJB	CHP-MEL-GA-280-01    Sheet 1 of 1    Rev. 1

1	31 Oct 2022	Inner Ring changed to 300m diameter from 320m
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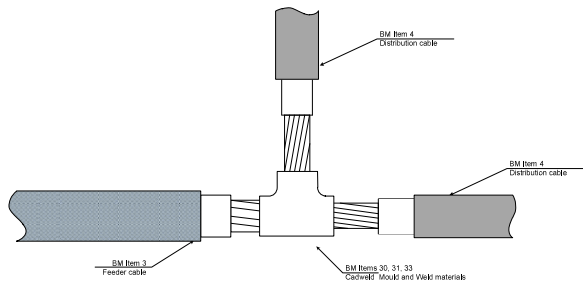


Section J-J - This Sheet

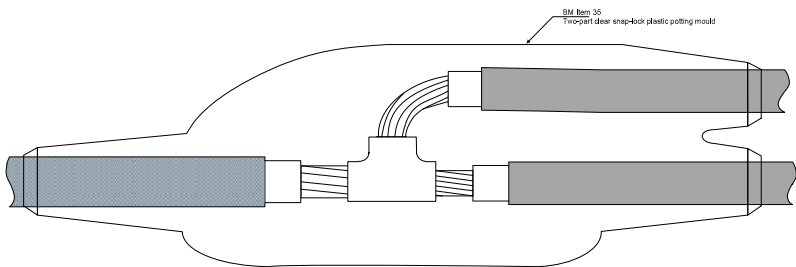
Section K-K - This Sheet Trench Detail-Outer Ring Near Monitoring Location

Detail G - This Sheet Bottom of Measuring Tube Details

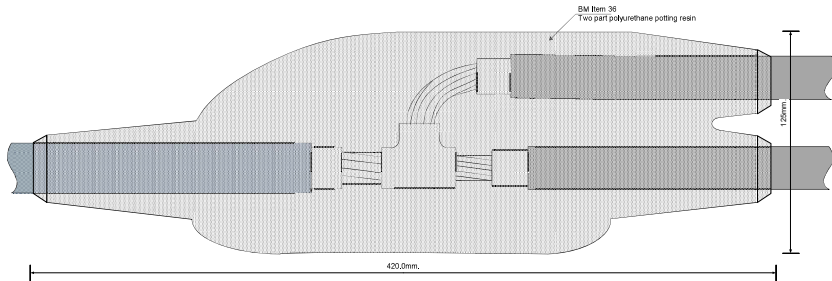
		<b>Chandrapur Padghe HVDC System</b>	
		21-Sept-2022	
Date 10cm = 0.5 m Design BJB Checked JH Approved BJB	<b>Malegaon Electrode Station Sections and Details</b>		
	CHP-MEL-SD-280-02	Sheet 3 of 5	Rev. 0



Strip the outer PVC Sheath about 2 cm more than the insulation as shown.  
Strip distribution cable and feeder cable insulation only enough to accommodate Cadweld mould.  
After removing mould grind or trim away excess metal prior to potting taking care not to damage the conductors.  
Do not perform cadwelding in wet or rainy weather.

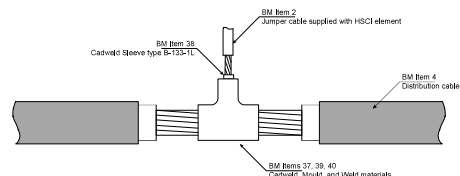


Ensure Feeder cable and distribution cable are clean and dry.  
Bend the distribution cables so they will exit the mould cleanly without binding or stressing the mould.  
Apply two-part clear snap-lock potting mould and align to ensure bare wire is positioned so it will be completely encased by the potting compound.

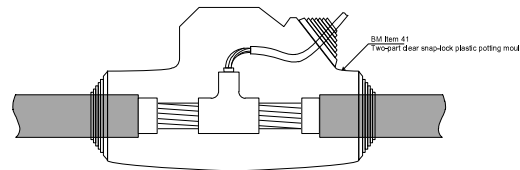


Apply tape at cable entry points of the mould to prevent leakage of potting compound.  
Mix potting compound and fill the mould using potting compound according to instructions.  
Ensure that the mould is completely filled and that there are no voids or air bubbles in the potting compound.  
Allow to cure. Do not allow cables to move during curing.  
Do not pot joints in rainy weather. Protect from rain and water seepage until compound is cured.  
Do not remove plastic mould.  
Backfill the mould with fine sand and protect using a treated wooden plank.

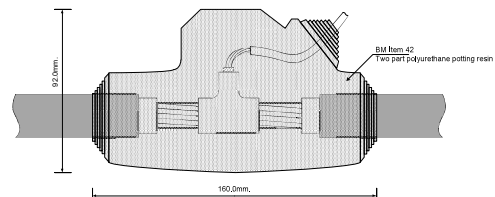
**Detail D**  
Cadweld Jointing Detail  
Feeder Cable to Distribution Cable



On distribution cable strip the outer PVC Sheath about 1 cm more than the insulation as shown. Do not cut the distribution cable just remove insulation where needed for tapping the jumper cable. Use stripping tools.  
Strip distribution cable and jumper cable insulation only enough to accommodate Cadweld mould.  
Apply Cadweld sleeve to jumper cable prior to welding.  
After removing cadweld mould grind or trim away excess metal prior to potting taking care not to damage the conductors.  
Do not perform cadwelding in wet or rainy weather.

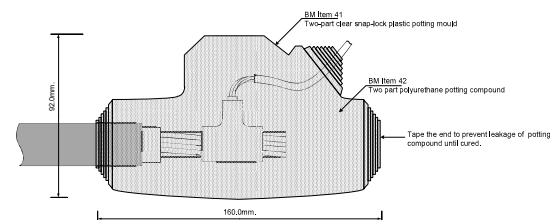


Ensure distribution cable and jumper cable are clean and dry.  
Bend jumper cable to exit mould cleanly and without binding.  
Apply two-part clear snap-lock potting mould and align to ensure bare wire is positioned so it will be completely encased by the potting compound.



Apply tape at cable entry points of the mould to prevent leakage of potting compound.  
Mix and fill the mould using potting compound according to instructions.  
Ensure that the mould is completely filled and that there are no voids or air bubbles in the potting compound.  
Allow to cure. Do not allow cables to move during curing.  
Do not pot joints in rainy weather. Protect from rain and water seepage until compound is cured.  
Do not remove plastic mould.  
After all joints have been cured rotate distribution cable 90 degrees so that jumper cable and distribution cable are in the same horizontal plane.  
Cover with 100 mm of fine sand.

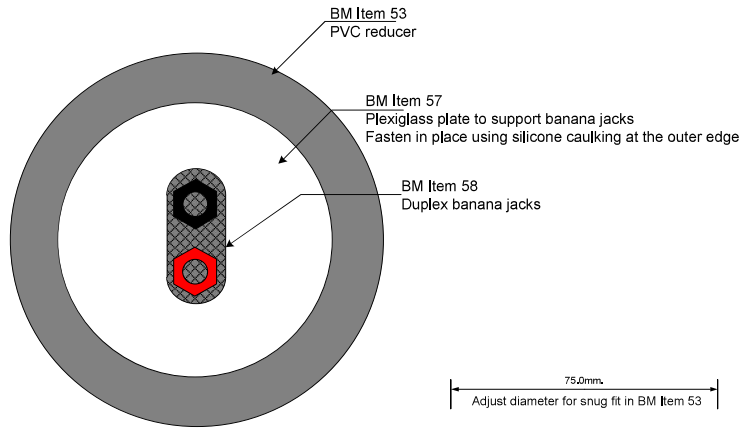
**Detail E**  
Cadweld Jointing Detail  
Distribution Cable to HSCI Jumper



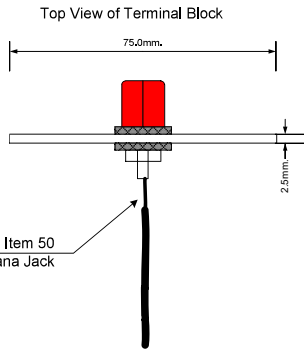
Follow procedure as Detail E except tape open end of plastic mould to retain potting compound until cured

**Detail F**  
Cadweld Jointing Detail  
Distribution Cable to HSCI Jumper  
(end connection of each section)

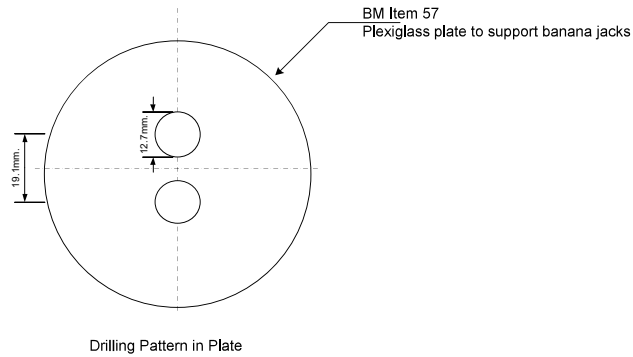
Scale	<b>Malegaon Electrode Station Sections and Details</b>	CHP-MEL-SD-280-02	Sheet 4 of 5	Rev. 0
Drawn				
Checked				
Approved				
Author				



75.0mm  
Adjust diameter for snug fit in BM Item 53



Side View of Terminal Block



### Detail I Top of Temperature Measuring Tube



Chandrapur Padghe HVDC System

21-Sept-2022

Scale	1mm = 1mm
Designed	BJB
Checked	JH
Approved	BJB



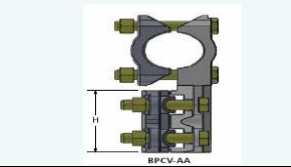

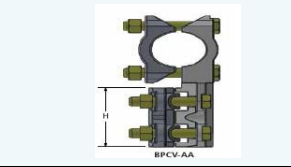
## Malegaon Electrode Station Sections and Details

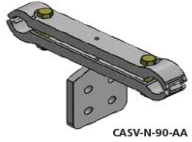
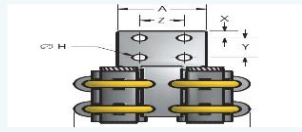

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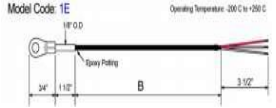
## 16.EKD (Erection key Diagram) – Material details (for reference only)

Employer has prepared detail of materials for erection key diagram for reference purpose only. It is the responsibility of the contractor to verify/ review these detail before execution. Contractor may propose superior material based upon relevant standards/ guideline to complete the work in line with technical specification subject to Employer's approval. Details of the electrode materials is given below:

BOQ ref.	EKD item	Description	Notes
<b>AA.I.1</b>	<b>HSCI element fitted with jumper cables</b>		
	2	High Silicon Chromium Iron of 2.5m length with factory installed 8mm <sup>2</sup> copper, 1.1kV XLPE-insulated 3m long jumper cable	
<b>AA.I.2</b>	<b>Calcined petroleum coke of high conductivity</b>		
	1	Calcined petroleum coke	
<b>AA.I.3</b>	<b>6.6kV Feeder cable 150mm<sup>2</sup>(copper)</b>		
	3	Feeder Cables – 6.6-11kV	
<b>AA.I.4</b>	<b>PVC conduit with bend and support strap, 63 mm diameter, 2.5 mm thickness to protect feeder cables</b>		
	16	63 mm diameter- 2.5 mm thickness, 3 m length PVC conduit to protect feeder cables	Cut to length on site
	17	90 Degree PVC Conduit long Bend 63mm	
	18	Steel support strap for PVC conduit	
<b>AA.I.5</b>	<b>6.6kV Distribution cable without screen (copper)</b>		
	4	Distribution Cables – 3.8-6.6kV	
<b>AA.I.6</b>	<b>Hook stick disconnect Switch &gt;600A including one hook stick or Double break disconnecter Manually operated &gt; 600 A</b>		
	9	Hook stick Disconnect Switch >600 A including one hook stick or Double break disconnecter	Any disconnecter with Rating of greater than 600A and 150kV BIL or larger.
<b>AA.I.7</b>	<b>Steel structures for disconnectors along with channels/ platform</b>		
	80	4m Steel structure	
	83	Steel channel 6"x1.75" 5m long Hot dip galvanized	
<b>AA.I.8</b>	<b>Electrode line impedance supervision Reactor 0.5mH, 2000A, 130kV BIL, 10kA thermal current 1 sec, air core, Class F insulation</b>		
	86	Reactor 0.5mH, 2000A, 130kV BIL, 10kA thermal current 1 sec, air core, Class F insulation	
<b>AA.I.9</b>	<b>Electrode line impedance supervision Blocking Filter Capacitor 0.52uF, 4.652kV</b>		
	87	Blocking Filter Capacitor 0.26uF (two series connected units of 0.52uF)	
<b>AA.I.10</b>	<b>Electrode line impedance supervision Arrester Uc=1kV (min), Discharge class 3, Residual voltage 12kVp @5kA Lightning Impulse</b>		
	85	Arrester	

AA.I.11	Erection hardware such as Insulators, Post insulators, 3" aluminum bus, Clamp and connectors, Support structures for all equipment, flexible conductors, Bare copper conductors for earthing, earthing flats/riser, PVC Conduits and other erection hardware in line with TS		
	5	120mm <sup>2</sup> bare copper conductor for local ground loop	
	6	Wooden planks	
	10	Bronze alloy bolted clamp for connecting two feeder cables to disconnect	
	11	Bimetallic transition plate for copper to aluminum joints at top of hook stick disconnects	
	12	Stainless steel bolts 14mm x 50 mm long for bolting clamps to disconnect	
	13	Stainless steel nuts 14 mm	
	14	Stainless steel flat washers 14 mm (larger than Bellville washer)	
	15	Stainless steel BELLEVILLE washers 14 mm	
	67	HVDC line disc insulators	
	68	Aluminum tubular bus nominal 3" IPS OD=3.5" 6.5m long	
	69	AAC conductor 1031 A	
	70	AAC conductor 615 A	
	71	High strength Insulator 150kV BIL	
	72	Fixed Bus Connector 3" tubular bus to insulator	
	73	Sliding Bus Connector, 3" tubular bus to insulator Sliding	
	74	Aluminum Connector from 3" bus to single AAC	
	75	Aluminum Connector from 3" bus to Two   AAC	
	76	Aluminum Connector 3" bus to one electrode dc line dropper	

	77	Aluminum Connector from arrester to twin AAC	 CASV-N-90-AA
	78	Aluminum Connector Reactor to twin AAC	
	79	Aluminum Connector from reactor or capacitor to single AAC	 UL-N-AA
	81	3m or suitable height Steel Structure(for arrester and capacitor)	
	82	2m or suitable height steel structure (for blocking filter reactor)	
	84	Adapter from steel structure to insulator	
<b>AA.I.12</b>	<b>Electrode watering system comprising of pump, borewell, DG set, watering pipes, seeping well, valves, joints and connectors of various sizes as per Technical Specification.</b>		
	19	Tough Hose-Twin-LineR Drip Polytube as per IS:12786	4000 m (minimum)
	20	Power-Loc Tee fitting	Metal free fitting
	21	Power-Loc 90 degree elbow	Metal free fitting
	22	Power-Loc straight coupling	Metal free fitting .
			Supplied in case it is necessary to join irrigation hose.
	23	Power-Loc w 3by4 FHT Threaded cap	Metal free fitting
	24	Seeping well concrete curb - Precast or cast in place concrete circular ring without iron reinforcing- 1m diameter 300 mm high 100mm thick	Can be cast in place if desired. Steel reinforcing should not be used.
	25	Round river rock 50 to 100mm size - or clean, silt free, crushed rock	
	26	Pea gravel fill (<50mm size) for use as filter in seeping wells	
	28	Sacrificial Paper Form for seeping wells 2.5 m height 1 m diameter - inner ring	
	29	Sacrificial Paper Form for seeping wells 3.0 m height 1 m diameter -outer ring	
<b>AA.I.13</b>	<b>Water permeable Geotextile cloth</b>		
	27	Water Permeable Geotextile cloth - 100% Polyester continuous filament, needle punched, nonwoven geotextile	
<b>AA.I.14</b>	<b>RTD Temperature Measurement Sensor along with conduits and other accessories</b>		

	50	RTD Temperature Measurement Sensor – Ring Terminal Style RTD PT100 Class 0.1	Fastened to wall of measuring tube using a short stainless steel screw. 
	52	PVC pipe 63mm 6m length	Each pipe needs to be cut to the length as per the drawing
	53	ABS reducer – male female – threaded 4 inch to 2.5 inch	
	54	PVC End Cap 63 mm -Cemented	
	55	PVC threaded Cap 4 inch	
	56	PVC Adapter Female Cemented, Male-threaded – 63mm (2.5in)	
	57	Plexiglass terminal board – 75 mm circular shape drilled for installation of duplex banana jack	
	58	Duplex banana plug binding posts	
	59	Banana plug meter leads for temperature measurement	
	61	Extension tube 1m for moisture measurement Extensions are needed to reach the bottom of the moisture measuring tubes.	
	62	Extension tube 0.5m for moisture measurement	
	63	PVC pressure pipe to EN1452-2 - 25 mm diameter 3.5 m long	For use as dipstick and also to extend moisture measurement probe to bottom of well.
	64	PVC socket adapter cemented threaded with Reinforcing Ring	Installed at the end of item 63 to permit use of dipstick to extend moisture measuring probe to bottom of wells.
	65	PVC Solvent Cement	With solvent applicator brush.
	88	Closed cell spray foam filler material for to seal out moisture and condensation in temperature measuring tubes	
<b>AA.I.15</b>	<b>Joints, welds and resin material</b>		
	30	Cadweld mould – 150mm <sup>2</sup> run to 150mm <sup>2</sup> Tap Connection from feeder to distribution cable	assumes 1 mould will be good for 15 welds
	31	Cadweld handle clamp	Used on all moulds
	32	Cadweld weld material - cathodic protection type for joining 150 mm <sup>2</sup> cables	

Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with  $\pm 500kV$  1500MW Chandrapur-Padghe HVDC Bipole link.

	33	Cadweld metal disks	
	34	Cadweld flint ignitor	
	35	Plastic two-part -snap-lock potting mould 420mm x 125 mm	
	36	Cable Potting pack for joining feeder/distribution cables - 3000ml two part polyurethane	
	37	Cadweld mould - tee connection 150mm <sup>2</sup> distribution cable to HSCI Jumper cables	
	38	Cadweld adapter sleeve insert - to be used on Jumper cable	
	39	Cadweld weld material -for 150mm <sup>2</sup> to Jumper cathodic protection type	For taps only. Not adequate for joining 150mm <sup>2</sup> run conductor - includes 50 spare
	40	Cadweld metal disks	
	41	Plastic snap-lock potting mould, 160mm x 92mm	
	42	Cable Potting pack for joining feeder/distribution cables - 825 ml two part polyurethane	
	43	Cable cleaning brushes	
	44	Mould cleaning brush	
	45	Cadweld mould - connection from ground lead to structures	Uses handle L160
	46	Cadweld weld material - cathodic protection type ground leads to structures (one connection per structure)	
	47	Cadweld metal disks	
	89	Cadweld mould - tee connection 150mm <sup>2</sup> ground conductor to 150mm <sup>2</sup> riser to structures	
<b>AA.I.16</b>	<b>Warning tape - "Caution Electric Cable Below" roll of 300 m (1000ft)</b>		
	7	Warning tape - "Caution Electric Cable Below" roll of 300 m (1000ft)	
<b>AA.I.17</b>	<b>Testing and maintenance equipment as per Technical specification</b>		
		Clamp on Ammeter with Ohmmeter and Voltmeter Functions (used to measure resistance (of RTD) and current in sub-electrodes)	Allows two measuring crews
	60	Moisture measuring system including Moisture sensor, Meter (readout unit), replacement sensor rods, and a carry case.	
	<b>Fine sand backfill</b>		
	8	Fine Sand Backfill for cables	

Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with ±500kV 1500MW Chandrapur-Padghe HVDC Bipole link.

Electrode line dead end structure		
66	Electrode line dead-end structure (not in present scope of supply. Same shall be provided by Employer)	
Tools		
48	Cable Sheath stripping Pliers 8-21 mm Diameter	<b>Optional</b> to ensure right tools are available
49	Cable Insulation Stripping tool -14-40 mm Diameter with depth gauge	<b>Optional</b> to ensure right tools are available

In-case of any discrepancy between the EKD Material details as above and the Bill of Quantities in bid price schedule, the Bill of Quantities specified in bid price schedule shall prevail.

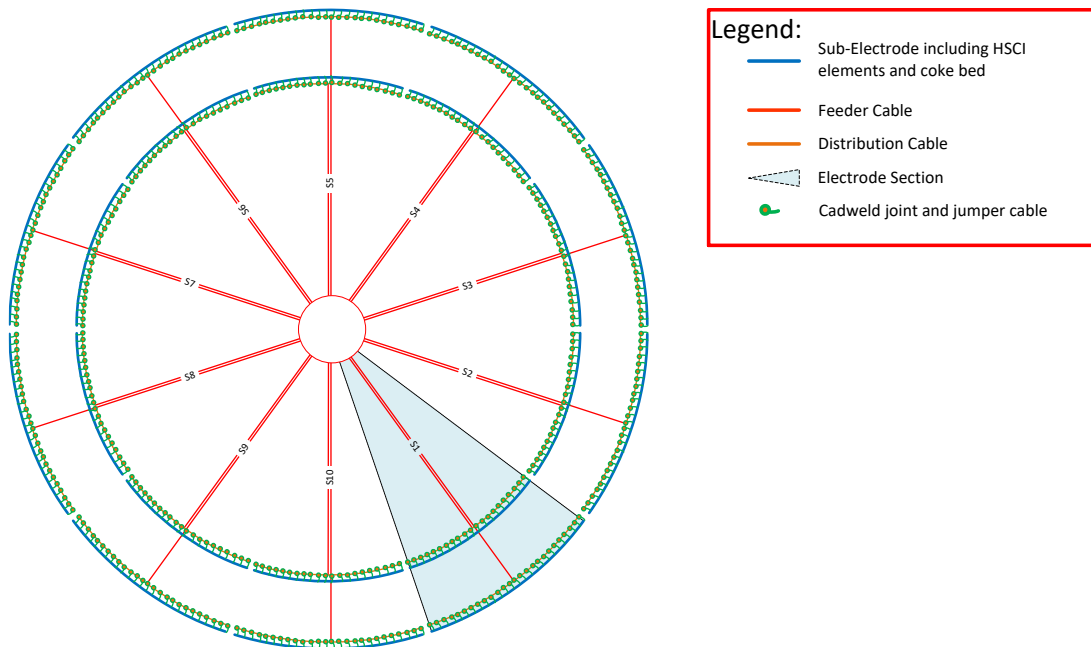
## 17. Material specification

### 17.1 Introduction

This material specification summarizes the technical requirements for major equipments of Malegaon Electrode Station on the Chandrapur–Padghe HVDC System. Other materials shall be proposed by the contractor during detail engineering for Employer’s approval as per relevant standards.

### 17.2 Definitions

Electrode Element	Metallic material component in main body of electrode used as current distributor made of high silicon chromium iron (HSCI).
Conductive Backfill	Conductive material used as media between electrode elements and earth for improved operation of electrode.
Calcined Petroleum Coke	Small particle solid residue left by the cracking process of petroleum refining, and calcined to reduce resistivity for use as conductive backfill.
Feeder Cable	Cable connecting between electrode center bus and distribution cable
Distribution Cable	Cable to distribute current to electrode elements
Jumper Cable	Cable connecting between distribution cable and electrode element
Electrode Section	A continuous subsection of electrode fed by a single feeder cable consisting of electrode elements and backfill, and separated from the adjacent subsections by native soil.
Sub-electrode	A portion of the electrode connected to a single disconnect switch. For the Malegaon electrode this consists of one electrode subsection in each of the inner and outer rings.



**Figure 2-1 – Conceptual Arrangement of Electrode and Cabling**

### 17.3 Material

#### Electrode Conductor

The electrode conductor shall be High Silicon Chromium Iron (HSCI) as specified in Table A 1.

#### Calcined Petroleum Coke

The calcined petroleum coke shall be used as specified in Table A-2, which shall be packed and shipped as stated below.

The coke shall be kept free of contaminants. It shall be delivered up to carload lots in woven polypropylene-polyethylene lined bags holding 50-100 lbs of coke; the bags can be palletized for handling.

Coke can also be loaded in large sack containers of that can be handled by nylon slings and rope cradles.

#### Feeder/Distribution/Jumper Cable

The cables shall be insulated cables as specified in Table A-3, Table A-4 and Table A-1. The cables shall be suitable for direct burial. The insulation of the cable shall be resistant to oxidization, mechanical abuse, weathering, oils, acids and alkalis and shall have a low coefficient of moisture absorption.

#### Connections and Joints

CADWELD process shall be used for connecting HSCI elements with jumper cables to the distribution cables, and distribution cables with feeder cables. The connections and joints shall be encapsulated in insulating resin to prevent the deterioration of the metal in the joints due to the electrolytic corrosion.

#### Disconnect Switches

Disconnect Switches are not required for connecting the feeder cables to the electrode line. The line is solidly connected to the electrode via the blocking filter. Individual electrode sections may be disconnected using the provided hook-stick disconnect switches.

#### 17.4 Technical Data Requirements

**Table A-1 - Electrode Conductor/Element**

Description	Units	Required
<b>Electrode Element</b>		
Type		High Silicon Chromium Iron – in accordance with ASTM A518
Composition (by weight %)		Silicon: 14.20 to 14.75% Chromium: 3.25 to 5.0% Carbon: 0.7 to 1.10% Manganese: 1.5% max Copper: 0.5% max Molybdenum: 0.2% max
Manufacturer		Supplier
Diameter	mm	65
Length	m	2.5
Weight	kg	35
No. of electrode elements (including spares for breakage)		475
<b>Factory Installed Jumper cable</b>		
Voltage Rating	V	1000
Insulation type		XLPE
Minimum Cross-sectional Area	mm <sup>2</sup>	8
Minimum cable length	m	3
Conductor material		Stranded copper

The method of fastening of the jumper cable to the HSCI element and the protection of the fastening point from corrosion during service is subject to approval by the Employer.

The connection shall not be subject to electrolytic corrosion and pull-out tension shall exceed the breaking strength of the jumper cable.

**Table A-2 - Conductive Backfill – Calcined Petroleum Coke**

Description	Units	Required
Type		Calcined Petroleum Coke

<b>Maximum Resistivity</b> (at 10 kN/m <sup>2</sup> compression)	Ohm*m	0.2
<b>Bulk Density</b>	kg/m <sup>3</sup>	950 to 1050
<b>Specific Gravity</b>		1.6
<b>Porosity</b>	%	45 to 50
<b>Chemical Analysis</b>		
Carbon	%	>95
Sulphur	%	<1
Volatiles	%	<0.7
Ash	%	<1
Other minerals (Iron, Silicon)	%	<0.5
Moisture	%	<0.5
<b>Particle Size</b>		
48 mesh	mm	1-5
	%	<4

**Table A-3 - Feeder Cables**

Description	Units	Required
<b>Rated power frequency voltage</b>	kV	6.6 -11kV
<b>Impulse withstand voltage</b>	kV	>60
<b>Continuous current Rating</b>	A	300
<b>Cross sectional area</b>	mm <sup>2</sup>	150
<b>Maximum Temperature</b>	°C	90
<b>Conductor Material</b>		Copper stranded non-tinned
<b>Insulation Material</b>		XLPE Insulated - PVC Sheathed
<b>Armor</b>		No
<b>Screen*</b>		Optional

Note: If screens are provided on the feeder cables, the screens must be grounded at the center structure

**Table A-4 - Distribution Cables**

Description	Units	Required
<b>Rated power frequency voltage</b>	kV	3.8-6.6

<b>Impulse withstand voltage</b>	kV	60
<b>Continuous current rating</b>	A	300
<b>Cross sectional area</b>	mm <sup>2</sup>	150
<b>Maximum Temperature</b>	°C	90
<b>Conductor Material</b>	Copper stranded non-tinned	
<b>Insulation Material</b>	XLPE Insulated - PVC Sheathed	
<b>Armor</b>	No	
<b>Screen</b>	No	

**Table A 5 - Hook Stick Disconnect Switch**

Description	Units	Required
<b>Type</b>		Hook-stick operated
<b>Rated Voltage</b>	kV	23
<b>Impulse withstand voltage</b>	kV	150
<b>Rated Current</b>	A	600 or larger

Manually operated Double break disconnect can also be provided by the Contractor.

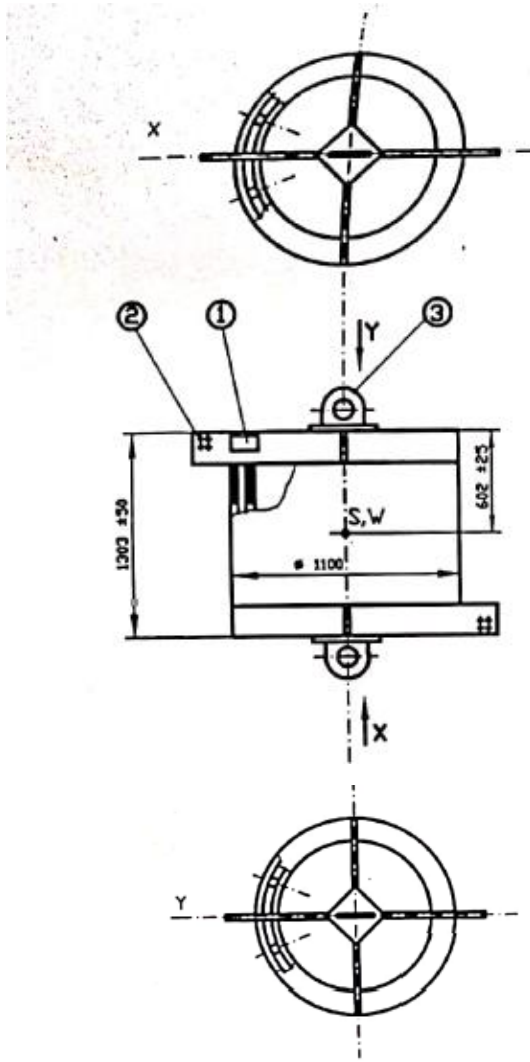
## 18. Existing Equipment Details at Anjur Electrode Station

The details of the existing Equipment at Anjur station are given below. The drawings provided here are for reference purpose only.

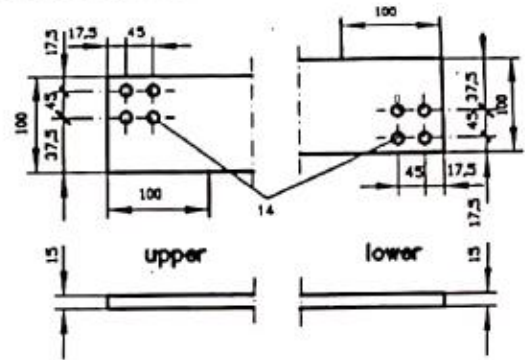
### 18.1 Blocking Reactor

Reactor at Electrode Station 0.5 mH  
Rated DC Current : 2000 A

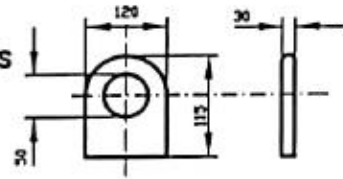
No. HE .....	Typ. DLTC 2000/0.5 Tip.	dat. 1995 ano.
$I_N$ 2000	A	$L_{IN}$ 0.5 mH
$I_{kN}$ 21	kA	$L_p$ 0.55 mH
$f_{pN}$ 50/60/DC	Hz	t 1 s
m 395	kg	← → 12904 N
Item: WN-W1.L1		Equip. Doc. No. ES-CP-025
Lightning impulse withstand voltage: 130 kV		
Temperature class of insulation: F		



② FLAT ALU PAD TERMINALS

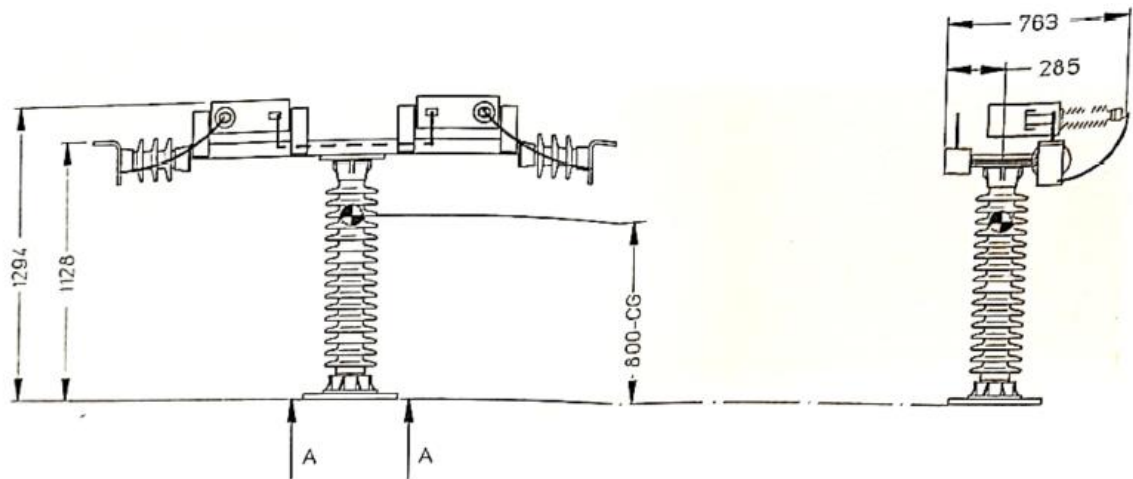
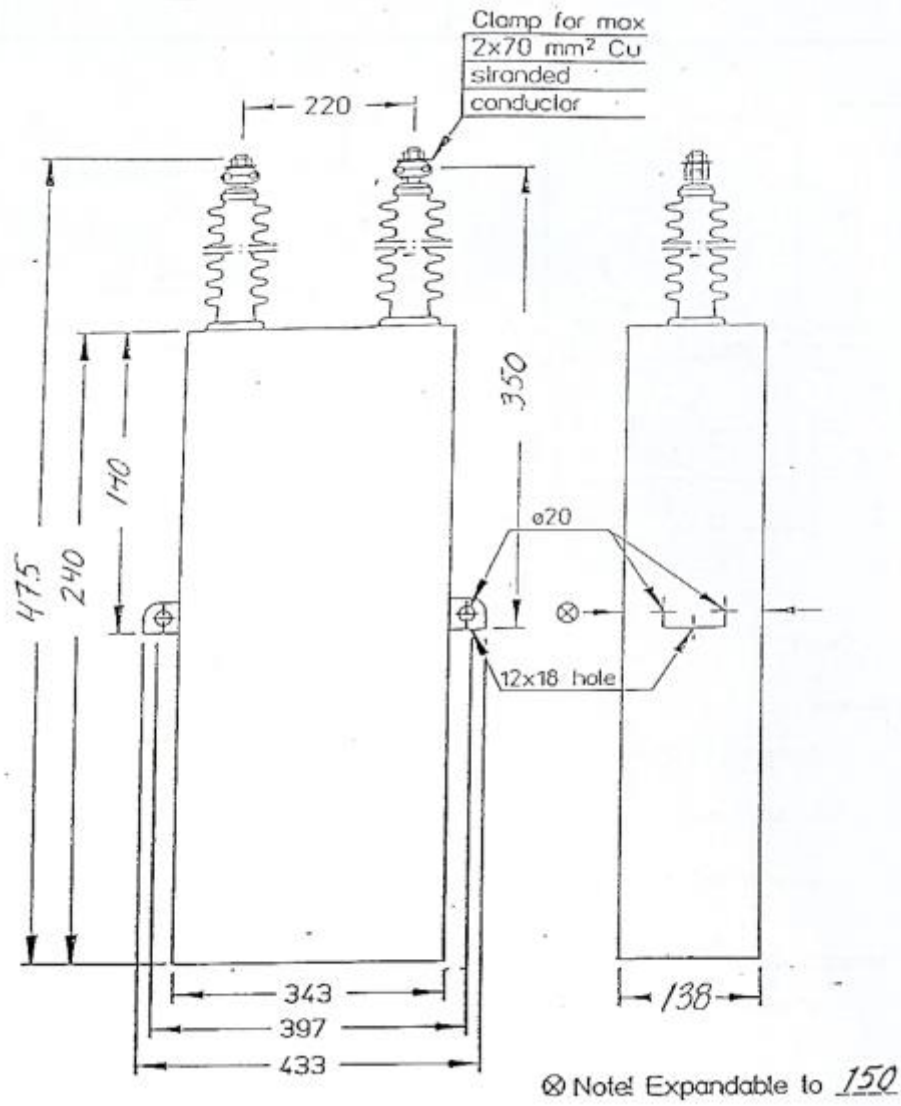


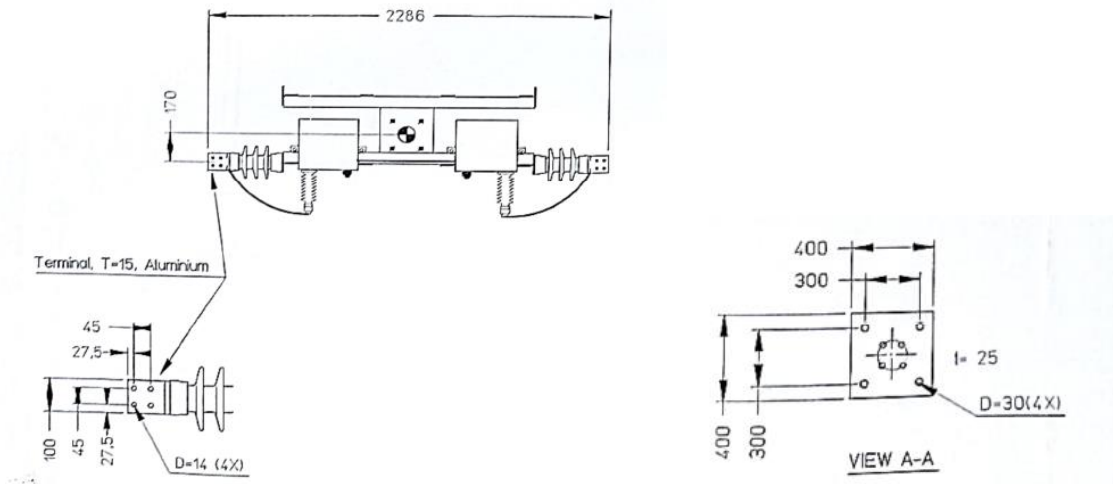
③ LIFTING EYES



18.2 Blocking Capacitor

**Capacitor at Electrode Station-** Two unit in series with rated capacitance of 0.52 micro Farad each, Unit Voltage rating 4.652 kV





### 18.3 Electrode Station Surge Arrester:

Sl.	Parameter	Rating
1.	System Voltage	33 kV
2.	Rated Voltage	30 kV
3.	MCOV	25kV
4.	Nominal Discharge current	10 kA
5.	Pressure relief current	40kA
6.	LD Class	2

## 19.Sub system and Pre-commissioning tests

### 19.1 General

This procedure is prepared for commissioning and testing the Malegaon electrode which will replace the original Anjur electrode of the Chandrapur-Padghe Project. A single line diagram of the Malegaon is shown in Figure 19-1 and a general arrangement is shown in Figure 19-2. The electrode is designed two concentric rings with the inner ring being 300m in diameter and the outer ring being 380m in diameter. The electrode is divided into 10 sections and may operate with up to 3 sections out of service in the event that maintenance is needed.

The testing and commissioning is divided into the following activities:

- a) Pre-Commissioning Inspection and Measurements
  - Post Construction Inspection
  - Measurement of ambient soil temperature and moisture levels at all measurement locations
- b) Commissioning Tests and Measurements

The commissioning and test program defines the required measurement and tests to be carried out during the electrode commissioning to verify the

electrode has been constructed in accordance with the design specification, to evaluate the electrode performance and ensure it meets the specified criteria and requirements.

c) Performance Evaluation of Electrode

This section describes preliminary evaluation of design and performance of electrode based on the measurement and test results.

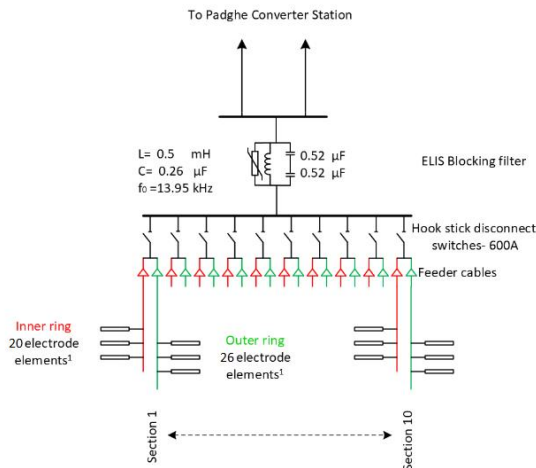


Figure 19-1 – Single line Diagram of Malegaon Electrode

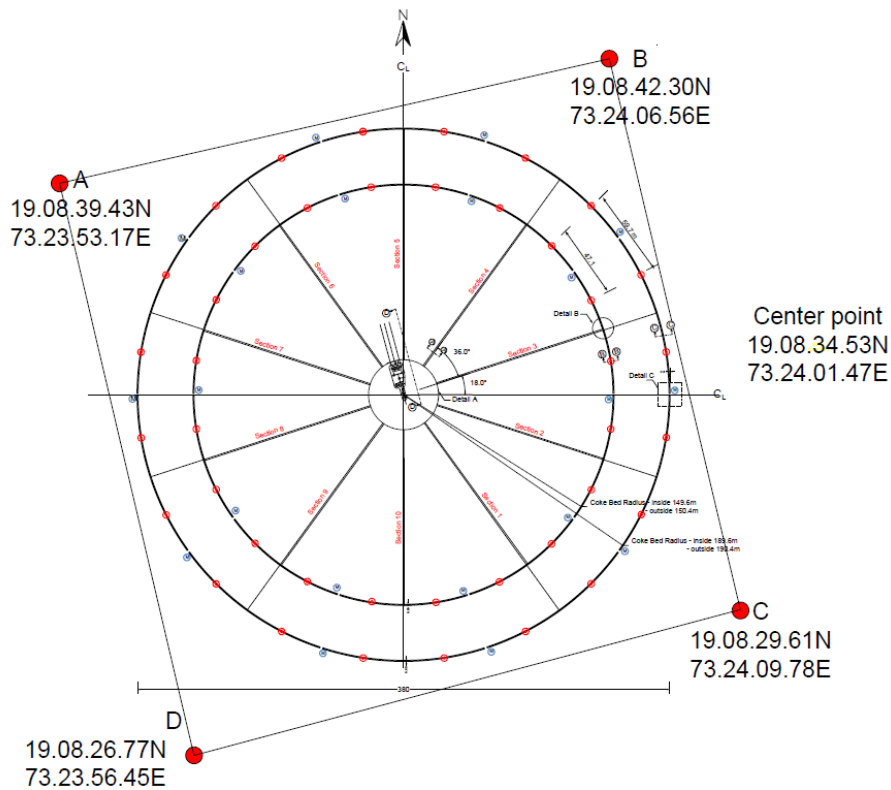


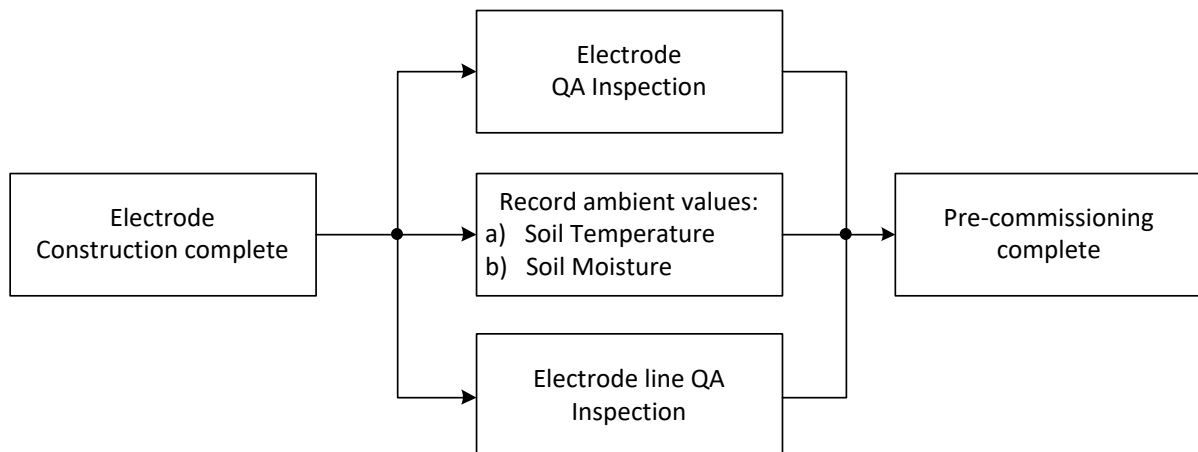
Figure 19-2 – General Arrangement of the Electrode

## 19.2 Pre-Commissioning Tests

The commissioning of electrode shall be performed in two stages, pre-commissioning and commissioning.

### Overview of Pre-Commissioning Tests

Pre-commissioning tests are necessary to ensure that electrode construction is complete, temporary grounds are removed, the electrode is constructed in accordance with the design and thus can be safely put into service. Figure 19-3 shows an overview of the tests.



**Figure 19-3 - Electrode Pre-Commissioning Tests**

### Pre-Commissioning Inspection

Prior to electrode energization, the electrode station shall be inspected to ensure that the electrode has been constructed as specified and all the temporary construction grounds have been removed.

#### **Required Test Equipment:**

- Inspection check sheet
- Torque wrench (1/2-inch drive click type) and sockets
- Micro-Ohmmeter (rental or provided by Customer)

#### **Procedure:**

- a) Electrode QA Inspection - The pre-commissioning inspection is to verify the construction is completed in accordance with the design. Each item on the check sheet provided in Table A-1 of Sample tables shall be verified.
- b) Verify that all connections are torqued to specification for the type/size of bolt and marked.
- c) Measurement of contact resistances of clamps to bus, arrester, reactor and capacitor connections and contact resistances of hook stick switches

### Measurement and Recording Soil Ambient Temperature and Moisture

#### **Required Test Equipment:**

---

*Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with ±500kV 1500MW Chandrapur-Padghe HVDC Bipole link.*

- Multimeter with Ohmmeter function with cable for measuring the resistance of RTD in temperature measuring station. Temperature is determined from the measured value of the resistance of the RTD. The RTD is a PT100 with temperature coefficient of 0.00385 Ohms/degree C.
- Soil moisture test kit. The instrument reads the soil moisture directly when the probe is inserted to the bottom of the temperature measuring pipe.

### **Procedure:**

Soil temperature and moisture measurements shall be performed manually at the measuring wells prior to any ground return mode operation using the specified portable instruments. The results shall be recorded in sheets based on Table A-2 of Sample tables.

#### Electrode Line QA inspection

Although the Electrode line is not within the scope of this work the following items should be checked prior to the electrode tests:

- a) The line conductors are complete with no missing sections, insulators are clean and arcing gaps ( if included in the line design) are installed.
- b) The shield wires are sectionalized and single point grounded for the specified distance from the electrode.
- c) All working grounds are removed
- d) There are no clearance violations to any items under the electrode line conductors.

## 19.3 Commissioning Tests

### Overview of Commissioning Tests

The energization of electrode will be performed using the converters at Padghe. Measurements will be taken at the Padghe converter station and at the Malegaon electrode station. If any items have been identified for mitigation in the design report measurements would be required at these facilities as well.

Tests and measurements performed during commissioning include:

#### Group 1 Tests:

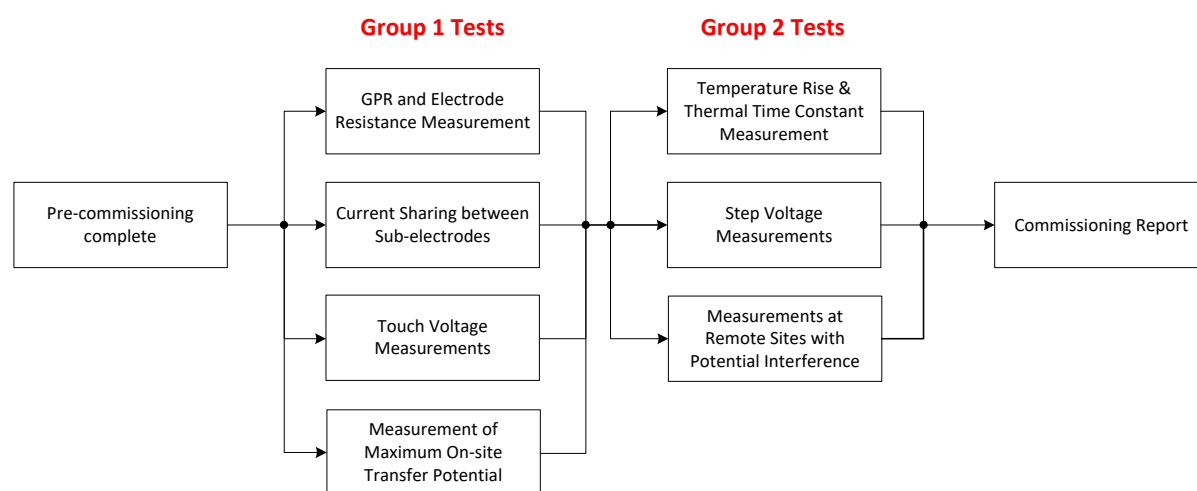
- a) Measurement of electrode potential rise
- b) Calculation of dc resistance of electrode to remote earth without any outage and with outage of 30% of sub-electrodes
- c) Measurement of current sharing between electrode sections of inner and outer rings without any outage and with outage of 30% of sub-electrodes
- d) Measurements of touch voltages
- e) Measurement of maximum transfer potential within the electrode substation.

#### Group 2 tests:

- a) Measurements of temperature rise and calculation of temperature rise time constant of the electrode

- b) Measurements of step voltages
- c) Measurements of possible interference at offsite locations.

An overview of the commissioning tests is shown in Figure 19-4. Note that the tests can be conveniently carried out in two groups. The Group 1 Tests will include the measurement of GPR, electrode resistance to remote earth, touch voltage and maximum on-site transfer potential. The Group 2 Tests will include the electrode thermal verification, measurement of step voltages and measurements at facilities which could be subject to interference (if required). Group 2 Tests are separated from Group 1 because these measurements require relatively long periods of operation at constant current.



**Figure 19-4 - Overview of Electrode Commissioning Tests**

### Measurement of Electrode Potential Rise and Resistance to Remote Earth

A good estimate of the ground potential rise at the electrode station can be obtained by injecting a known amount of current into the ground electrode through one of the electrode line conductors. The other conductor of the electrode line is open circuited at the converter station end and is used to measure the voltage change of the electrode with respect to remote earth. The open circuited electrode line conductor would be used to measure the electrode voltage at the Padghe converter station which represents remote earth. The open conductor ensures that the dc resistance of the electrode line is not included in the measurement of electrode resistance.

The voltage between the converter station ground and the open circuited electrode line conductor is the ground potential rise (GPR). The electrode resistance to remote earth is calculating the ratio of voltage over current. Current may be measured using the electrode line current transducer. Refer to Figure 19-4.

This method assumes that the ground potential rise at the converter station is negligible. The potential rise at any other electrode current can be determined by linear extrapolation of the measured value.

#### **Test Equipment Required at Padghe:**

- Voltmeter suitable for measurement up to 1kV with accuracy of < 1%.

- Current transducer (the existing electrode line current transformer may be used)

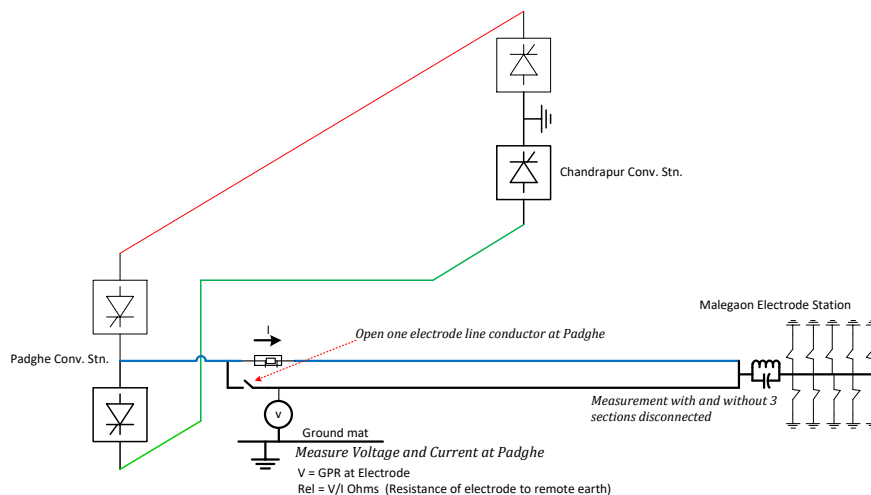
### Procedure:

The following is the sequence of steps to be followed

1. Inject dc current into one electrode line conductor **at Padghe** at the indicated measuring locations with magnitude of 0, 150, 1000, -150 and without outages and with outage of any 3 sub-electrodes. Both polarities of current are tested to detect possible polarization effects (if any). It should be verified that a single electrode line conductor can be thermally capable of carrying 1000A for up to 1 hour.
2. Maintain current at a constant value at each current test level until measurements at Padghe and at Malegaon are complete.
3. At each current step perform the following:
  - a) At Padghe, record the voltage (GPR) and calculate the electrode resistance ( $Rel = V/I$ ). (Table A-3)
  - b) At Malegaon, measure and record current in inner and outer sub-electrodes in accordance with Section-Measurements of Current Sharing between Sub-electrodes.
  - c) Stop HVDC system and connect both electrode line conductors
  - d) Increase electrode line current to rated current (1500 A)
  - e) At Malegaon, measure and record currents in each sub-electrode (Table A-4) in accordance with Section-Measurements of Current Sharing between Sub-electrodes.
  - f) Increase electrode line current to rated current (1650 A)
  - g) At Malegaon, measure and record currents in each sub-electrode (Table A-4) in accordance with Section-Measurements of Current Sharing between Sub-electrodes.

### Safety precautions:

It is expected that the electrode resistance will be within the range between 0.6 to 0.7 Ohms. Thus, the GPR may reach 600V to 700V at current of 1000A. A safety officer should be assigned at Padghe and at Malegaon by the Contractor to ensure that test equipment is adequate for the purpose and that safe practices and working procedures are followed throughout the tests.



### Measurements of Current Sharing between Sub-electrodes

This test will confirm the continuity of each sub electrode (feeder cables, distribution cables, individual sub-electrodes). Note that there is a large variation in soil resistivity over the site area and thus equal currents are not expected when comparing sub-electrodes. Inner ring sub-electrodes are expected to have lower current than outer ring sub-electrode. Currents shall be measured and recorded in each sub-electrode using the dc clip-on ammeter at the feeder cables below the disconnect switches. Acceptability of current sharing will be assessed after completing the measurements.

#### **Test equipment required at Malegaon**

- Clamp-on dc ammeter 0-600A (calibrated)

#### **Procedure:**

- a) At Malegaon, for each electrode current test level, measure and record the current in each of the 20 feeder cables to the sub-electrodes with no outage of electrodes sections similar to Table A-4 of Sample tables.
- b) Open hook stick switch of the three electrode sections selected for outage
- c) Repeat the measurements in a) above
- d) Reclose the hook stick switches

### Measurements of Touch Voltages

Touch voltages shall be measured and recorded at all structures on the site at test level of rated current (1500A) and, if possible, at the short time overload rating (1650A).

#### **Test equipment required at Malegaon**

- DC voltmeter with 2m test leads
- 200mm long steel rods driven into ground 150mm from all structures on the site.

#### **Procedure:**

- a) Drive the metal rods into the ground to a depth of about 100mm at a distance of about 1.2m from the structure. Leave them in place until the measurements are complete.
- b) Verify that the current injected is at one of the specified test levels (1500A, 1650A)
- c) Measure and record the voltage between the all structure and their associated metal rod. (Table A-5)
- d) Adjust the electrode current to the next test level and repeat the measurements.

Note: If the grounding of structures is correctly implemented then the touch voltages are expected to be nearly zero.

### Measurement of the maximum touch voltage that can occur on the site

The maximum touch voltage that can occur within the site is the voltage between the center of the inner ring (which has the highest potential rise) and the centre of the electrode which has the lowest potential rise. Due to unbalance of currents between the sub-electrodes of the outer ring, the GPR of the outer ring sub electrodes is not equal. The maximum GPR will occur on the sub-electrode with the lowest current. It is this sub-electrode that will be selected for measurement.

Slightly higher maximum touch voltages may be encountered during outages of three electrode sections. This may result in another different electrode section having lowest current and the measuring point would need to be moved.

### **Test equipment required at Malegaon**

- DC voltmeter with test leads
- Measuring leads or wire of 160m length stretching from centre of electrode to a point immediately above the inner ring near the middle of the sub-electrode. (Quantity 2)
- 20 cm metal rod to ensure contact with the soil. (Quantity 2)

Procedure:

- a) Identify the inner ring sub electrodes that have minimum current for the no-outage condition and for the case which has outage of three electrode sections
- b) Drive the metal rods at the center of the identified inner ring sub-electrode sections stretch out the 160m test leads from the centre of the electrode to the driven metal rods and fasten (or clip) the lead to the metal rod
- c) The other end of the 160m leads near the centre of the electrode may reach relatively high voltage and should not be handled during the test although it should be accessible for measuring using the insulated test leads of the multimeter.
- d) At each of the test currents (1500A and 1650A) and for outage and no-outage conditions record the voltage between the 160m test lead and one of the ground leads of the structures supporting the hook stick switches. Record the results in Table A-5.

### Measurement of temperature rise and calculation of temperature rise time constant

As the soil temperature increases slowly with large time constant, temperature measurements should be made over a duration of ideally up to one week one week of operation at constant dc ground current, ideally at maximum continuous current. If operation at maximum current cannot be arranged for one week, then a lower current which can be maintained at a constant value for at least three days (72 hours) should be selected.

Measurements of soil moisture and soil temperature at each of the electrode monitoring locations on the inner and outer rings shall be recorded. Measurements should be taken once per day at about the same time each day and recorded in Table A-6.

### **Safety Precautions:**

As the measurement of soil moisture will be carried out very near the coke bed of the electrode there is a risk of transfer potential from the electrode to the surface on the instrument leads or any metallic conductor. Suitable safety precautions need to be taken to avoid risk to personnel during measuring operations in monopolar operation. Also, all dip sticks used for water level measurement shall be non-conducting.

#### **Test equipment required at Malegaon**

- DC voltmeter with banana plug test leads for measuring resistance of temperature sensor RTDs.
- Soil moisture meter.

#### **Procedure:**

- a) Perform an initial set of temperature and soil moisture readings at all measuring locations and note the time
- b) Raise the electrode ground current to the rated value and hold it constant for the permitted test duration. A duration of 1 week is desirable but a minimum of 3 days
- c) Perform a set of soil moisture and temperature measurements every 24 hours at about the same time of day.
- d) Analyze the results to determine the thermal time constant and permitted time to maximum soil temperature of 90°C.

#### Measurement of Step Voltages

Step voltages shall be measured in the radial direction on at least 3 electrode sections (for instance 1, 4 and 7) and shall extend from at least 10 m inside the inner ring to 10m outside the outer ring. Step voltages would be measured at electrode currents of  $\pm 1500\text{A}$  and  $\pm 1650\text{A}$ .

#### **Test equipment required at Malegaon:**

- DC voltmeter with 2m test leads
- Measuring jig with 1m spacing to make it easier to measure profiles of voltage gradient  
(similar to Figure 19-5)

#### **Procedure:**

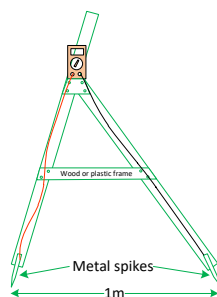
- a) Select the electrode sections that will be used to measure the step voltages and mark the tracks of the of the measurements on the ground using a temporary marking method such as stakes and string.
- b) Adjust the electrode current to the test level (1500A).
- c) On each of the selected electrode sections, measure a series of step voltages along a radial line taken near the middle of the section and a second profile should be measured near one end of the sub-electrodes. Record the results in Table A-7.

Profiles can be conveniently measured by constructing a measuring jig as shown in Figure 19-5. The jig can be walked along the profile by "walking" the jig by lifting the trailing edge and rotating it forward 180 degrees around the

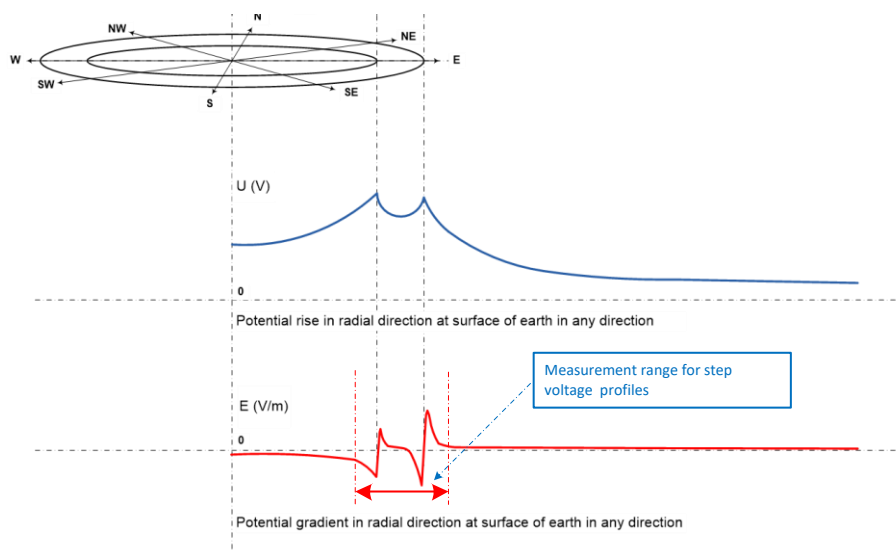
leading edge. A reading should be taken at each step. Note that the meter is reversed every "step" and thus polarity of meter readings need to be observed and adjusted.

The measurement shall be done radially along a line that passes through the centre of the electrode as shown in Figure 19-6. The voltage difference between each successive 1m step on the soil surface would be measured in the indicated range. The maximum step potential would be expected 2.5 to 3.5m outside each electrode ring.

- d) Perform a second set of measurements with an outage of three electrode sections. In this case, the measurements should be carried out on in-service electrode sections only.
- e) Repeat the step voltage profiles for a test current of 1650A and record results in Table A-7a.



**Figure 19-5 - Measuring Jig to Facilitate Step Voltage Profile Measurement**



**Figure 19-6 - Potential Gradient Measurements**

### Off-Site Measurements

Facilities that may be subject to interference from the Malegaon electrode have not been identified at this time. If necessary procedures for performing

measurements will be developed for each at-risk facility and will be described in a separate report.

## 19.4 Sample Tables for Recording Test Measurements

Table A-1 - Precommissioning Checklists Malegaon Electrode Station		
Item	Description	Verified
1	Constuction is complete	
2	Electrode Line is connected	
3	Electrode circuit matches single line diagram	
4	All structures are grounded at one point	
5	Cable Screens grounded (if screens are provided)	
6	Line shield wire is isolated at station (not grounded)	
7	All hookstick switches are closed	
8	Temperature and moisture measuring points installed and complete	
9	Site fences are in place (if applicable)	
10	Watering pipes installed and capped to	
11	Seepage wells installed in accodace with drawings	
12	connections are prepared with connection paste	
13	Cu/Al transition plates are installed at Hook switch top connections	
14	Bus supports include 1 sliding and one fixed fixing point.	
15	Structures ar level and anchor bolts are toqued and marked	
16	Insulators are in good condition and clean	
17	All working grounds removed	
	<b>Clamp Bolt Torque Checks</b>	<b>Verified</b>
1	incoming line conector west side	
2	Incoming line conector east side	
3	Bus connector to arrester leads	
4	Connections at at arrester	
5	Connections at at Reactor	
6	Connections at capacitor	
7	Connectors at electrode distribution bus	
8	Connectors at top of Hook switches	
9	Connectors at bottom of Hook switches	
	<b>Connector Resistance measurements</b>	<b>Value (<math>\mu\Omega</math>)</b>
1	incoming line conector west side	
2	Incoming line conector east side	
3	Bus connector going to reactor	
4	Reactor incoming conector (line side)	
5	Reactor ooutgoing connector (electrode side)	
6	reactor connection to capacitor (top)	
7	Reactor connection to capacitor (bottom)	
8	Capacitor connection to reator(top)	
9	Capacitor to reactor (bottom)	
10	bus connector going to reactor(electrode side)	
11	Bus connector to Hookstick switch 1	
12	Bus connector to Hookstick switch 2	
13	Bus connector to Hookstick switch 3	
14	Bus connector to Hookstick switch 4	
15	Bus connector to Hookstick switch 5	
16	Bus connector to Hookstick switch 6	
17	Bus connector to Hookstick switch 7	
18	Bus connector to Hookstick switch 8	
19	Bus connector to Hookstick switch 9	
20	Bus connector to Hookstick switch 10	
21	hookstick switch 1 connection to bus	
22	hookstick switch 2 connection to bus	
23	hookstick switch 3 connection to bus	
24	hookstick switch 4 connection to bus	
25	hookstick switch 5 connection to bus	
26	hookstick switch 6 connection to bus	
27	hookstick switch 7 connection to bus	
28	hookstick switch 8 connection to bus	
29	hookstick switch 9 connection to bus	
30	hookstick switch 10 connection to bus	
31	Hook stick Switch 1 switch top to bottom	
32	Hook stick Switch 2 switch top to bottom	
33	Hook stick Switch 3 switch top to bottom	
34	Hook stick Switch 4 switch top to bottom	
35	Hook stick Switch 5 switch top to bottom	
36	Hook stick Switch 6 switch top to bottom	
37	Hook stick Switch 7 switch top to bottom	
38	Hook stick Switch 8 switch top to bottom	
39	Hook stick Switch 9 switch top to bottom	
40	Hook stick Switch 10 switch top to bottom	
41	Hook stick Switch 1 to Feeder cable	
42	Hook stick Switch 2 to Feeder cable	
43	Hook stick Switch 3 to Feeder cable	
44	Hook stick Switch 4 to Feeder cable	
45	Hook stick Switch 5 to Feeder cable	
46	Hook stick Switch 3 to Feeder cable	
47	Hook stick Switch 6 to Feeder cable	
48	Hook stick Switch 7 to Feeder cable	
49	Hook stick Switch 8 to Feeder cable	
50	Hook stick Switch 9 to Feeder cable	
51	Hook stick Switch 10 to Feeder cable	
52	Connector at top of arrester	
53	Connector at botom of arrester	

Technical specification for Shallow type ground electrode station at Malegaon (Padghe terminal) associated with  $\pm 500\text{kV}$  1500MW Chandrapur-Padghe HVDC Bipole link.

Precommissioning Measurements Malegaon Electrode Station				
Table A-2 - Ambient Soil temperature and Moisture levels				
	Soil Ambient Temperature and Moisture Levels	RTD Resistance( $\Omega$ )	Temperature( $^{\circ}$ C)	Soil Moisture (%)
	Electrode Section 1 Inner ring	105.1	13.2	
	Electrode Section 1 Outer ring	100	0.0	
	Electrode Section 2 Inner ring	100	0.0	
	Electrode Section 2 Outer ring	100	0.0	
	Electrode Section 3 Inner ring	100	0.0	
	Electrode Section 3 Outer ring	100	0.0	
	Electrode Section 4 Inner ring	100	0.0	
	Electrode Section 4 Outer ring	100	0.0	
	Electrode Section 5 Inner ring	100	0.0	
	Electrode Section 5 Outer ring	100	0.0	
	Electrode Section 6 Inner ring	100	0.0	
	Electrode Section 6 Outer ring	100	0.0	
	Electrode Section 7 Inner ring	100	0.0	
	Electrode Section 7 Outer ring	100	0.0	
	Electrode Section 8 Inner ring	100	0.0	
	Electrode Section 8 Outer ring	100	0.0	
	Electrode Section 9 Inner ring	100	0.0	
	Electrode Section 9 Outer ring	100	0.0	
	Electrode Section 10 Inner ring	100	0.0	
	Electrode Section 10 Outer ring	100	0.0	

Table A-3 - Electrode GPR and Resistance to Remote Earth			
	Deccription	GPR	Electrode Resistance( $\Omega$ )
Item	Measurement of GPR and Resistance	Voltage (V)	
1	GPR at Iel = 0 A ( at Padghe)		--
2	GPR at Iel = 150 ( at Padghe)		0
3	GPR at Iel = 500 ( at Padghe)		0
4	GPR at Iel = 1000 ( at Padghe)		0
5	GPR at Iel = -150 ( at Padghe)		0
6	GPR at Iel = -500 ( at Padghe)		0
7	GPR at Iel = -1000 ( at Padghe)		0

**Commissioning Tests - Group 1  
Malegaon Electrode Station**

Table A-4 - Current Distribution between Electrode Sections				
<b>1</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 150A, No outage</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>2</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = -150A, No outage</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>3</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1000A, No outage</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>4</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1500A, No outage (2 conductors on line)</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>5</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1500A, 3 outages</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>6</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1650A, No outage (2 conductors on line)</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	
<b>7</b>	<b>Current distribution between Subelectrodes</b>			
	<b>Iel = 1650A, 3 outages</b>	<b>Inner ring (A)</b>	<b>Outer ring (A)</b>	<b>Section current(A)</b>
	Hookstick Disconnect 1			0
	Hookstick Disconnect 2			0
	Hookstick Disconnect 3			0
	Hookstick Disconnect 4			0
	Hookstick Disconnect 5			0
	Hookstick Disconnect 6			0
	Hookstick Disconnect 7			0
	Hookstick Disconnect 8			0
	Hookstick Disconnect 9			0
Hookstick Disconnect 10			0	

**Commissioning Tests - Group 1  
Malegaon Electrode Station**

**Table A-5 - Touch Voltage at Maximum Current**

	<b>Touch voltage Measurements @ Iel=1650A</b>	<b>Touch voltage(V)</b>
	incoming tower	
	incoming bus structure 1 west	
	Incoming bus structure 2 east	
	Arrester structure	
	Reactor structure	
	Capacitor structure	
	Electrode distribution Bus structure 1	
	Electrode distribution Bus structure 2	

**Table A-5a - Maximum Possible Transfer Potential on Site**

	<b>Maximum Transfer Potential on site @1650A</b>	<b>Transfer Voltage(V)</b>
	First electrode section (center) no outage	
	First electrode section (edge) no outage	
	Second electrode section (center) no outage	
	Second electrode section (edge) no outage	
	First electrode section (center) outage 3 sections	
	First electrode section (edge) outage 3 sections	
	Second electrode section (center) outage 3 sections	
	Second electrode section (edge) outage 3 sections	

**Commissioning Tests Group 2  
Malegaon Electrode Station**

**Table A-6 - Soil Temperature Rise and Moisture levels**

Soil Ambient Temperature and Moisture Levels	Day 0 - 9:00am Initial Cond			Day 1 - 9:00am		
	RTD Resistance(Ω)	Temperature(°C)	Soil Moisture (%)	RTD Resistance(Ω)	Temperature(°C)	Soil Moisture (%)
Electrode Section 1 Inner ring	105.1	13.2		105.1	13.2	
Electrode Section 1 Outer ring	100	0.0		100	0.0	
Electrode Section 2 Inner ring	100	0.0		100	0.0	
Electrode Section 2 Outer ring	100	0.0		100	0.0	
Electrode Section 3 Inner ring	100	0.0		100	0.0	
Electrode Section 3 Outer ring	100	0.0		100	0.0	
Electrode Section 4 Inner ring	100	0.0		100	0.0	
Electrode Section 4 Outer ring	100	0.0		100	0.0	
Electrode Section 5 Inner ring	100	0.0		100	0.0	
Electrode Section 5 Outer ring	100	0.0		100	0.0	
Electrode Section 6 Inner ring	100	0.0		100	0.0	
Electrode Section 6 Outer ring	100	0.0		100	0.0	
Electrode Section 7 Inner ring	100	0.0		100	0.0	
Electrode Section 7 Outer ring	100	0.0		100	0.0	
Electrode Section 8 Inner ring	100	0.0		100	0.0	
Electrode Section 8 Outer ring	100	0.0		100	0.0	
Electrode Section 9 Inner ring	100	0.0		100	0.0	
Electrode Section 9 Outer ring	100	0.0		100	0.0	
Electrode Section 10 Inner ring	100	0.0		100	0.0	
Electrode Section 10 Outer ring	100	0.0		100	0.0	

Table A-7 -Step Voltage Profiles (1500A)						
Distance from center (m)	no outage	no outage	no outage	3 outages	3 outages	3 outages
	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)
150						
151						
152						
153						
154						
155						
156						
157						
158						
159						
160						
161						
162						
163						
164						
165						
166						
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200						

Table A-7a -Step Voltage Profiles (1650A)						
Distance from center (m)	no outage	no outage	no outage	3 outages	3 outages	3 outages
	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)	Electrode Section 1 (V)	Electrode Section 4 (V)	Electrode Section 7 (V)
150						
151						
152						
153						
154						
155						
156						
157						
158						
159						
160						
161						
162						
163						
164						
165						
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## 20.Section: Civil works

### 20.1 General

- a) All civil works shall be carried out as per design/drawings provided by the Employer/ Contractor and as per these specifications provided by the Employer. *In case design/drawings are prepared by the contractor then these shall be approved by the employer before execution.* In case any item is not covered under specification then the same shall be carried out as per CPWD specification /applicable BIS Standards and Codes. Any item for which specification is not provided herein and is not covered under CPWD specification/ BIS Standards, the same shall be executed as per manufacturer guidelines with the approval of employer. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the order of precedence shall be as under:
- Technical specification,
  - BIS codes
  - CPWD specification.
- The decision of engineer in charge in this regard shall be final and binding.
- b) Wherever reference to CPWD/BIS Codes is made, it shall be to the latest edition/revision of the same, issued up to 7 days prior to the date of opening of this tender.
- c) The Contractor shall arrange all labour, tools, equipment, materials, temporary works, constructional plant & machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with drawings, specifications and direction of Employer.
- d) All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the Contractor.
- e) The Contractor shall execute the work as per the Field Quality Plan (FQP) of the Employer, if any. All testing required shall be arranged by the Contractor at his own cost. If standard FQP is not available, contractor shall submit field quality plan for Employer's approval before execution.
- f) The bidder shall fully apprise himself of the prevailing conditions at the proposed site, Climatic conditions including monsoon patterns, local conditions and site specific parameters, soil parameters, availability of construction material and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

- g) Unless leveling is in the scope of the bidder, fairly leveled site with single level/terraces with different levels/ gradual slope shall be handed over to the Contractor, in a phased manner. The finished ground level (FGL) with a tolerance of (+/-) 100mm shall be decided by the Employer. The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. The Contractor shall provide all assistance in instruments, materials and personnel to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

In case leveling is in the scope of bidder, FGL shall be decided by the employer.

- h) Employer has standardized its technical specification for various items/ works. Specification for items which are covered in the scope & Bid Price Schedule shall only be referred.
- i) The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan of Employer, if any. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification/ relevant BIS.

## 20.2 Geotechnical Investigation:

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the various structures safely and rationally.

A report to the effect shall be submitted by the Contractor for Employer's specific approval giving details regarding data proposed to be utilized for the design.

### SCOPE:

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata starting from 0.5M from existing ground level for the various structures of the substation. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in

field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the Employer.

#### BORE HOLES:

- a) Bore holes of 150 mm diameter in accordance with the provisions of IS: 1892 at the rate of minimum one number bore hole per hectare up to 15meter depth into virgin soil or to refusal whichever occurs earlier shall be drilled. Total area of substation plot (including of Switchyard, Township and Future area) shall be considered for arriving at number of bore holes to be drilled. In any case number of boreholes shall not be less than five and shall not exceed twenty. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. In case rock is encountered within five meter from existing ground level, coring in all the boreholes shall be carried out up to 3 meter in rock.
- b) The Contractor shall carry out Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 0.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.
- c) The Contractor shall collect undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 0.5 m below ground level onwards in clayey strata.
- d) The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the water table for rainy season shall be collected from reliable sources and recorded in the report.
- e) All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.
- f) The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the laboratory without any damage or loss.
- g) The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.

#### TRIAL PITS:

Trial pits shall be carried out at minimum one location per hectare as directed by the Employer. In case hard rock is encountered in trial pit, test need not be carried out. Total area of substation plot shall be considered for arriving at number of Trial Pit to be excavated. Minimum number of trial pits shall be five and maximum number shall be ten. The trial pits shall be 2 m x 2 m in size extending to 4 m

depths, or as specified by the Employer. Undisturbed samples shall be taken from the trial pits as per the direction of the Employer.

### WATER SAMPLE

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air- tight containers.

### BACK FILLING OF BORE HOLES

On completion of each hole, the Contractor shall backfill all bore holes as directed by the Employer. The backfill material can be the excavated material.

### LABORATORY TEST

- a) The laboratory tests shall be carried out progressively during the field work after sufficient number of samples has reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.
- b) All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid down in the relevant I.S. Codes.

The following laboratory tests shall be carried out

- i) Visual and Engineering Classification
- ii) Liquid limit, plastic limit and shrinkage limit for C-Ø soils.
- iii) Natural moisture content, bulk density and specific gravity.
- iv) Grain size distribution.
- v) Swell pressure and free swell index determination.
- vi) California bearing ratio.
- vii) Consolidated drained test with pore pressure measurement.
- viii) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.
- ix) In case of rock samples following tests shall also be conducted:
  - Rock quality designation (RQD), RMR.
  - UCC test.
  - Point load index test.

### TEST RESULTS AND REPORTS

- a) The Contractor shall submit the detailed report in three (3) copies wherein information regarding the geological detail of the site, summarized observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the Contractor shall submit draft report and after the draft report is approved, the final report in three (3) copies shall be submitted. The site test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of Employer.
- b) The report shall include, but not limited to the following:-
- i. A plan showing the locations of the exploration work i.e. bore holes, trial pits, Plate load test etc.
  - ii. Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.
  - iii. Test results of field and laboratory tests shall be summarized strata wise as well as in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.
  - iv. The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Employer. The observations and recommendations shall include but not limited to the following:
    - Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.
    - Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.
    - Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 2.5.
    - Recommendation regarding liquefaction potential/characteristics of soil during ground shaking and possible remedies shall be provided.
    - Recommendations regarding slope of excavations and dewatering

schemes, if required.

- Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
  - If expansive soil is met with, recommendations on removal or detainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification of materials to be used, construction method, equipment's to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.
  - Recommendations for additional investigations beyond the scope of the present work, if considered such investigation as necessary.
  - In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given based on RMR value
- v. All Geotechnical investigation reports must be signed and stamped by qualified Geotechnical engineer/ consultant even if they have been prepared by NABL accredited test labs.

### 20.3 Standard Drawings:

#### BOUNDARY WALL

Boundary wall shall be brick masonry wall with RCC frame. The construction drawing of the boundary wall applicable is enclosed with tender document. *All walls shall have adequate weep holes/ gratings as per drawing/ as per site conditions for the drainage of water.* The layout shall be as per approved layout drawing during detail engineering.

a) Brick masonry wall with RCC frame:

Boundary wall shall consist of frame of RCC column and foundation at regular intervals connected through plinth beam and supporting 230 thick brick masonry. Details such as height, column spacing, structural details, fencing/grating works, plastering/ painting, etc. shall be as per tender/construction drawing.

b) All structural steel angle for supporting barbed wire/concertina coil shall be painted with epoxy paint of approved brand and colour shade.

### 20.4 Excavation and Backfill of Foundations:

Excavation for foundations shall be in accordance with CPWD Specification/ the relevant BIS code. Excavation shall include removal of all materials of whatever nature at all depth and whether wet or dry necessary for the construction of

foundations. The bottom of excavation shall be leveled both longitudinally and transversely unless otherwise mentioned in the drawings or as directed by Engineer-in-charge. Excavation shall be measured as classified under:-

- Excavation in all kind of soil including soft/ disintegrated rock, PCC, WBM, Brickwork/ stone masonry etc (excluding hard rock).
  - Excavation in hard rock (required blasting)
- a) If required the sides of excavations should be supported in such a way as is necessary to secure these from falling in, and the shoring, if required, shall be provided and maintained in position as long as necessary. No extra payment shall be made for shoring.
- b) Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, The excavation shall be kept free from water:-
- i. When concrete and/or masonry works are in progress and till they come above the natural water level
  - ii. Till the Employer considers that the concrete/ mortar is sufficiently set.

No extra payment shall be made for dewatering.

- c) Material unsuitable for foundations shall be removed and replaced by suitable fill material as per specification and to be approved by the Employer.
- d) Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted. Requirements regarding density / tests of backfilled earth shall be as specified in Field Quality Plan of the Employer, if any. The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC (optimum moisture content). Cohesion less material sub-grade shall be compacted to 70% relative density (minimum).
- e) If, excavated material is not suitable or not required for backfill, it shall be disposed off in areas as directed by Employer up to a maximum lead of 2 km from the substation boundary.
- f) REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION:
- i. The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.
  - ii. The filling shall be done in accordance with clause 4.10 of IS: 1080. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the Employer.

- iii. Cohesive Non Swelling (CNS) soil, if required, for filling under / around the foundations, cable trenches, drains, roads etc shall conform to IS: 9451: 1994 reaffirmed 2004

#### 20.5 Cement:

- a) The type of cements which can be used are Portland Pozzolana cement (conforming to IS:1489), Ordinary Portland cement (conforming to IS:269 or IS:8112 or IS:12269), and Portland Slag cement. (Conforming to IS: 455). Cement shall be arranged by contractor.
- b) Generally PPC type shall be used for concrete work. However depending on availability, OPC may also be used without any additional financial implication to Employer.
- c) Extra care for curing shall be taken for concrete made with OPC 53 grade & PPC.
- d) Extra care for removing form work shall be taken, when PPC is used.
- e) Portland Slag Cement has low heat of hydration and is relatively better resistant to soils and water containing excessive amount of sulphates of alkali metals, alumina and iron, as well as to acidic waters. Hence it can be specifically allowed for above conditions with prior approval of EIC.

#### 20.6 Chemical Admixtures & Additives

- a) Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.
- b) It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect. The amount of admixture added to mix shall be recorded in the production record by the producer.
- c) Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.
- d) When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

#### 20.7 Reinforced Concrete Cement (RCC):

All RCC work including material properties, proportioning, batching, mixing, transporting, pouring, compacting, finishing, curing, sampling, testing, acceptance criterion etc. shall be as per IS : 456-2000 (or latest)

#### DESIGN MIX CONCRETE

- a) For new substations and extensions except minor works, Reinforced cement concrete shall be M-25 design mix conforming to IS: 456. IS: 10262 shall be followed for mix proportioning. The minor work may be defined as any work involving less than 3.0 cum of concrete in a single day of concreting at one particular construction site.
- b) Design mix concrete may be procured from approved RMC plant as per latest IS: 4926 or may be prepared by using a portable/mini/compact weigh batch plant conforming to latest IS: 4925
- c) As per provisions of IS: 456, fly ash conforming to grade I of IS: 3812 (part-1) may be used as part replacement of cement, when OPC cement is used for concrete works. Uniform blending with cement is to be ensured.

#### VOLUMETRIC MIX CONCRETE

- a) Use of volumetric mix concrete shall be restricted to minor works only (as per clause 8.1.1) with approval of engineer incharge. In such cases reinforced cement concrete shall be of volumetric mix 1:1.5:3 (1 cement: 1.5 coarse sand: 3 well graded stone aggregate 20mm nominal size) conforming to CPWD specifications. Volumetric mix 1:1.5:3 shall be considered equivalent to M-20.
- b) In case of volumetric mixes, Standard measuring boxes of 35cmX40cmX25cm (35 liters capacity as per CPWD) shall be used for measuring fine and coarse aggregates.
- c) However, full 50 kg of OPC/PPC/Slag cement shall be directly unloaded into the mixer hopper to ensure that cement consumption is 400kg per cum of 1:1.5:3 concrete irrespective of different types of cements with different densities.
- d) The cement consumption shall be as per DSR (CPWD) for other grades of concretes provided as volumetric concrete in the BPS.
- e) For volumetric mix concretes, the cement used may be generally PPC type, however concrete may be prepared with OPC also, without any financial implication to Employer.

#### 20.8 Reinforcement Steel:

Reinforcement steel shall be thermo mechanically treated (TMT) or HYSD reinforcement bars of grade Fe 500D/550D conforming to IS: 1786. Reinforcement shall be arranged by contractor.

## 20.9 Drawings and Design to be developed By Contractor / Employer During Detailed Engineering:

The following clauses are applicable for the design and drawings which are to be developed during detailed engineering either by *contractor*/ vendor or by employer as per technical specification.

### BUILDING DESIGN CONSIDERATIONS:

- a) To the requirements of the National Building Code of India, and the standards quoted therein.
- b) For the specified climatic & loading conditions.
- c) To adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
- d) With a functional and economical space arrangement.
- e) To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.
- f) To allow for easy access to equipment and maintenance of the equipment.
- g) With wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire.
- h) With materials preventing dust accumulation.
- i) With the FFL of building shall be minimum 750 mm above finished ground level or as indicated in the tender drawings. In case of extension of existing buildings, FFL should match with the existing buildings.
- j) With anti-termite treatment, plinth protection, DPC, peripheral drain, sanitary, water supply, electrification etc.
- k) With the building lighting, in accordance with the requirements of relevant section.
- l) With the building auxiliary services like air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services, in accordance with the requirements specified in relevant section or elsewhere in this Specification.
- m) Most critical combinations of dead loads, super- imposed loads, equipment loads, crane load, wind loads, Snow load, seismic loads, any other load etc whichever is applicable shall be considered.
- n) The individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion deflection etc.
- o) The permissible stresses for different load combinations shall be taken as per relevant BIS Codes.
- p) *All structures and its components must be designed and detailed as per latest BIS standards incorporating ductile detailing. List of reference codes e.g IS 456-2000 (latest), IS 875 all parts, IS 1893 all parts, IS 4326, IS 13920, SP34*

*etc.*

- q) RCC columns shall be provided with rigid connection at the base.
- r) The design of steel structures for the Pre-engineered buildings shall be done in accordance with IS: 800-2007 with limit state method or elsewhere mentioned in section project.
- s) Limit state method of Concrete design shall be adopted unless specified otherwise in the specification.
- t) Clear cover to reinforcement shall be as per IS: 456 (latest).
- u) Expansion joints wherever necessary with provision of twin columns shall be as per the provisions of relevant IS or National building codes.
- v) Any sub-soil water encountered at founding level, same shall be considered in the design.
- w) For maintaining adequate air pressure inside GIS Halls following measures need to be adopted:
  - i. Elastomeric sealants to be provided at doors/windows junction with walls, duct entry points, roof joint, etc. to check any air leakages.
  - ii. Cable sealing system shall be provided at the cable entry points.
  - iii. Mats to be provided on cable trenches to reduce air leakage.
  - iv. External doors shall be inward opening.
  - v. Providing of an air lock lobby for separating the inside area of GIS hall.

#### DESIGN LOADS:

The following loads shall be considered in design, in addition to the equipment manufacturer's requirements if any. However, all the loads, which are required for design, are subjected to employer's approval.

##### a) DEAD LOADS

- i. Dead loads shall include the self-weight of all structures complete with finishes, fixtures and partitions.
- ii. In addition, RCC beams shall be designed for any incidental point loads to be applied at any point along the beams if applicable.

##### b) IMPOSED LOADS

- i. Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads wherever these loads are expected. Equipment loads shall constitute, if applicable, all load of equipment's to be supported on the building frame.
- ii. Floors/slabs shall be designed to carry loads imposed by equipment, cables and other loads associated with building. Cable load shall also be considered additionally for floors where these loads are expected.

- iii. The floor loads shall be subject to Employer's approval. Floors shall be designed for live loads as per relevant IS 875 part 2 (latest), however, for Buildings, the following loads may be considered.

Roof	1.5 kN/m <sup>2</sup> for accessible roofs and 0.75 kN/m <sup>2</sup> for in-accessible roofs
RCC-Floor	i) 5 kN/m <sup>2</sup> for offices ii) 10 kN/m <sup>2</sup> (min.) for equipment floors or actual requirement, if higher than 10kN/m <sup>2</sup> on equipment component and layout plans
Stairs & balconies	5 kN/m <sup>2</sup>
Toilets	2 kN/m <sup>2</sup>
Chequered plate floor	4 kN/m <sup>2</sup>
Walkways	3 kN/m <sup>2</sup>

- iv. For crane loads an impact factor of 30% and lateral crane surge of 10% (lifted weight + trolley) shall be considered in the analysis of frame according to provisions of IS:875. The horizontal surge shall be 5% of the static wheel load. Crane load shall be applied as per the requirement of building.

c) WIND LOAD

- i. The wind loads shall be computed as per IS 875 part 3 (latest), the class of structure for design, k<sub>1</sub> factor, shall be considered under the category as 'important buildings and structures like hospitals, communication buildings/towers, power plant structures' for Control Room building, GIS hall, Towers, Gantries, equipment structure. For other buildings/structures wind loads shall be computed as per IS 875 part 3 (latest).
- ii. Wind and Seismic forces shall not be considered to act simultaneously.

d) SEISMIC LOAD

- i. Seismic Coefficient method/Response Spectrum method shall be used for the seismic analysis as per IS: 1893: Part 1 with importance factor 1.5.
- ii. Wind and Seismic forces shall not be considered to act simultaneously.

e) LOAD COMBINATIONS

- i. The critical load combinations for design of RCC structures shall be computed or generated by using IS: 875 Part-5 (latest), IS: 456 (latest), IS: 1893- part 1 (latest).
- ii. The critical load combinations for design of Steel structures shall be computed or generated by using IS: 875 Part-5 (latest), IS: 800, IS: 1893- part 1 (latest).

#### DESIGN OF FOUNDATIONS FOR BUILDINGS & OTHER SWITCH YARD STRUCTURES:

- a) All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456. Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction
- b) The switchyard foundation's plinths shall be minimum 300mm and buildings plinth shall be minimum 600 mm above finished ground level respectively. If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.
- c) The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Isolated/ Combined/ Strip footings / Raft or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided
- d) The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant BIS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details.
- e) Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.
- f) If pile foundations are adopted, the same shall be cast-in-situ bored or pre-cast or under reamed type as per relevant parts of IS: 2911. Only RCC piles shall be provided. Necessary initial load test shall be carried out by the Contractor to establish the pile design capacity. Only after the design capacity of pile has been established, the Contractor shall take up the job of piling. Routine tests for the pile shall also be conducted as per IS: 2911/IS :10262. All the testing work shall be planned in such a way that these shall not cause any delay in project completion.

RCC for pile works shall be Design Mix of minimum grade M-25 and also minimum cement content shall be 400Kg/ cu.m as per IS:2911 (Latest revision). In case extra cement is required to meet the provisions of IS: 2911, it will be paid extra.

- g) The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

DESIGN OF WATER TANKS, CHANNELS, SUMPS, TRENCHES AND OTHER UNDER-GROUND STRUCTURES:

- a) RCC water retaining structures like storage tanks, etc. shall be designed as un-cracked section in accordance with IS: 3370 (Part I to IV) by working stress method. In case of water channels, shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method.
- b) All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant BIS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.
- c) Earth pressure for all underground RCC structures like cable trenches, underground water tanks, Oil collection pits, Septic tanks, basements etc. shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.
- d) In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures for the vehicular traffic in the vicinity of the structure.
- e) Underground tanks shall be checked for full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid). They shall also be checked for full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
- f) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against

buoyancy shall be ensured ignoring the superimposed loadings. Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

- g) Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

#### WATER PROOFING TREATMENT

- a) Integral cement based water proofing treatment including preparation of surface as required for treatment of roofs, balconies, terraces etc consisting of following operations:
- a) Applying a slurry coat of neat cement using 2.75 kg/sqm. of cement admixed with water proofing compound conforming to IS. 2645 and approved by Engineer-in-charge over the RCC slab including adjoining walls upto 300mm height including cleaning the surface before treatment.
- i. Laying brick bats with mortar using broken bricks/brick bats 25 mm to 115 mm size with 50% of cement mortar 1:5 (1 cement : 5 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge over 20 mm thick layer of cement mortar of mix 1:5 (1 cement :5 coarse sand ) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs
  - ii. After two days of proper curing applying a second coat of cement slurry using 2.75 kg/ sqm of cement admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge.
  - iii. Finishing the surface with 20 mm thick joint less cement mortar of mix 1:4 (1 cement :4 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge including laying glass fibre cloth of approved quality in top layer of plaster and finally finishing the surface with trowel with neat cement slurry and making pattern of 300x300 mm square 3 mm deep.
  - iv. The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge

- v. With average thickness of 120mm and minimum thickness at khurra as 65 mm.
- b) Alternatively in case of non- availability of good quality of brick bats, the water proofing treatment can also be done in the following manner:  
The water proofing membrane shall be laid on the RCC slab without any break. The grading concrete (1:2:4) of average thickness of 50 mm with water proofing compound as per manufacturer's specification shall be laid over the membrane. Cement concrete flooring of 40mm thick with (1cement: 2 fine aggregate: 4 stone aggregate 20mm graded stone aggregate) finished with a floating coat of neat cement including cement slurry complete shall be laid over grading concrete and checkered pattern in the grid of 300mm x 300mm shall be made .

#### SUNKEN WATER PROOFING (RCC):

- a) Water proofing treatment shall be done in sunken portion of WCs, bathroom etc. by applying cement slurry mixed with water proofing cement compound consisting of:
  - i. First layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer will be allowed to air cure for 4 hours.
  - ii. Second layer of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing for 48 hours.
- b) Treatment and sealing of joints, corners, junction of pipes and masonry with polymer mixed slurry shall be carried out as per CPWD specifications.

#### 20.10 General Specification for Buildings:

These clauses are applicable for Buildings, which are to be constructed as per drawings provided by employer such as overhead water tank. Architectural drawings of buildings covered in the scope are enclosed with the tender documents and are also available on website. These drawings are good for construction except for foundation drawings of the buildings which will be issued to the successful bidder after award of work and after receipt of soil investigation report depending upon soil parameters.

This shall also be applicable for vendor designed buildings wherever applicable.

- a) The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan, if any, of the Employer. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification.

- b) Post constructional Anti termite treatment shall be carried out for all buildings as per DSR item no. 2.34 & 2.35. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.
- c) Reinforced cement concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, and water retaining structures for achieving water-tightness
- d) FPS or Modular clay/fly ash based Bricks having minimum 75 kg/cm<sup>2</sup> compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm<sup>2</sup> compressive strength before submitting his offer. However, Contractor can propose to use aerated concrete block or solid concrete blocks of compressive strength not less than 75kg/cm<sup>2</sup> without any cost implication to Employer.
- e) Full brickwork shall be provided with cement mortar 1:6 (1cement: 6 coarse sand). Half brick work masonry shall be provided with cement mortar 1:4 (1cement: 4coarse sand) and two no 6mm dia ms bar at every third course.
- f) 12mm cement plaster of mix 1:6 (1cement: 6 fine sand) shall be provided on the smooth side of internal walls. However rough side of walls shall be provided with 15mm cement plaster of mix 1:6 (1cement: 6 fine sand).
- g) External plaster in two coats - 18mm Cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement: 5coarse sand) finished with a top layer 6mm thick cement plaster (1cement : 6 fine sand). External plastered surface shall be finished with white cement based putty of average thickness 1 mm, of approved brand and manufacturer to prepare the surface even and smooth. After putty the walls shall be finished with Premium Acrylic Smooth exterior paint of approved brand and manufacturer with Silicone additives of required shade (Two or more coats applied @ 1.43 ltr/ 10 sqm. over and including priming coat of exterior primer applied @ 2.20 kg/ 10 sqm).
- h) 6 mm thk. Cement plaster of mix 1:3 (1 cement: 3 fine sand) to RCC ceiling shall be done except areas where false ceiling are provided.
- i) Internal walls shall be finished with Plaster of Paris putty of average thickness 2 mm, of approved brand and manufacture, over the plaster surface to prepare the surface even and smooth complete. In case plastered surface of buildings are covered under wall paneling, dado work, skirting etc. no putty and painting are required.
- j) Internal walls shall be painted with minimum two coats of premium acrylic emulsion paint having VOC (volatile organic compound) content less than 50gm per litre of approved brand and manufacture including applying additional coats wherever required, to achieve even shade and colour over priming coat as per manufacturer specification/ recommendation.

- k) Non - VOC premium acrylic emulsion paint having volatile organic compound content less than 50gm per litre of approved brand and manufacture shall be used wherever specified.
- l) Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade shall be provided on the steel doors, flush doors and rolling shutters in various buildings or as specified in the drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.
- m) Two or more coats of French spirit polishing with a coat of wood filler shall be provided on the wooden doors and frames.
- n) Polished vitrified tiles in 60x60 cm size (thickness to be specified by the manufacturer) in flooring and skirting, with water absorption's less than 0.08% and conforming to IS: 15622 of approved make in all colours and shades, laid on cement mortar 20mm thick min. for flooring & 12mm thick for skirting 1:4 (1 cement: 4coarse sand) including grouting the joints with white cement and matching pigments etc., complete.
- o) Glazed Ceramic floor tiles 300x300mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS:15622 of approved make in colours as approved by Engineer-in-charge in toilet and pantries area on 20mm thick min. cement mortar 1:4 (1 cement : 4coarsesand) including grouting the joints with white cement and matching pigments etc., complete.
- p) 62 mm thick cement concrete flooring with concrete hardener topping, under layer 50 mm thick cement concrete 1:2:4 (1 cement: 2 fine aggregate : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix: 2 graded stone aggregate, 6mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer's specifications.
- q) Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement: 3 coarse sand) mixed with metallic concrete hardener in same ratio as for floor finished with a floating coat of neat cement. 21 mm thick in ACDB/DCDB room.
- r) Ceramic glazed wall tiles of 1st quality conforming to IS: 15622 (thickness to be specified by the manufacture) of approved make in all colours, shades as approved by Engineer-in-Charge in dados over 12mm thick bed of cement Mortar 1:3 (1 Cement: 3 Coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm including pointing in white cement mixed with pigment of matching shade complete. Height of dado shall be 2.1m high in toilets, kitchen and pantry or elsewhere specified in the drawings or TS.
- s) Circular/hexagonal M.S. sheet ceiling fan box shall be provided in the ceiling with clamp of internal dia. 140 mm, 73 mm height, 3 mm thick rim, top and bottom lid of 1.5 mm M.S. Sheet. Lids shall be screwed in to M. S. box by means of 3 mm round headed screws, clamps shall be made of 12 mm dia. M. S. bar bent to shape as per standard drawing with overall length as 80 cm.

- t) Powder Coated (minimum thickness 50 micron) aluminium work for doors, windows, ventilators and partitions shall be provided and fixed in building with extruded built up standard tubular and other sections of approved make conforming to IS:733 and IS : 1285, fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing / panelling, C.P. brass/ stainless steel screws including glazing and fittings as specified.
- u) All doors except for toilet shall have 100mm 6 lever CP Brass mortice lock . Anodized aluminum handles of ISI marked and approved size shall be provided for all doors and windows as per requirement and instruction of E.I.C.
- v) Cylindrical keyless lock of 25 mm diameter and 50mm diameter knob on both sides (ISI marked) shall be provided for toilets.
- w) Door shall be provided with anodized aluminum tower bolt (barrel type) 250x10mm wherever door closers are not provided.
- x) All windows shall have aluminum tower bolt (barrel type) 150x10mm as per requirement.
- y) Plinth protection 50 mm thick of cement concrete 1:2:4 (1 cement : 2 fine aggregate : 4 graded stone) aggregate 20 mm nominal size) shall be laid over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and shall be grouted with fine sand including finishing the top smooth. Minimum width of plinth protection shall be 1000 mm.
- z) Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

#### 20.11 External Water Supply from Bore-Well to Overhead Water Tank/Security Post:

- a) The drawing for the water supply from bore-well to fire water tank shall be developed by the Contractor. Water supply will be made available to the Contractor from a bore-well by the Employer at any one location within the sub-station. 80 mm dia CPVC pipe shall be provided by the Contractor from the bore-well to the fire water tank. The underground pipe line shall be laid as per CPWD Specification. The ball valve, NRV etc. shall be provided as per requirement. From this pipe line a 25 mm dia tap off shall be connected by the Contractor to the roof water tank provided for the control room building & transit camp.
- b) The Contractor shall carry out all the external plumbing/erection works required for supply of water to the control room building, firewater tank and/ or transit camp beyond the single point as given at 14.1.

- c) A scheme shall be prepared by the Contractor indicating the layout and details of water supply which shall be got approved from the Employer before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.

#### 20.12 Submission:

The following information shall be submitted for review and approval to the Employer:

- a) Editable Soft as well as hard copies of structural design calculations and structural drawings (including construction/fabrication) for all reinforced concrete and structural steel structures.
- b) Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall identify the major building components. Auto cad drawings shall also be submitted.
- c) Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
- d) Product information of building components and materials, including walls partition flooring ceiling, roofing, door and windows and building finishes to be submitted to EIC.
- e) A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

#### 20.13 Miscellaneous Requirements:

- a) All joints including construction and expansion joints for the water retaining structures (RCC tank for Fire Fighting and underground water tank) shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.
- b) All mild steel parts used in the firefighting water tank and underground water tank shall be hot-double dip galvanised. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanised structures and shall comply with IS:2628 and IS:2633. Galvanizing shall be checked and tested in accordance with IS: 2633. The galvanizing shall be followed by the application of an etching primer and

dipping in black bitumen in accordance with BS: 3416. The structural steel provided for roofing shall have enamel paint of approved shade two or more coat to give even shade over steel primer.

- c) Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab.
- d) For sump pit of switch yard Horizontal type submersible type pump as per BOQ rating having level switch shall be provided.
- e) The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan, if any, of the Employer. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification.
- f) Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.
- g) For communication Room GI Pipe of 40 mm dia shall be laid below floor to extend communication cable coming from switchyard via ACDB/DCDB Room.

#### 20.14 Interfacing:

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

#### 20.15 Statutory Rules:

- a) Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc.
- b) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.
- c) Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation. In case sulphate resistant cement is used as per requirement, differential cost between sulphate resistant cement and PPC cement shall be payable as an extra item.

- d) All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.
- e) All tests as required in the standard field quality plans, if any, have to be carried out without any financial implication to employer.

## 20.16 Specification for Site Levelling Work

### SCOPE OF WORK AND GENERAL CONDITION

This specification shall apply to site levelling works as are required to be executed under the Contract or otherwise directed by the Engineer-in-Charge. All testing shall be carried out as per standard field quality plan, if any, of the Employer.

Site levelling work shall consist of clearance of site, excavation in all kinds of soils, soft/disintegrated rock, hard rock, dewatering, transporting of excavated earth, filling, consolidation of earth, levelling benching, giving slopes and making formations, levelling operations, removal and satisfactory disposal of unsuitable materials necessary for achieving desired formation level, if required, in accordance with the requirements of the specifications and the lines, grades and cross-sections shown in the drawings or indicated by the Engineer-in-Charge. The work shall include the hauling and stacking of or the hauling to levelling site, of suitable materials as required, as also the disposal of unsuitable materials in specified manner; and the trimming and finishing of works.

This work also includes cutting of diversion channel to prevent the area from flooding and construction of kuchcha surface drains for drainage of the area.

The quality of work and materials shall comply with the requirements set forth in the succeeding sections. Where the drawings and Specifications describe a portion of the work only in general terms, and not in complete details, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer-in-Charge are to be fully complied with.

The work to be performed under this specifications consists of providing all labour, supervision, materials, planking and strutting, power, fuel, construction equipments, tools and plants, supplies, transportation, blasting materials if required, storage, insurance, royalty and all incidental items not shown or specified by reasonably implied or necessary for successful completion of work including contractor's supervision and in strict accordance with drawing and specifications.

The scope may however vary based on the specific requirement of various works/site, which shall be specified by the Owner.

The work shall be executed according to "Released for Construction", drawings with additions, alterations and modifications made from time to time as required or approved by the Engineer-in-Charge and also according to any other drawings

that would be supplied to the Contractor progressively during the execution of the Contract.

Construction traffic shall not use the levelled area without prior permission of the Engineer-in-Charge. Any damage arising out of such use shall be made good by the Contractor at his own expense.

The words like Contract, Contractor, Engineer-in-Charge, Drawings, Owner, works, site used in this Specifications shall be considered to have the meaning as understood from the definition of these terms included in the General Conditions of Contract.

#### PRESERVATION OF PROPERTY/AMENITY:

The Contractor shall undertake all reasonable precautions for the protection and preservation of Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers or other subsurface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which in the opinion of the Engineer-in-Charge shall be continued in use without any change.

The Contractor shall provide and install at his own expenses, suitable safeguards approved by the Engineer-in-Charge for this purpose. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition without any financial implication to Employer.

#### DISPOSAL OF MATERIALS:

All materials arising from jungle clearing, grubbing operation, all type of excavation etc. shall be the property of Employer and shall be disposed of by the Contractor as hereinafter provided or directed by the Engineer-in-Charge within a lead of 2000 m beyond the periphery of substation area. Also boulders, stones and other materials usable shall be neatly stacked.

All products of clearing and grubbing which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be cleared away to waste areas and burnt, if so desired, at locations away to a lead mentioned above in a manner as directed. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed up with the materials meant for filling.

Where the excavated material is directed to be used in the filling area, it shall be directly deposited at the required location complying with the total requirements. All disposed material other than hard material shall be spread in layers at the places within specified leads.

All hard materials, such as hard moorum, rubble, etc., not intended for use in the filling, shall be stacked neatly on Employer's land as directed by the Engineer-in-Charge, for future use.

Unsuitable and surplus materials not intended for use in any part of the works shall be disposed off.

### SITE CLEARANCE

The work shall consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engineer-in-Charge are unsuitable for incorporation in the works, from within the limits and areas as may be specified by the Engineer-in-Charge.

All trees up to a girth (perimeter) of 30 cm measured at one metre above the ground level shall also be cut and useful portion of the trees so cut shall be stacked at a suitable place as directed by the Engineer-in-Charge and shall be considered incidental to clearing and grubbing operations.

The roots of trees shall be dug up to 60 cm below the ground level or 15 cm below formation level whichever is deeper and after removal of all vegetable and organic matter from the holes so formed by removal of the roots, holes and hollows shall be filled with good earth in layer of 20 cm, well rammed, consolidated and levelled.

The serviceable and unserviceable materials obtained from the site clearance shall be removed from the area and disposed of to a place as per the directions of the Engineer-in-Charge. All unserviceable and serviceable materials obtained from the site clearance shall be the property of Employer.

Clearing and grubbing item is not payable and the same shall be deemed to be included in the earth work in excavation and filling.

Trees having girth above 30 cm are not in the scope of Contractor.

### CLASSIFICATION OF EXCAVATED MATERIALS:

All materials involved in excavation shall be classified in the following groups:

#### a) All Kind of Soils and Soft/Disintegrated Rock

The material which can be quarried/excavated with pick, shovels, jumpers, scarifiers, crowbars etc. and other mechanical implements. All materials involved under this classification are as below:

All kind of soils includes various types of soils, plain concrete, shingle and river or nallah bed boulders, soling of road, paths and hard core, macadam surface of any description, stone masonry below the ground level, soft conglomerate and laterite stone which can be detached from the matrix with picks and shovel.

Soft/disintegrated Rock (Not requiring blasting): Rock and boulders which may be quarried and split with crow bars and other mechanical implements etc. It includes lime stone, sand stone, hard conglomerate.

b) Hard Rock:

All kind of rocks which can be excavated by machines and requires blasting chiselling in edging or in another agreed method. This can be classified under the following categories:

- Hard Rock (Requiring Blasting)-This shall comprise:
  - i) Any rock for the excavation of which the use of mechanical plant or blasting is required;
  - ii) Reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground; and
  - iii) Boulder requiring blasting.
- Hard Rock (Blasting Prohibited)

Hard rock requiring blasting as described under (a) above but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

c) Authority for Classification Excavation:

The classification of excavation shall be decided by the Engineer-in-Charge and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer-in-Charge. All the excavated material shall be the property of the Employer.

SITE LEVELLING OPERATIONS:

a) SETTING OUT AND MARKING PROFILES.

After the site has been cleared, the limits of site levelling shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-Charge. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and establishment of bench marks. A grid system of co-ordinates shall be established by the Contractor at the site. The Contractor shall be responsible for the maintenance of permanent reference pillars, bench marks and other marks and stakes as long as in the opinion of the Engineer-in-Charge they are required for the work. All such marks/pillars shall be removed by the Contractor at his own cost as soon as the purpose is over.

Masonry pillars shall be erected at suitable places in the area to serve as bench marks for the execution of the work. These bench marks shall be connected

with G.T.S. of any other permanent bench mark approved by the Engineer-in-Charge. Necessary profiles with pegs, bamboos and strings or "*Burgeis*" shall be made to show the correct formation levels before the work is started and the same shall be approved by the Engineer-in-Charge. The contractor shall supply all labour, tools, equipment, materials, safeguards and incidentals necessary for setting out and making profiles and burgeis & pillars for the work at his own cost. The profiles and burgeis shall be maintained during the execution of the work.

Marks/pillars shall invariably be diagonal unless otherwise directed, and should be such that their average height is representative of average depths. Payments will be made on the basis of volume measurement after with-holding the amount corresponding to 5% of the volume of earth work on account of non-removal of marks/pillars.

The Contractor shall have to remove the marks/pillars and utilise the earth spoils as per the directions of the Engineer-in-Charge. The withheld amount as stated in the above paragraph may be paid after certification of the Engineer-in-Charge; regarding his full satisfaction and to the effect that the mark/pillars, etc. have been removed and soils/earth thereof has been utilised as directed by him.

If the contractor fails to remove, partly or fully the marks/pillars in the manner and within the period as aforesaid double the amount spent by the owner for removal of marks/pillars will be recovered from dues payable to the contractor.

## b) EXCAVATION AND FILLING

All excavations shall be carried out in conformity with the directions laid herein under and in a manner approved by the Engineer-in-Charge. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as decided upon before disposal.

While planning or executing excavation, the Contractor shall take all adequate precautions against soil erosion, water pollution, air pollution etc.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed with a negative tolerance of 100mm. The Contractor shall not excavate outside the slopes or below the established grade or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels shall be made good at the cost of the Contractor with suitable material of similar characteristics and compacted to the required density and to the satisfaction of the Engineer-in-Charge.

All debris and loose material on the slopes of cuttings shall be removed.

Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be allowed. Final surface shall be neatly dressed. The

earth from cutting shall be directly used for filling and no extra claim for double handling of earth shall be admissible to the contractor.

If cutting be taken deeper, it shall be brought to the required level as per the instructions, by filling it with the earth and duly consolidating at the Contractor's cost.

Filling shall be done in regular horizontal layers not exceeding 20 cm. in depth. The earth shall be free from all roots, grass, rubbish and humps and clods exceeding 80mm in any direction shall be broken. Each layer shall be consolidated by breaking clods and Compacting each layer with wooden /steel rammer or movement of dozers, trucks or 8/10 tonne power road rollers, sheep foot roller and vibratory compactors etc. so that compaction of 95% of the maximum dry density is achieved at optimum moisture content. The surface finished shall be neatly dressed to the required formation levels with tolerance of ( $\pm$ ) 100 mm.

Tests for Compaction are to be performed as per the procedures laid down in the relevant I.S. Codes of practice and Standard Field Quality Plan of Employer, if any. In cases of compaction below the stipulated percentage, the contractor shall adopt proper techniques as directed by the Engineer in-Charge and to his satisfaction to ensure the specified degree of compaction. The cost of tests to be performed shall be borne by the Contractor.

During the execution of work, natural drainage of the area shall be maintained by the contractor.

#### c) HARD ROCK EXCAVATION

Hard Rock, when encountered during excavation, shall be removed up to the finished ground level or as indicated on the drawings. In all cases, the excavation operations shall be so carried out that at no point on cut formation the rock protrudes above the specified levels, provided, however, that a negative tolerance of 150 mm shall be permissible.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer-in-Charge. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when prised by a crowbar shall be removed.

Blasting shall be carried out as per relevant clause mentioned elsewhere in this specification and all precautions indicated therein to be observed.

#### d) DEWATERING

If water is met with in the excavation due to stream flows, springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and other excavation kept dry whenever so required or directed by the Engineer-in-Charge, Care shall be taken to so discharge the drained water

as not to cause damage to the works, crops or any other property. No extra payment shall be admissible to the contractor on this account.

#### e) FINISHING OPERATIONS

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces. When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock where no point shall vary more than 600 mm from the designated slope. In no case shall any portion of the slope encroach on the road way.

#### EARTH FILL MATERIAL:

##### a) SUITABLE MATERIAL

The borrowed earth used in filling shall be free from all roots, grass, shrubs, rank vegetation, brush wood, tree sapling and rubbish.

##### b) UNSUITABLE MATERIAL

Unsuitable material shall mean materials unsuitable for placing as fill in the works and shall comprise:

- Material from swamps, marshes and bogs;
- Peat, logs, stumps and perishable materials;
- Material susceptible to spontaneous combustion;
- Any natural material or industrial and domestic produce which will adversely affect other materials in the work;
- Clay with liquid limit exceeding 80% and/or plasticity index exceeding 55%.

##### c) SPREADING AND COMPACTION OF FILLING

For the earth works contractor shall satisfy the Engineer-in-Charge that the entire specified requirement regarding compaction can be achieved. Testing shall be carried out as per standard field quality plan of Employer, if any.

The Final formation shall be correct in level and profile after compaction.

In the case of earth work consolidated under optimum moisture conditions, each layer of earth shall be carefully moistened to give field moisture content of about + 1% to - 2% of the optimum moisture content (OMC). The OMC shall be determined according to IS: 2720 (Pt.VII &VIII) Methods of Tests for Soils.

Each layer shall then be compacted by rolling with wooden/ steel rammer or movement of dozers, trucks, 8/10 tonnes power road roller, sheep foot roller and vibratory compactors/roller. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as

per test. The density to be achieved for each layer of the material shall not be less than 95% of the density obtained in the laboratory (Proctor Method).

Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent pounding.

## BLASTING OPERATIONS.

### a) GENERAL

Blasting shall be carried out only with the written permission of the Engineer-in-Charge. All the statutory laws, regulations, rules, Indian Standards, etc., pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed.

The Contractor may adopt any method or methods of blasting consistent with the safety and job requirements, after approval from the Engineer-in-Charge and shall muffle the blasting adequately to the satisfaction of the Engineer-in-Charge. Blasting should be carried out as far as possible with the help of Ammonium Nitrate mixed with proper proportions of fuel oil which is a safer method. However, in the event of its non-availability the convenient practice of using gelatine with detonators can be resorted to.

The magazine for the storage of explosives shall be built to the designs and specifications of the Explosives Department concerned and located at the approved site. No unauthorised person shall be admitted into the magazine which when not in use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be hung in the lobby of the magazine.

- a) A copy of the relevant rules regarding safe storage both in English and in the language with which the workers concerned are familiar,
- b) A statement of up to date stock in the magazine,
- c) A certificate showing the last date of testing of the lightning conductor,
- d) A notice that smoking is strictly prohibited.

In addition to these, the Contractor shall also observe the instructions in following clauses and any further additional instructions which may be given by the Engineer-in-Charge and shall be responsible for damage to property and any accident which may occur to workmen or the public or the materials on account of any operations and blasting. The Engineer-in-Charge shall frequently check the Contractor's compliance with these precautions.

### b) MATERIALS, TOOLS AND EQUIPMENT.

All the materials, tools and equipment used for blasting operations shall be of approved type and shall be arranged by the contractor from any authorised dealer of such approved material. Necessary assistance in the form of approval for procurement of the material shall be given by the Corporation. The

contractor shall be fully responsible for entering into the agreement with any authorised magazine contractor in respect of rates, regularity of supply, etc. the Engineer-in-Charge may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a safe length being cut as will permit sufficient time to the firer to reach safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators fuses, etc., shall be fresh and not damaged due to damp, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed immediately.

#### c) PERSONNEL

The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

#### d) BLASTING OPERATIONS.

The blasting shall be carried out during fixed hours of the day preferably during the mid-day lunch hour or at the close of the work as ordered in writing by the Engineer-in-Charge. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only. Proper precautions for safety of persons and property shall be taken.

Red danger flags shall be displayed prominently in all directions during the blasting operations. People, except those who actually light the fuse shall be prohibited from entering this area. The flags shall be planted 200 metres from the blasting site in all directions and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning whistle being sounded for the purpose.

The charge holes shall be drilled to required depths and in suitable places. Blasting should be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping material which shall be tamped lightly but firmly.

At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a whistle in a recognised manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man in charge only. The man in charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the work site.

When blasting is to be carried out in the proximity of other existing structures, sand/earth bags, etc. shall be used on the top of the blast holes to prevent the rock fragment from causing damage to the structures.

However, when blasting is prohibited for any reasons the excavation shall be carried out by chiselling, wedging or any other agreed method.

e) MISFIRE

In case of misfire, the following procedure shall be observed:

- i) Sufficient time shall be allowed to account for the delayed blast. The man in charge shall inspect all the charges and determine the missed charges.
- ii) If it is the blasting powder charge it shall be completely flooded with water. A new hole shall be drilled at about 45 cm. from the old hole and fired. This should blast the old charge. Should it not blast the old, the procedure shall be repeated till the old charge is blasted.
- iii) If a misfire has been found to be due to defective detonator, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer-in-Charge for inspection to ascertain whether all the remaining materials in the box are also defective.

f) ACCOUNT.

A careful and day to day account of the explosives shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer-in-Charge at all times.

### RECORDING OF MEASUREMENTS

The ground levels shall be taken at every 5 metres distance and at closer distances where pits, undulations, etc. are met with. The ground level shall be recorded in field book, plotted on plans and shall be signed by contractor and the Engineer-in-Charge before the earth work is started.

The levels of the area after excavation shall be recorded in the field book duly signed by the Engineer-in-Charge and contractor. The labour, materials, tools, equipment, safeguards and incidentals required for taking levels shall be supplied by the contractor at his own cost.

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections.

All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits:

- |                                       |                          |
|---------------------------------------|--------------------------|
| a) Length and breadth                 | -- 10 mm                 |
| b) Height, depth or thickness of work | -- 5 mm                  |
| c) Area                               | -- two places of decimal |
| d) Cubical qty.                       | -- two places of decimal |

## 20.17 Mode of Measurement

*Mode of measurement for different items is given below, however, in case of any ambiguity relevant part of IS: 1200 (latest) shall be referred.*

### a) EARTHWORK

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling, compacting, dewatering (if required) and disposal of surplus earth/ rock to a suitable location within a lead up to two km. Excavation or dismantling of lean concrete shall be measured under this item. The quantity of excavation for foundations of towers, equipment structures, all transformers, firewall, cable trenches, water tank, reactors, buildings, marshalling kiosks, underground water tanks and covered car parking shall only be measured. The quantity of excavation for roads, rail cum road, drains, culverts, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing, chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including fixing of lamp posts/ electric poles, plinth protection, flooring, sewerage system, manholes, pipes, earth mat, pipe support etc. shall also not be paid for. The measurement of excavation for all concrete works shall be made considering dimension of the pit keeping 150mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. For hard rock excavation, the volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50% deduction for voids. The unit of measurement shall be in cubic meter. The unit rate shall include stacking, disposal of excavated material for leads up to 2000 meters beyond the levelling boundary.

The quantity shall be measured in cubic meters as per following details:

- a) Excavation in all kind of soil including soft/ disintegrated rock, PCC, WBM, Brickwork/ stone masonry etc (excluding hard rock).
- b) Excavation in hard rock (required blasting)

### b) PLAIN CEMENT CONCRETE (PCC)

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

- i. PCC 1:2:4 (1 cement : 2 fine aggregate : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer foundation, reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, gate etc. as indicated in the drawings.

- ii. PCC 1:3:6 (1 cement : 3 fine aggregate : 6 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.
- iii. PCC 1:4:8 (1 cement : 4 fine aggregate : 8 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.
- iv. PCC 1:5:10 (1 cement: 5 fine aggregate: 10 brick aggregate/ stone aggregate 40mm nominal size) shall be provided for site surfacing in switchyard. This shall include providing and laying cement slurry in case of site surfacing in switchyard.

All other PCC required for the completion of the work including hold fasts of doors/windows/rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits, water proofing of roof etc. shall not be measured and deemed to be included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

c) RCC

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, formwork, grouting of pockets and underpinning. This shall also include pre-cast RCC work and addition of water proofing compound & admixtures wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings having cross-sectional area up to 0.1 sq.m.

d) REINFORCEMENT STEEL

Reinforcement shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tons on the basis of sectional weights as adopted by Indian Standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

e) STONE FILLING

Measurement of stone (40-60mm size) for transformer/ reactor foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per drawings. This shall be measured in cu.m. no voids shall be deducted.

f) MISCELLANEOUS STRUCTURAL STEEL

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for mono rails (RS joists), rails for transformers/ reactors, trusses, frame work, purlins, gratings including factory made electro forged gratings, steel tubes, built up sections along with all other steel fittings and fixtures, inserts and embedment in concrete shall be made as per drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre- heating of the welded joints, applying a priming coat of steel primer / anti corrosive bitumastic paint/ synthetic enamel paint etc. wherever specified ( For gratings and its supports epoxy zinc phosphate primer shall be used) setting of all types of embedment in concrete, etc. Steel required for foundation bolts & fasteners (other than towers and equipment support structures), doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedment's required for rainwater harvesting, septic tank, soak pit, roof truss and purlins required for fire water tank, steel structures of PEB buildings, etc. shall not be considered for payment and measurements. Quantity shall be measured in MT.

g) BUILDINGS:

i. RCC FRAMED STRUCTURE BUILDINGS:

Payment for item shall be made on plinth area basis. However, the quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel shall be measured and paid as per relevant clauses as described above. The rest of the entire work (including internal & external finishing), stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system etc. required to complete the building in all respect as per the drawings furnished by the Employer shall be deemed to be included in the plinth area rate. Plinth area shall be calculated based on IS 3861-2002.

h) SEPTIC TANK AND SOAK PIT

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the clause including earth work (excavation, backfilling, disposal etc.), masonry work, all types of fillings, all types of pipes including plumbing and vent pipes, all type of fittings etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the relevant clauses mentioned above.

i) OVERHEAD WATER TANK

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings approved by the Employer. All the items including, compaction, brick work, roof truss, purlins, roofing, all types of miscellaneous steel, internal and external plastering, painting etc. shall be deemed to be included in this lump sum cost. However, concrete (all types) and reinforcement shall be measured and paid under the relevant clauses as mentioned above.

j) EXTERNAL WATER SUPPLY FROM BORE-WELL TO FIRE WATER TANK, CONTROL ROOM BUILDING AND TRANSIT CAMP:

The external water supply from Bore-well shall be measured in running meters of pipe of various diameters. It shall include all the items such as earth work (excavation, backfilling, disposal etc.), piping, pipe fittings, painting, brickwork, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs, etc. required to complete the job.

k) EXTERNAL SEWERAGE :

Sewage System of the shall be measured diameter wise in running meters. It shall include all the items such as earth work (excavation, backfilling, disposal etc.), piping, pipe fittings, manholes, gully trap, gully chamber, encasing in concrete and repairs etc required to complete the job. Any modification in the existing sewage system, if required, shall be done by the Contractor without any financial implication to Employer.

l) BOUNDARY WALL:

The measurements of boundary wall shall be in running meter of finished work. The rate shall be inclusive of earth work (excavation, backfilling, disposal etc.), concrete (all type), Reinforcement, MS steel, brick masonry, plastering barbed wire/ concertina coil, painting etc. complete required for completion of boundary wall. Nothing extra shall be payable on this account.

m) SITE LEVELLING:

i. EARTH WORK IN EXCAVATION AND FILLING

The quantity of excavation in all types of soil and soft/disintegrated rock shall be worked out by using initial and final levels. No void deduction shall be made to calculate net quantity of earth work. Only Excavation/cutting will be measured for payment purpose. The unit of measurement shall be in cubic metre.

In case hard rock is encountered during excavation, the level of rock surface before start and completion of rock excavation shall be recorded for calculating the quantity of excavation of hard rock. The volume of hard rock shall be computed on the basis of stacks of excavated rubble

after making 50 % deduction for voids. The item of excavation in hard rock shall be payable separately.

The quantity of earth work in excavation in all kinds of soil & soft/disintegrated rock shall be arrived by reducing quantity of hard rock from the gross excavated quantity.

The unit rate shall include all lifts and all leads within levelling boundary. It also includes disposal of surplus earth and stacking of unusable material up the lead of 2000 meters beyond the levelling boundary. Rate of item shall include all operations specified in the respective clause of technical specification.

ii. EARTH WORKS IN EXCAVATION IN ALL TYPES OF SOILS AND SOFT /DISINTEGRATED ROCKS, HARD ROCKS AND DISPOSAL.

Quantity of excavation in all type of soils and soft/disintegrated rocks shall be worked out based on initial level before start of excavation and final levels after excavation. No void deduction shall be made to calculate net quantity of earth work in excavation. The excavated soil and soft/disintegrated rock shall be used for filling in lower areas of the substation. The unit rate shall include disposal of excavated material for leads up to 1000 meters beyond the levelling boundary.

For hard rock excavation, the volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50% deduction for voids. The unit of measurement shall be in cubic meter. The unit rate shall include stacking, disposal of excavated material for leads up to 2000 meters beyond the levelling boundary.

Where soil, soft/disintegrated rock and hard rock are mixed, the quantity of earth work in excavation in all kinds of soil & soft/disintegrated rock shall be arrived by reducing quantity of hard rock from the gross excavated quantity. Rate of item shall include all operations specified in the respective clause of technical specification.

iii. FILLING USING EARTH BORROWED FROM OUTSIDE THE SUBSTATION LAND

For borrowed earth, the measurement shall be based on levels of area under filling only. The quantity of earth shall be worked out based on initial and final levels of levelling area. No void deduction shall be made to calculate net quantity of earth work. The unit of measurement shall be in cubic meter. The rate shall include arrangement of borrow area, payment of royalty, transportation, laying compaction, all leads and lifts etc. Rate of item shall include all operations specified in the respective clause of technical specification.

## 21. Section: Structures

### 21.1 General

The scope of specification covers fabrication, proto-assembly, supply and erection of galvanized steel structures for towers, beams, lightning masts and equipment support structures. If specified in section – Project, design of steel structure shall also be in the scope of contractor. The structures shall be of pipe type or lattice type as per Bid Proposal Sheet. Lattice structures shall be fabricated from structural steel conforming to IS: 2062 (latest). All pipe structures shall be fabricated from GI pipe conforming to YST 22 or of higher grade as per IS 806.

Line diagrams of equipment support structures are enclosed with the tender document. The fabrication drawings along with BOMs for these structures shall be provided to the successful bidder after the award. However, structure, which are to be designed at detailed engineering stage by the employer, only line diagram shall be provided by Employer and fabrication drawing shall be prepared by the Contractor. Any other structure necessary to suit the layout for a particular substation to complete the work in all respect shall be designed by the employer / contractor at detailed Engineering stage.

Equipment support structure standardization has been carried out by the employer with the provision of stool to facilitate interchangeability of equipment's at a later stage. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m. Zinc coating for coastal areas, if defined in section – Project shall not be less than 900gm/sq.m

Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the standard structure fabrication drawings. Nothing extra shall be payable or recoverable from the contractor on account of modification in support structures.

### 21.2 Design requirements for Structures

(To be referred only for structures to be designed by the Contractor)

- a) For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS:875,Parts I to V.
- b) For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall also be considered.
- c) Minimum thickness of galvanized tower member shall be as follows:

<b>Members</b>	<b>Minimum Thickness (mm)</b>
Leg members, Ground wire	5
Peak members/Main members	
Other members	4
Redundant members	4

Size and thickness of gusset plate, pack washer and pack plate shall be as per requirement.

- d) Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.
- e) Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.
- f) All bolts shall be M16 or higher as per design requirement.
- g) Step Bolts

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to IS: 10238.

h) Design Criteria

- i. All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA, 50kA, 63kA or as applicable. IEC-60865 may be followed for evaluation of short circuit forces.
- ii. All Pipe support structures used for supporting equipment's shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS: 1161 read in conjunction with IS: 806.
- iii. Foundation bolts shall be designed for the loads for which the structures are designed.

### 21.3 Design, Drawings, Bill of materials and Documents

#### a) STRUCTURES DESIGNED DURING DETAILED ENGINEERING:

- i. In case design of structure is to be done by employer, only line diagram of the structure shall be provided to the contractor and fabrication drawing shall be prepared by contractor based on line diagram and submitted for approval.
  - ii. In case design of structure is covered in the scope of contract, the contractor shall submit design along with line diagram for approval and based on approved line diagram, fabrication drawing shall be prepared and submitted for employers 'approval. The line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.
  - iii. The fabrication drawings to be prepared and furnished by the Contractor shall be based on line diagram provided by employer or the design approved by the employer. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the employer. The fabrication drawings and bill of material based on fabrication drawing shall be submitted to the employer for approval. Approved bill of material prepared based on fabrication drawing shall be the basis for payment.
- b) Such approval shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

### 21.4 Fabrication and Erection

- a) The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provisions in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.
- b) The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

- c) Samples of equipment support structures may be trial assembled in fabrication shop in order to ensure fitment of various members and to avoid problems during erection.
- d) The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipment's and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification, if any, required during erection shall be done at site with the approval of Engineer – in- charge.

#### 21.5 Bolting

- a) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- b) In case of fasteners, the galvanizing shall conform to IS-1367(Part 13). The spring washer shall be electro galvanized as per Grade IV of IS-1573.

#### 21.6 Welding

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, Symbols for welding on erection and shop drawings shall be according to IS:813. Welding shall be carried out in accordance with IS:816.

#### 21.7 Foundation Bolts

- a) 7.1 Foundation bolts for the towers and equipment supporting structures shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.
- b) 7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.
- c) 7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.
- d) 7.4 All foundation bolts shall be provided with two no. standard nuts of class 5 confirming to IS:1363/1367/6639, one check nut of class 4 confirming to IS:1364, one anchor plate at the bottom of foundation bolt and one plain washer.
- e) 7.5 All foundation bolts shall conform to IS 5624, however, the material, shall be MS conforming to IS:2062/ SAE:1018.

#### 21.8 Stability of Structure

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

#### 21.9 Grouting

The method of grouting the column bases shall be subject to approval of employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base plate. No additional payment for grouting shall be admissible.

#### 21.10 Galvanising

All structural steel works, equipment support structures and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement of IS 4579. Purity of zinc to be used shall be 99.95% as per IS:209.

#### 21.11 Touch-up Painting

Minor defects in hot dip galvanized members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction the employer before erection.

#### 21.12 Inspection before dispatch

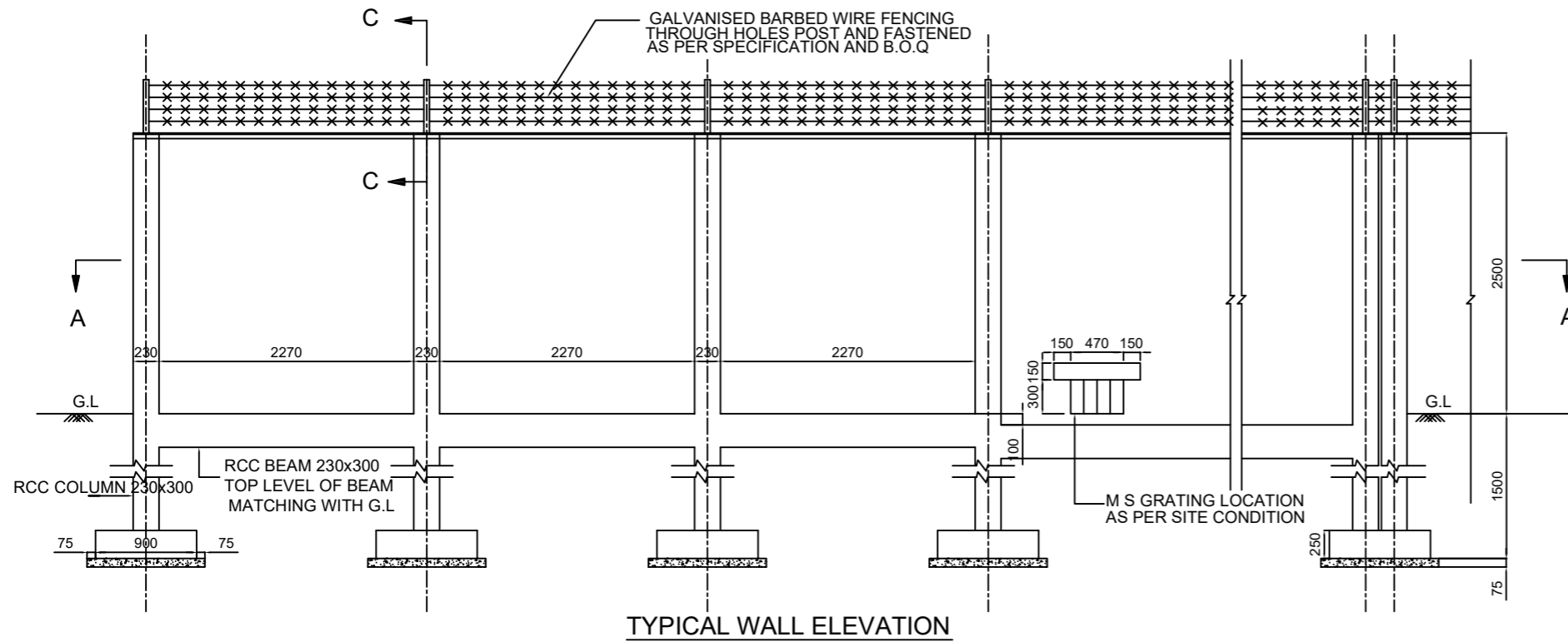
Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the employer or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

#### 21.13 Test Certificate

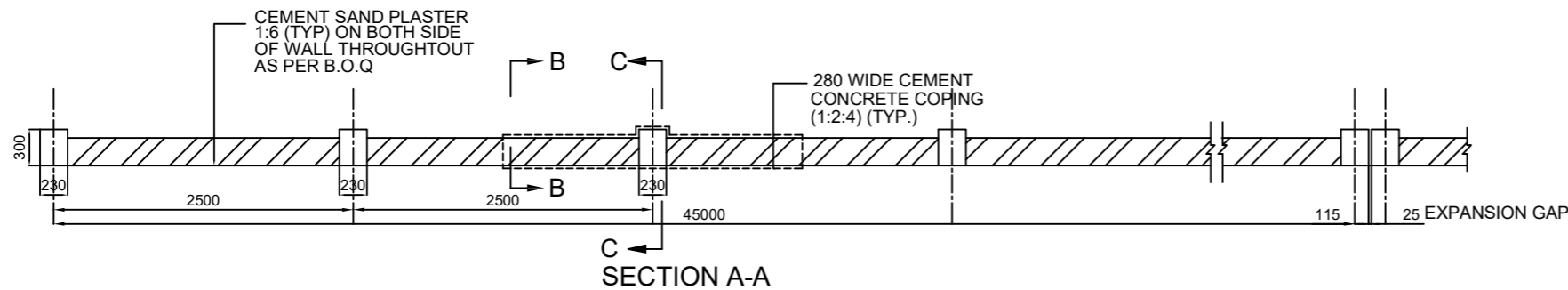
Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted during inspection.

#### 21.14 Safety Precautions

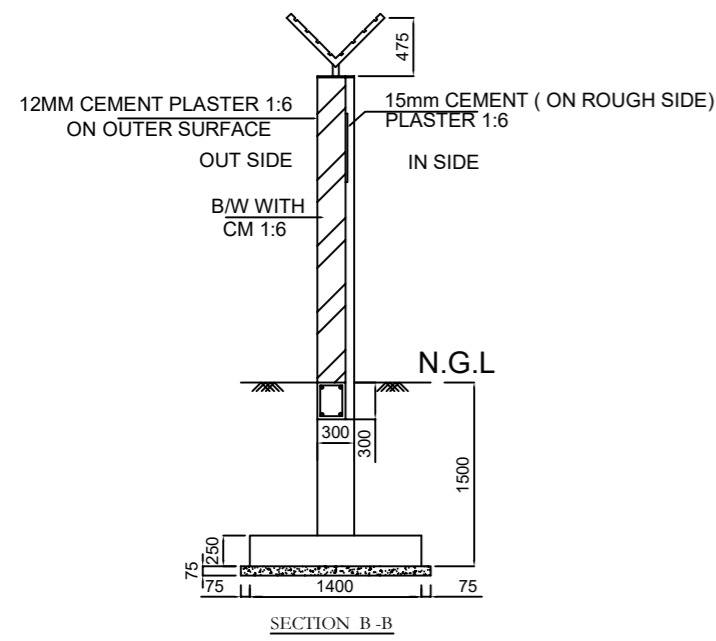
The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work-IS:7205.



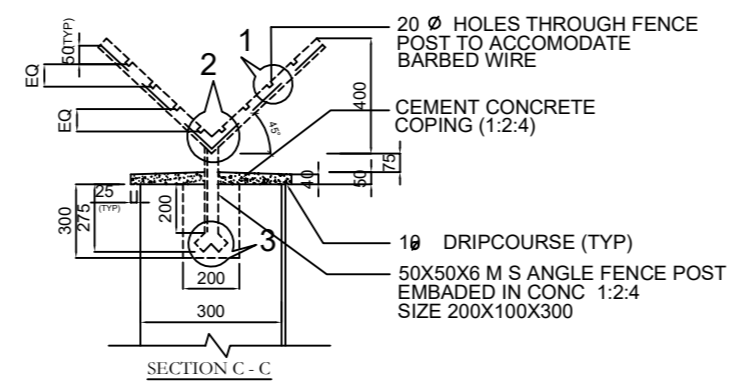
TYPICAL WALL ELEVATION



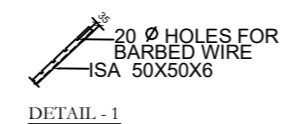
SECTION A-A



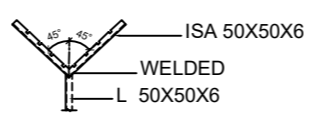
SECTION B-B



SECTION C-C



DETAIL - 1



DETAIL - 2

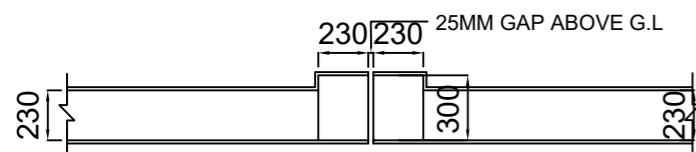
NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. LOCATION OF BOUNDARY WALL SHALL BE AS PER GA./ DRG. LATEST APPROVED.
3. PROVIDE BRICK WORK IN ENGLISH BOND IN 1:6 CEMENT MORTAR (1CEMENT : 6 COARSE SAND).
4. CONC GROUTING FOR ANGLE POST AT TOP OF BOUNDARY WALL SHALL BE IN 1:2:4 (1CEMENT:2COURSE SAND:4 STONEAGGREGATE ).
5. BARBED WIRE SHALL BE GALVANISED STEEL BARBED WIRE AND SHALL BE IN AS A-4-IS:278 CONFORMING TO IS:278.
6. a). BRICK TO BE DONE WITH BRICK OF FIRST CLASS DESIGNATION-75 b). PLASTER WORK SHALL BE IN CEMENT MORTAR 1:6 (1CEMENT:6 FINE SAND) THICKNESS OF PLASTER SHALL BE AS PER B.O.Q.
7. THE LAST 300mm EXCAVATION IN SOIL IS TO BE DONE JUST PRIOR TO THE PLACING OF FOUNDATION P.C.C.
8. P.C.C. OF 1:4:8 GRADE SHALL BE WITH 40mm NOMINAL SIZE AGGREGATE.
9. EXPANSION JOINTS ARE TO BE PROVIDED MIN BOUNDARY WALL AT a). MAXIMUM OF 45.0 M.
10. ALL EXPOSED PLASTER SURFACES ARE TO BE PAINTED WITH WATER PROOFING CEMENT PAINT AS PER B O Q.
11. STRUCTURAL STEEL FOR ANGLE POSTS SHALL CONFORM TO IS:2062, ANGLE POST SHALL BE PAINTED WITH TWO OR MORE COATS OF ENAMEL PAINTS OF APPROVED BRAND AND MANUFACTURE OVER A PRIMING COAT OF APPROVED STEEL PRIMER.
12. THE RISE/FALL IN BOUNDARY WALL FOUNDATION SHALL BE PROVIDED WHEREVER THE DIFFERENCE IN GROUND LEVEL IS MORE THAN 500mm.
13. NO FOUNDATION SHALL REST ON THE FILLED UP SOIL, IF ANY, THE FOUNDATION SHALL BE MINIMUM 500mm, BELOW VERGIN SOIL.
14. THE HEIGHT OF BOUNDARY WALL EXCLUDING FENCE ON TOP SHALL NOT BE LESS THAN 2500mm, ABOVE GROUND LEVEL OR FORMATION LEVEL WHICHEVER IS HIGHER.
15. NO. OF M.S. GRATING AND THEIR LOCATION TO BE INSTALLED IN BOUNDARY WALL ALONG WITH THE LEVELS SHALL BE DECIDED BY THE SITE AS/THE SITE CONDITION KEEPING IN VIEW THE MAX. POSSIBLE CATCHMENT AREA FOR EACH GRATING.
16. ALL M.S SECTION USED FOR GRATING SHALL BE PAINTED WITH TWO OR MORE COATS OF BLACK ANTICORROSIVE BITUMASTIC PAINT OF APPROVED BRAND AND MANUFACTURE OVER A PRIMING COAT OF APPROVED STEEL PRIMER.
17. CONC. FOR R.C.C WORK SHALL BE OF GRADE AS PER BPS
18. REINF. BARS SHALL BE H.Y.S.D. BARS OR TMT BARS CONFORMING TO IS:1786 LATEST REVISION.
19. STRUCTURE STEEL USED FOR GRATING SHALL CONFORM TO IS:2062 LATEST EDITION.
20. LAP/ANCHORAGE SHALL BE 50 X DIA OF BAR
21. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS  
a) FOOTING - 50MM (b) SLAB - 20MM (c) COLOUMN - 40MM,  
d) BEAMS - 25MM
22. TOP OF PLINTH BEAM SHALL BE REDUCED BY 100mm WHEREVER MS GRATING IS TO BE PROVIDED
23. INCASE BLACK COTTON SOIL IS ENCOUNTERED SUITABLE TREATMENT IN FOUNDATION SHALL BE PROVIDED.

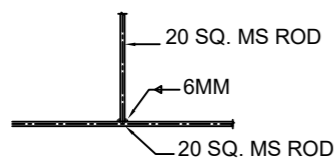
FOR REFERANCE ONLY

RELEASED FOR TENDER PURPOSE ONLY

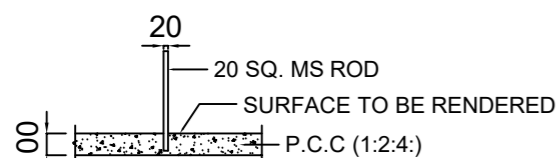
<b>MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION</b> 	
<b>PROJECT :</b> SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK	
<b>TITLE: DETAILS OF BOUNDARY WALL</b>	
DRAWING NO.	SCALE
<b>C/ENGG/MAHATRANSCO/BW/01</b> <small>(SHEET 01 OF 07)</small>	<b>1:100</b>
REV.	REV.
0	0
DESCRIPTION	APPD. DATE
CIVIL	REV.
REV.	REV.



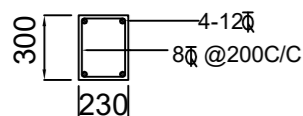
TYP.DETAIL OF EXPANSION JOINT



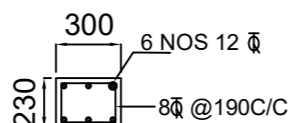
DETAIL - Y



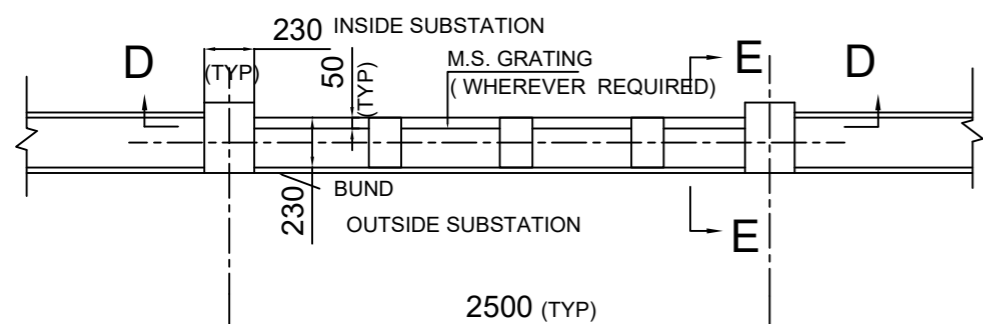
TYP.DETAIL OF 'X'



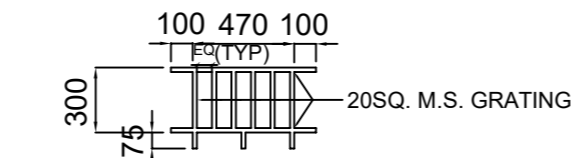
SECTION F-F



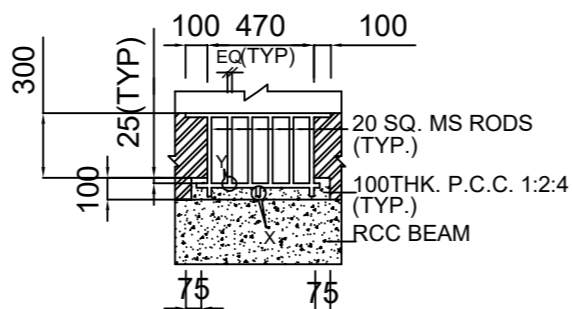
TYP. COLUMN REINFORCEMENT DETAILS



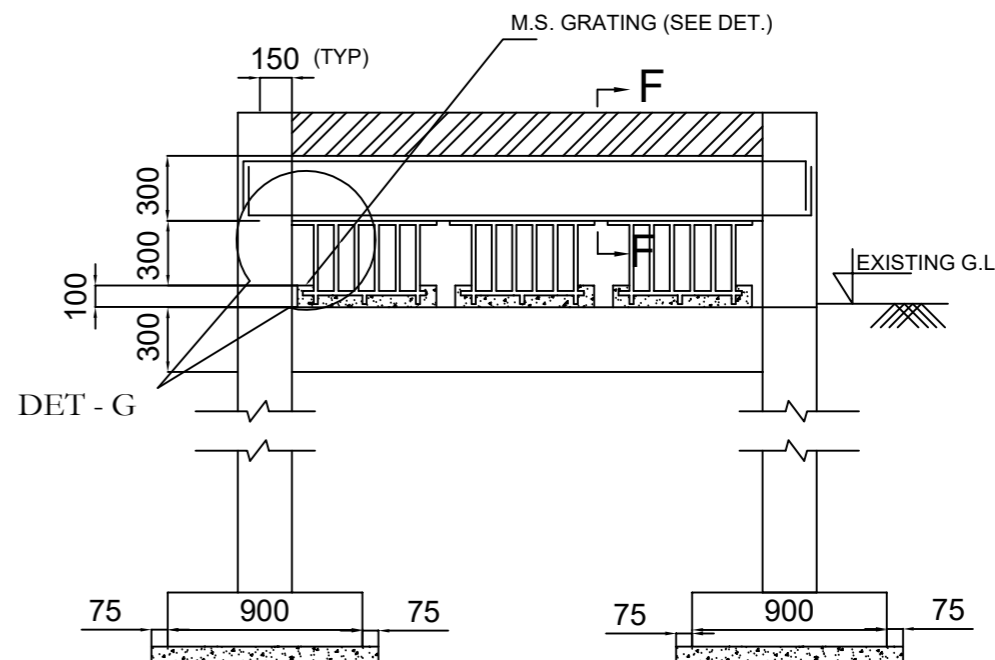
PLAN AT PLINTH LEVEL GRATING LOCATIONS



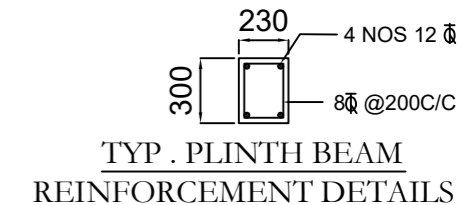
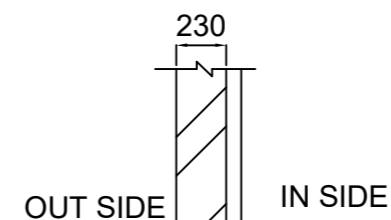
M S GRATING FOR DRAINAGE THROUGH BOUNDARY WALL



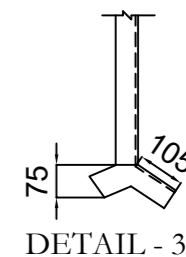
M.S GRATING FOR DRAINAGE THROUGH BOUNDARY WALL DETAIL 'G'



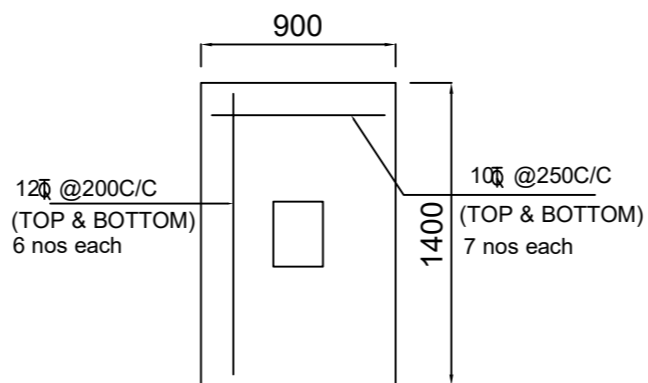
SECTION D - D



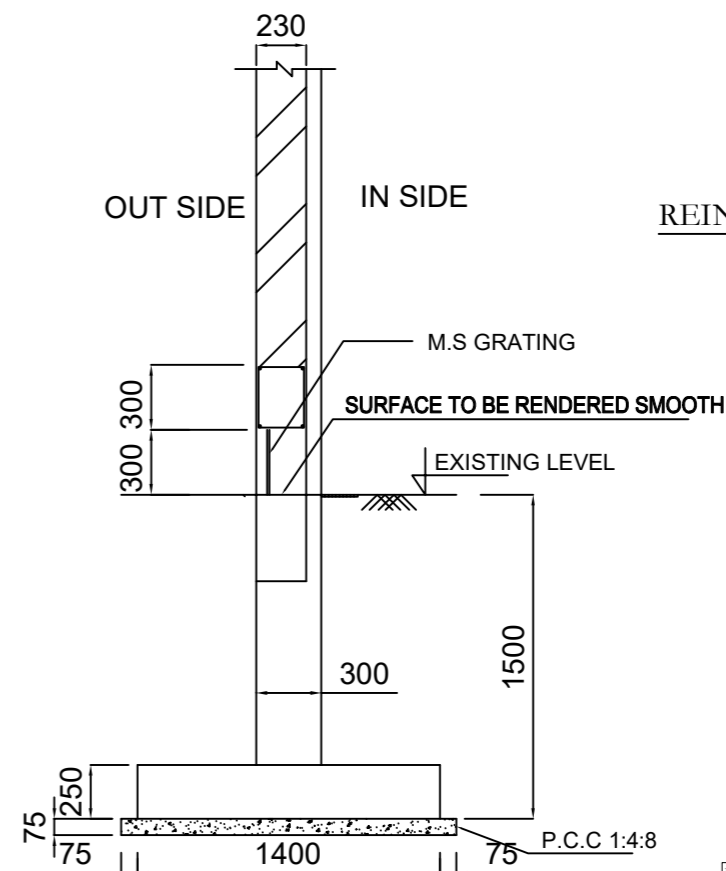
TYP. PLINTH BEAM REINFORCEMENT DETAILS



DETAIL - 3



TYP. FOOTING REINFORCEMENT DETAILS



SECTION E-E

FOR REFERENCE ONLY  
RELEASED FOR TENDER PURPOSE ONLY

MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION  
MAHATRANSCO

PROJECT: SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK

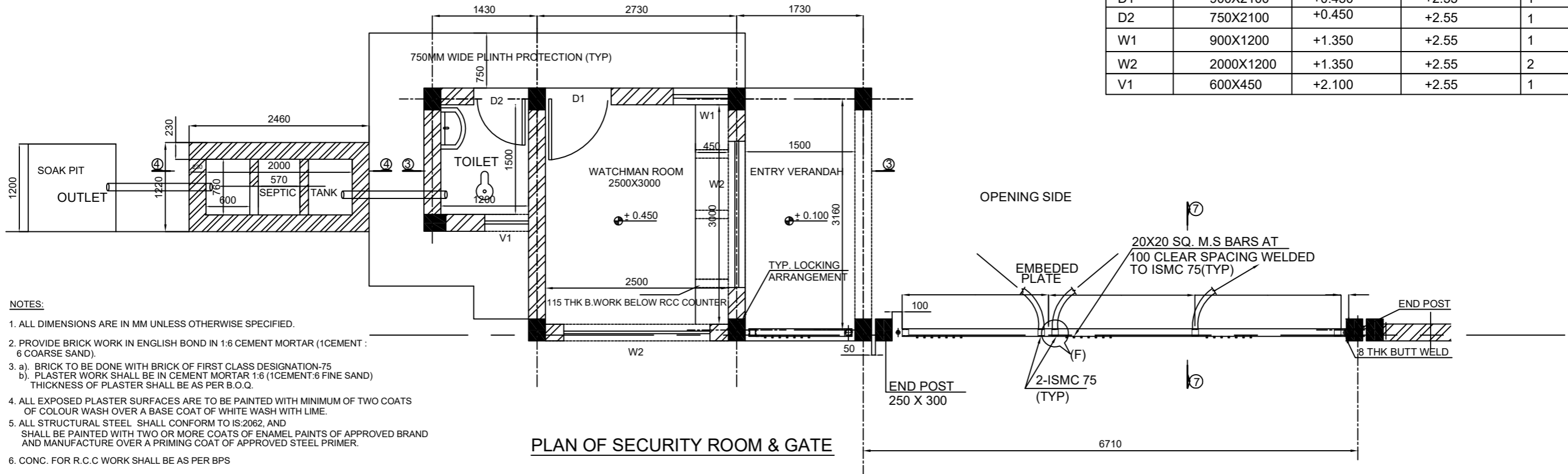
TITLE: DETAILS OF BOUNDARY WALL

DRAWING NO. C/ENGG/MAHATRANSCO/BW/01  
SCALE: 1:100  
REV: 0

REV.	DESCRIPTION	CIVIL	REVD.	REVD.	APPD. DATE
0	RELEASED FOR TENDER/CONSTRUCTION				

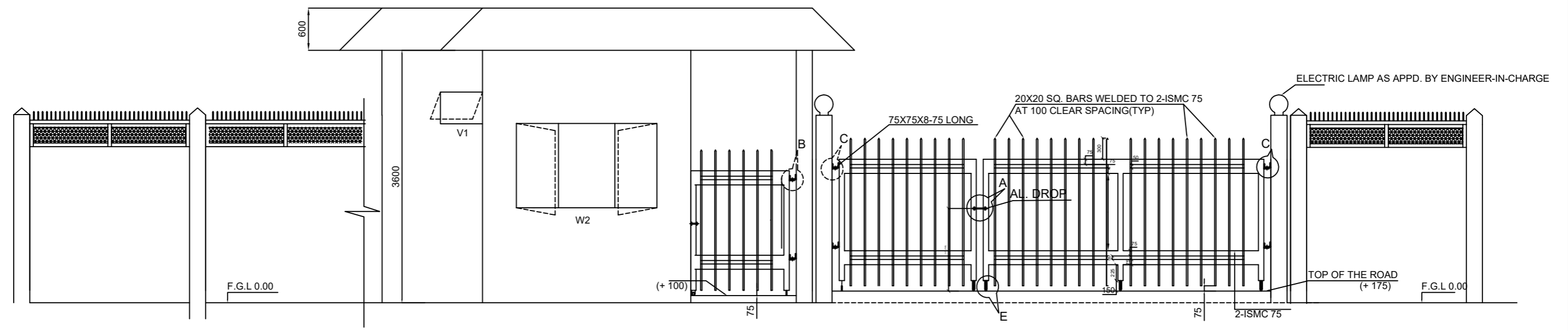
**DOOR WINDOW SCHEDULE**

TYPE	SIZE	SILL LEVEL	LINTEL LEVEL	TOTAL NOS
D1	900X2100	+0.450	+2.55	1
D2	750X2100	+0.450	+2.55	1
W1	900X1200	+1.350	+2.55	1
W2	2000X1200	+1.350	+2.55	2
V1	600X450	+2.100	+2.55	1

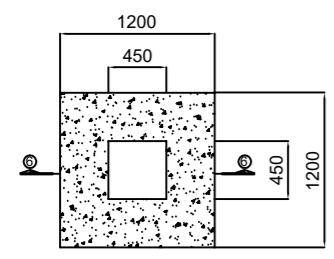


- NOTES:**
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
  2. PROVIDE BRICK WORK IN ENGLISH BOND IN 1:6 CEMENT MORTAR (1CEMENT : 6 COARSE SAND).
  3. a). BRICK TO BE DONE WITH BRICK OF FIRST CLASS DESIGNATION-75  
b). PLASTER WORK SHALL BE IN CEMENT MORTAR 1:6 (1CEMENT:6 FINE SAND) THICKNESS OF PLASTER SHALL BE AS PER B.O.Q.
  4. ALL EXPOSED PLASTER SURFACES ARE TO BE PAINTED WITH MINIMUM OF TWO COATS OF COLOUR WASH OVER A BASE COAT OF WHITE WASH WITH LIME.
  5. ALL STRUCTURAL STEEL SHALL CONFORM TO IS:2062, AND SHALL BE PAINTED WITH TWO OR MORE COATS OF ENAMEL PAINTS OF APPROVED BRAND AND MANUFACTURE OVER A PRIMING COAT OF APPROVED STEEL PRIMER.
  6. CONC. FOR R.C.C WORK SHALL BE AS PER BPS
  7. REINF. BARS SHALL BE H.Y.S.D. BARS CONFORMING TO IS:1786 LATEST REVISION.
  8. STRUCTURE STEEL USED FOR GRATING SHALL CONFORM TO IS:2062 LATEST EDITION.
  9. LAP/ANCHORAGE SHALL BE 50 X DIA OF BAR
  10. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS  
a) FOOTING - 50MM (b) SLAB - 20MM (c) COLOUMN - 40MM,  
d) BEAMS - 25MM

**PLAN OF SECURITY ROOM & GATE**



**FRONT ELEVATION OF SECURITY ROOM & GATE**



**PLAN SOAK PIT**

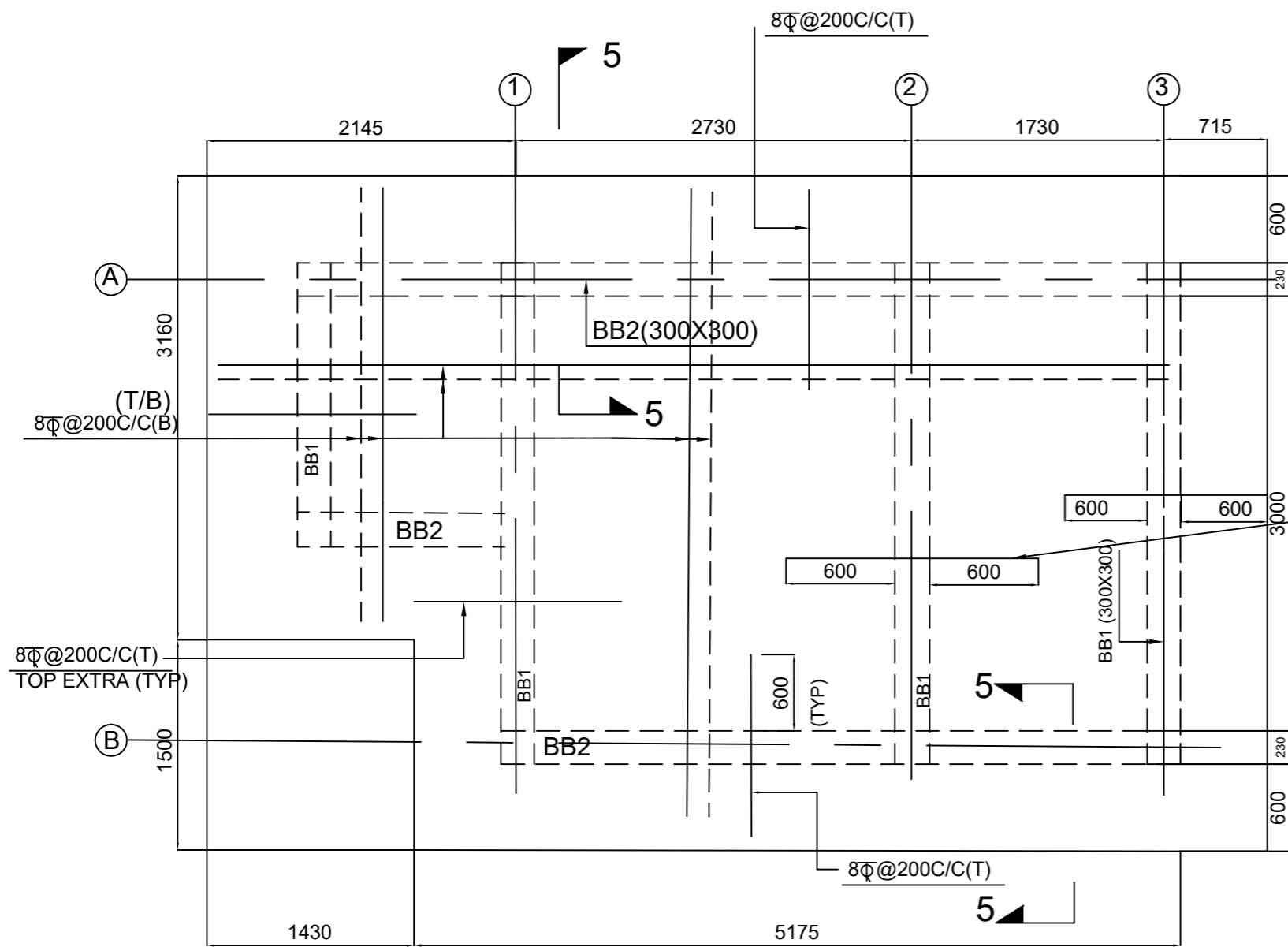
FOR REFERENCE ONLY  
RELEASED FOR TENDER PURPOSE ONLY

MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION  
MHA TRANSCO

PROJECT : SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK

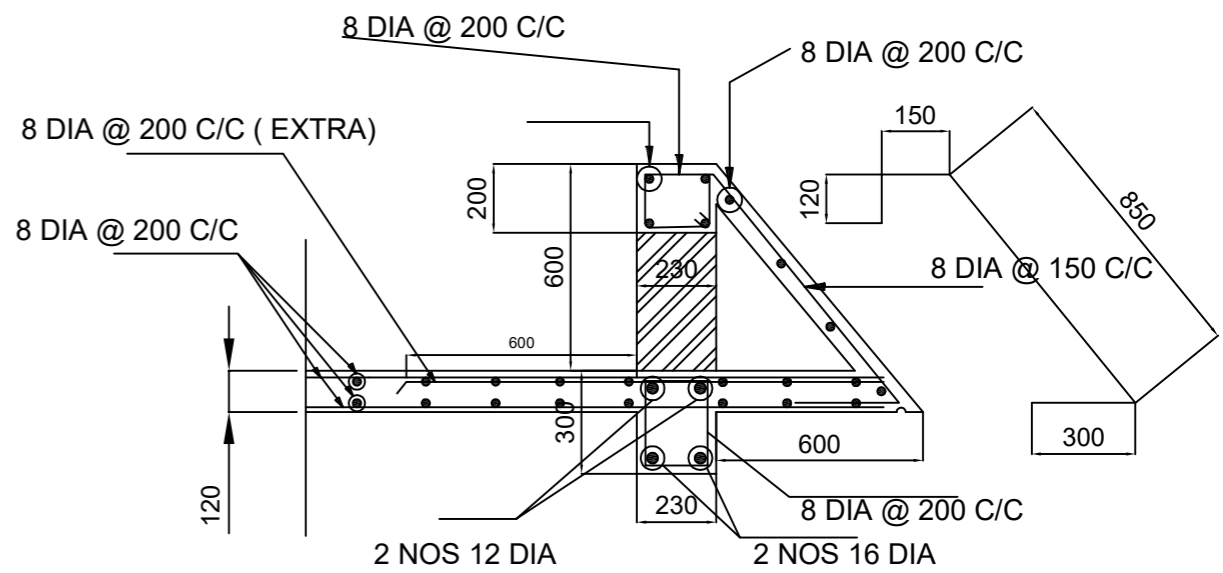
TITLE: DETAILS OF BOUNDARY WALL  
DRAWING NO: C/ENGG/MAHATRANSCO/BW/01  
SCALE: 1:100  
REV: 0

REV.	DESCRIPTION	CIVIL	REVD.	REVD.	APPD. DATE
0	RELEASED FOR TENDER CONSTRUCTION				

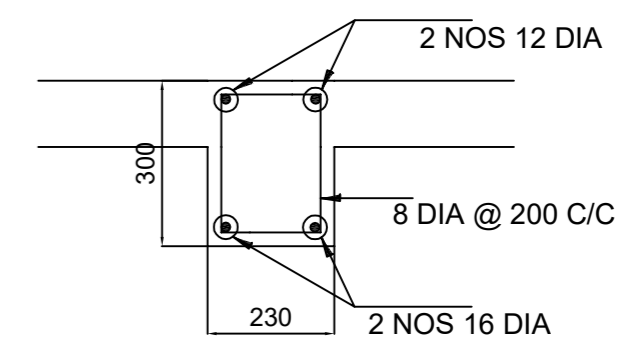


**REINFORCEMENT DETAIL OF ROOF SLAB**

THICKNESS OF SLAB 120



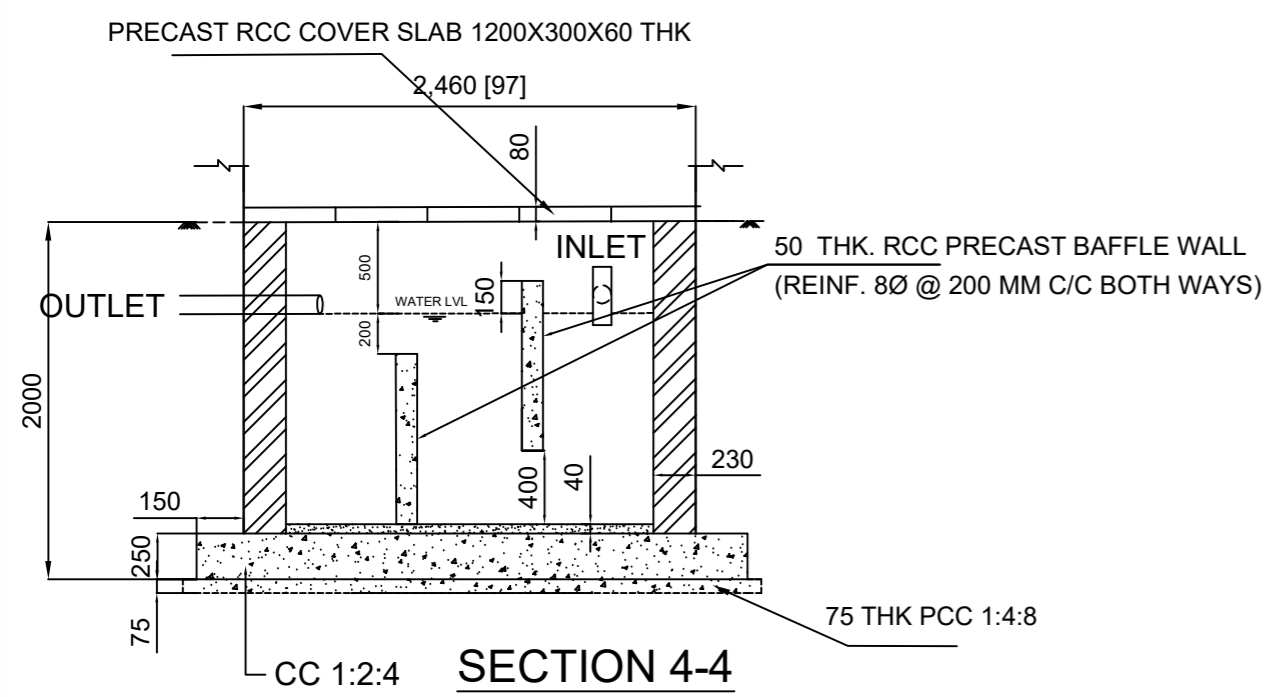
**SECTION 5-5**



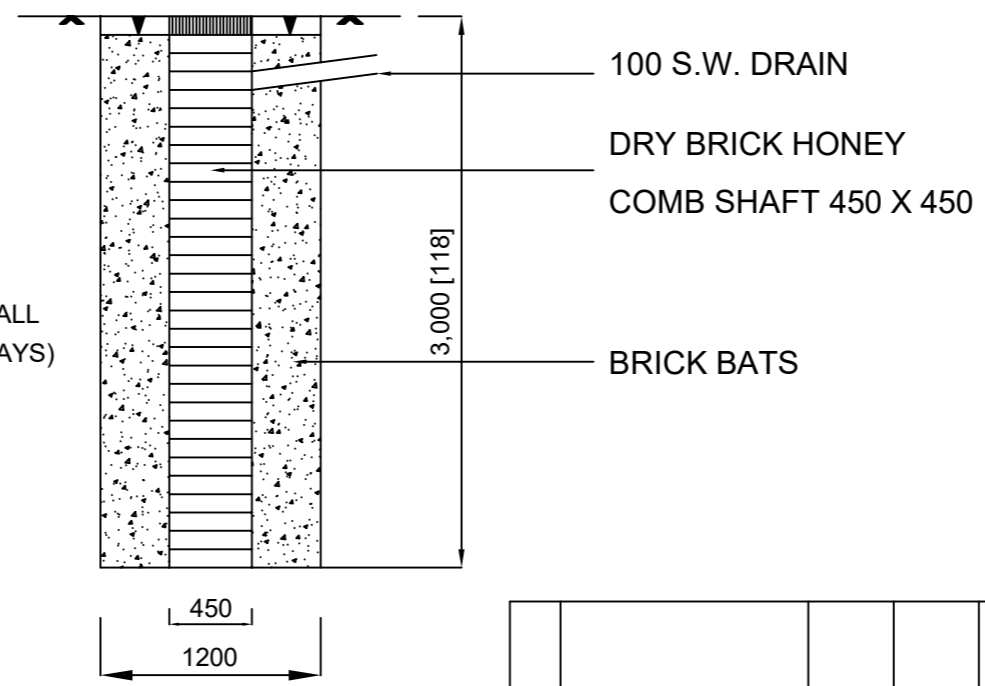
**TYP. DETAILS OF BEAM BB1 & BB2**

- Notes:
- ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
  - CONC. FOR R.C.C WORK SHALL BE AS PER BPS
  - REINF. BARS SHALL BE H.Y.S.D. BARS CONFORMING TO IS:1786 LATEST REVISION.
  - LAP/ANCHORAGE SHALL BE 50 X DIA OF BAR
  - CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS  
a) FOOTING - 50MM (b) SLAB - 20MM (c) COLOUMN - 40MM, d) BEAMS - 25MM
  - PROVIDE 230 THK BRICK WORK IN ENGLISH BOND IN 1:6 CEMENT MORTAR (1CEMENT : 6 COARSE SAND). & 115 THK BRICKWORK IN 1:4 CEMENT MORTAR
  - a). BRICK TO BE DONE WITH BRICK OF FIRST CLASS DESIGNATION-75  
b). PLASTER WORK SHALL BE IN CEMENT MORTAR 1:6 (1CEMENT:6 FINE SAND) THICKNESS OF PLASTER SHALL BE AS PER B.O.Q.

FOR REFERENCE ONLY  
RELEASED FOR TENDER PURPOSE ONLY



**SECTION 4-4**



**SECTION 6-6**

REV.	DESCRIPTION	CIVIL	REVD.	REVD.	APPD. DATE
0	RELEASED FOR TENDER/CONSTRUCTION				

MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION

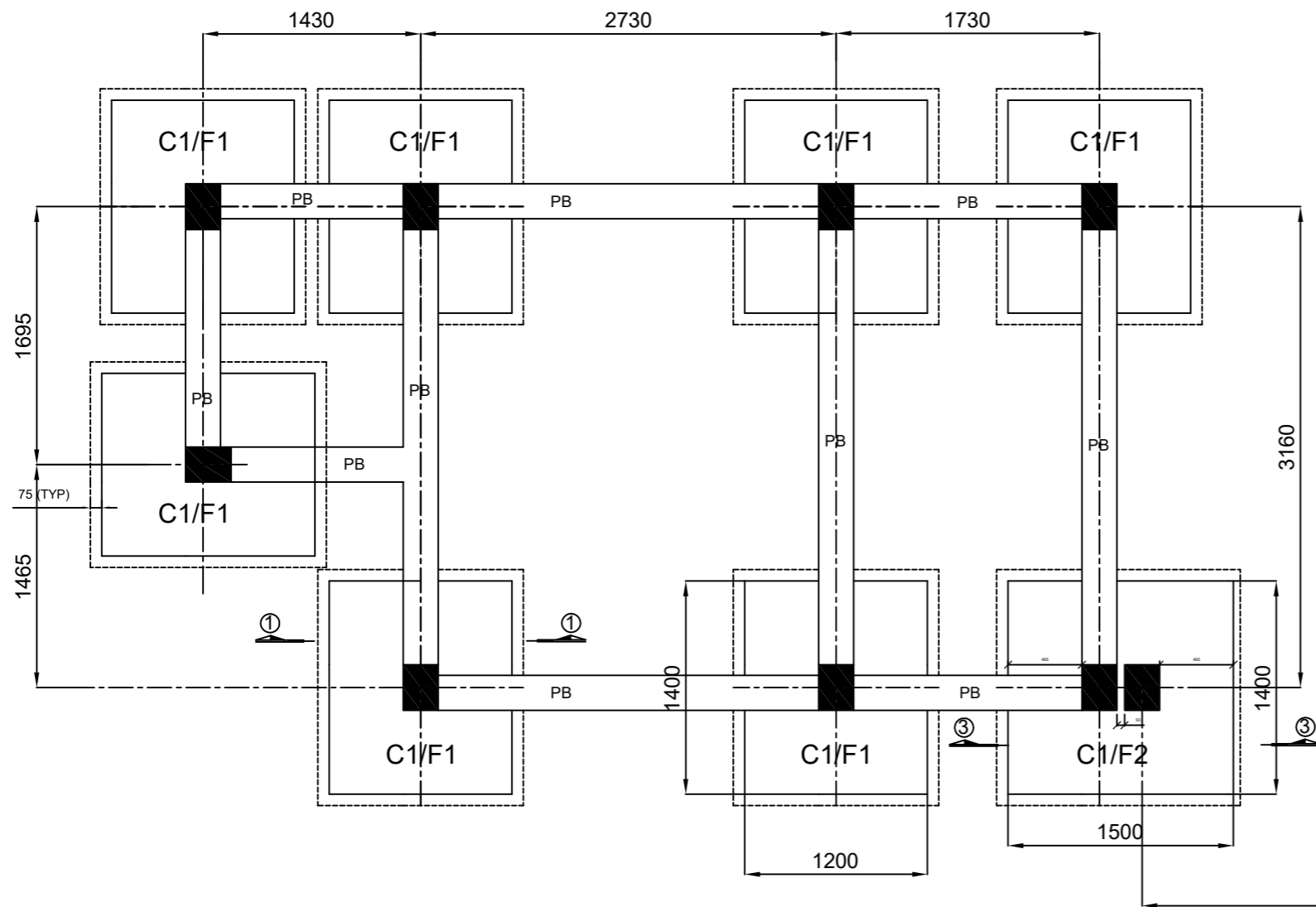
PROJECT: SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK

TITLE: DETAILS OF BOUNDARY WALL

DRAWING NO. C/ENGG/MAHATRANSCO/BW/01

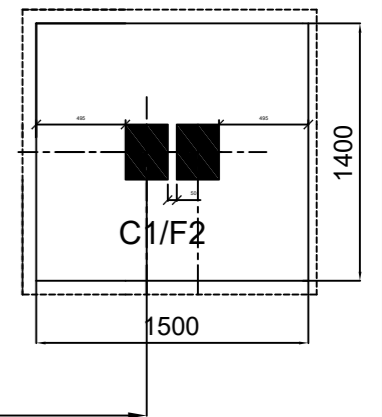
SCALE: 1:100

REV: 0

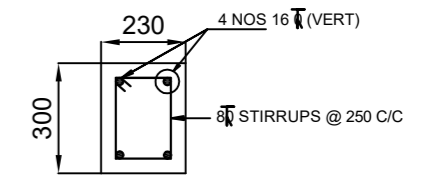
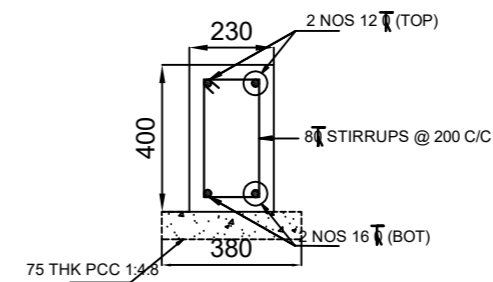
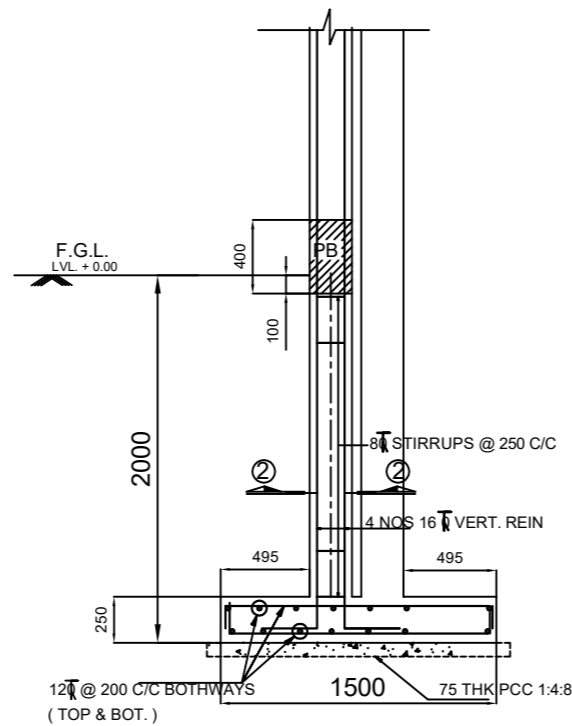
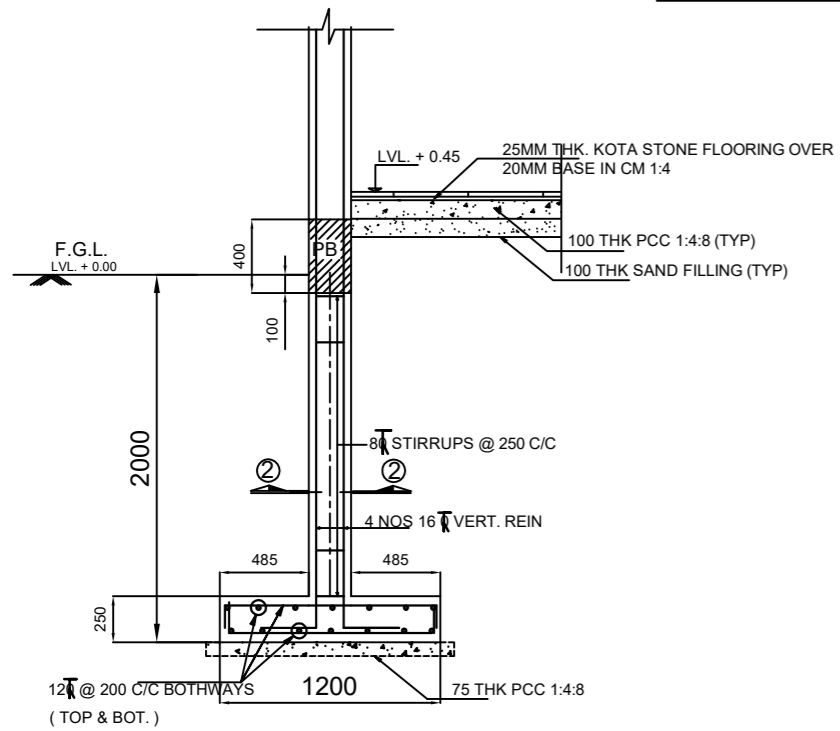


**NOTES:**

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. LOCATION OF SECURITY ROOM SHALL BE AS PER GA./ DRG. LATEST APPROVED.
3. THE LAST 300mm EXCAVATION IN SOIL IS TO BE DONE JUST PRIOR TO THE PLACING OF FOUNDATION P.C.C.
4. P.C.C. OF 1:4:8 GRADE SHALL BE WITH 40mm NOMINAL SIZE AGGREGATE.
5. CONC. FOR R.C.C WORK SHALL BE AS PER BPS
6. REINF. BARS SHALL BE H.Y.S.D. BARS CONFORMING TO IS:1786 LATEST REVISION.
7. LAP/ANCHORAGE SHALL BE 50 X DIA OF BAR
8. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS
  - a) FOOTING - 50MM (b) SLAB - 20MM (c) COLOUMN - 40MM,
  - d) BEAMS - 25MM



**FOUNDATION LAYOUT OF SECURITY ROOM & GATE**



**SECTION 2-2**

FOR REFERENCE ONLY  
 RELEASED FOR TENDER PURPOSE ONLY

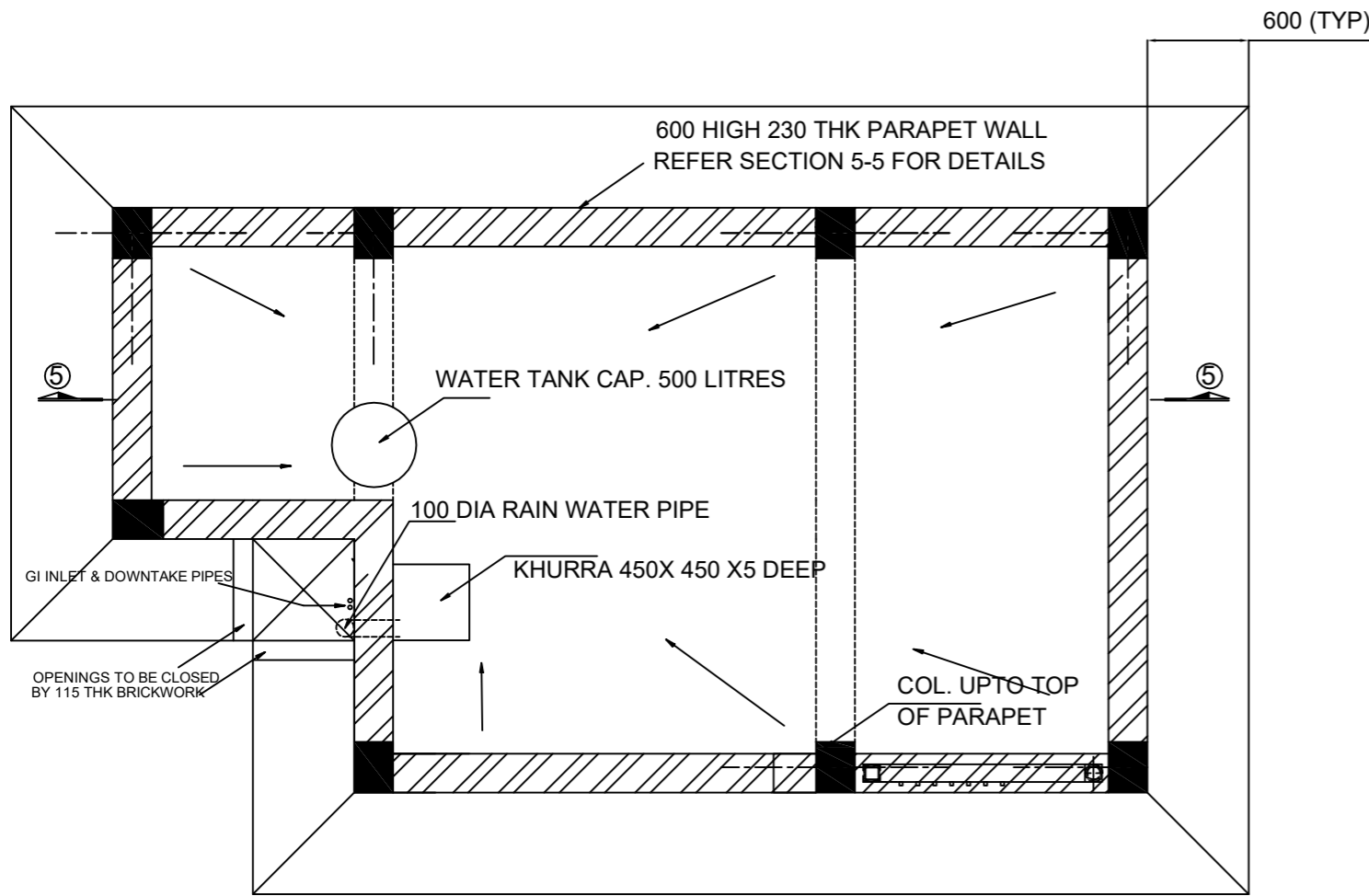
MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION

PROJECT: SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK

TITLE: DETAILS OF BOUNDARY WALL

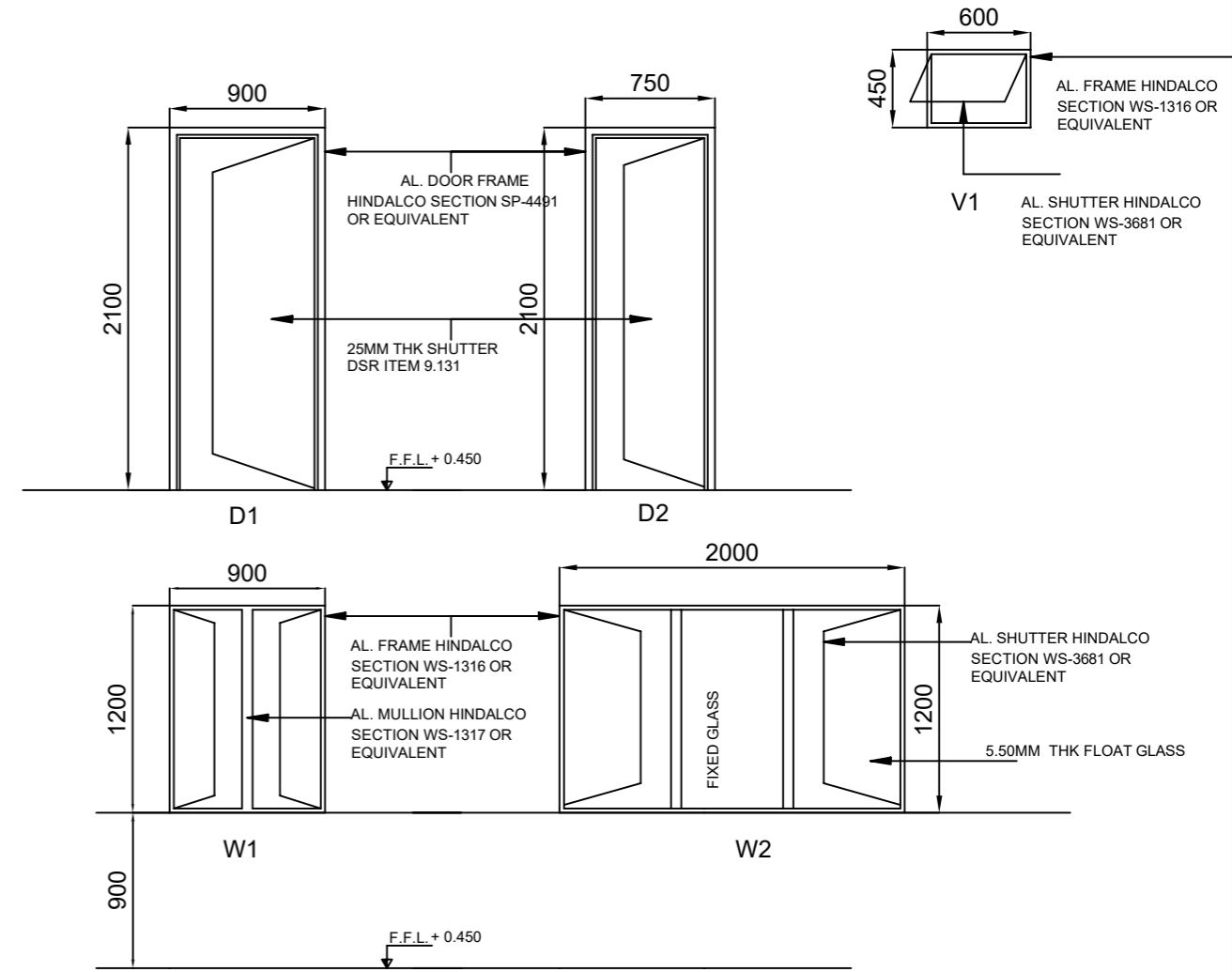
DRAWING NO.	C/ENGG/MAHATRANSCO/BW/01	SCALE	REV
	(SHEET 05 OF 07)	1:100	0

REV.	DESCRIPTION	CIVIL	REVD.	REVD.	APPD. DATE
0	RELEASED FOR TENDER/CONSTRUCTION				



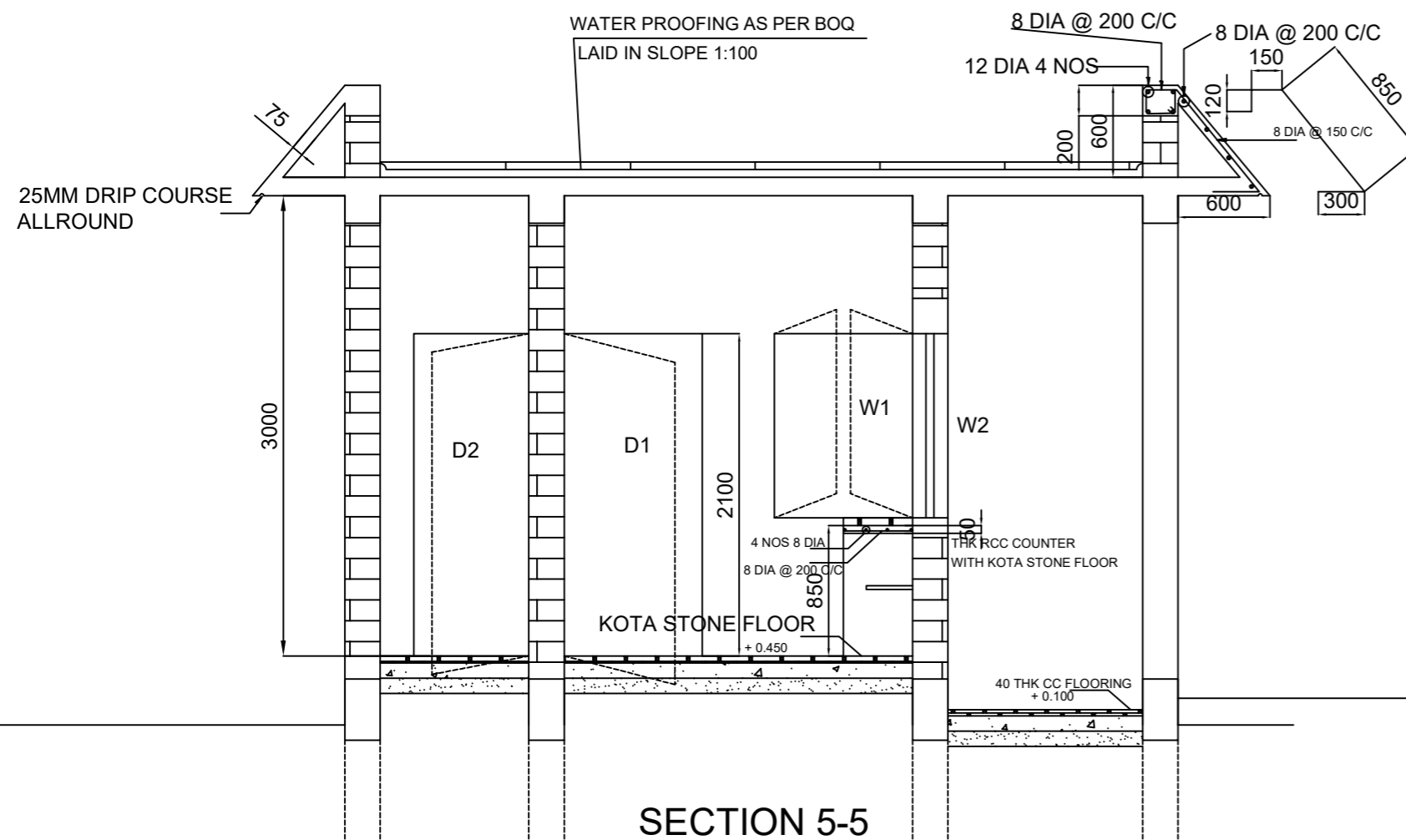
**ROOF PLAN**

**DETAILS OF AL. DOORS, WINDOWS & VENTILATORS**



**NOTES:**

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. PROVIDE 230 THK BRICK WORK IN ENGLISH BOND IN 1:6 CEMENT MORTAR (1CEMENT : 6 COARSE SAND), & 115 THK BRICKWORK IN 1:4 CEMENT MORTAR
3. a). BRICK TO BE DONE WITH BRICK OF FIRST CLASS DESIGNATION-75  
b). PLASTER WORK SHALL BE IN CEMENT MORTAR 1:6 (1CEMENT:6 FINE SAND) THICKNESS OF PLASTER SHALL BE AS PER B.O.Q.
4. ALL EXPOSED PLASTER SURFACES ARE TO BE PAINTED WITH MINIMUM OF TWO COATS OF COLOUR WASH OVER A BASE COAT OF WHITE WASH WITH LIME.



**SECTION 5-5**

FOR REFERENCE ONLY  
RELEASED FOR TENDER PURPOSE ONLY

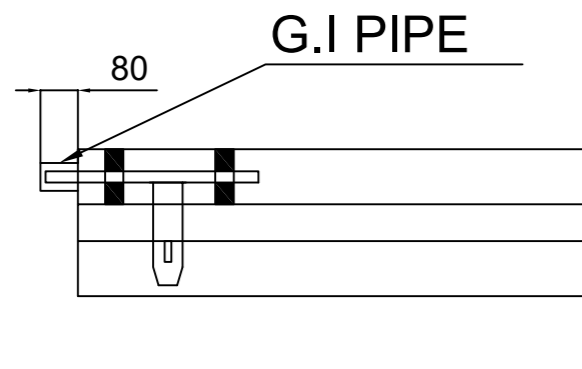
MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION

PROJECT : SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK

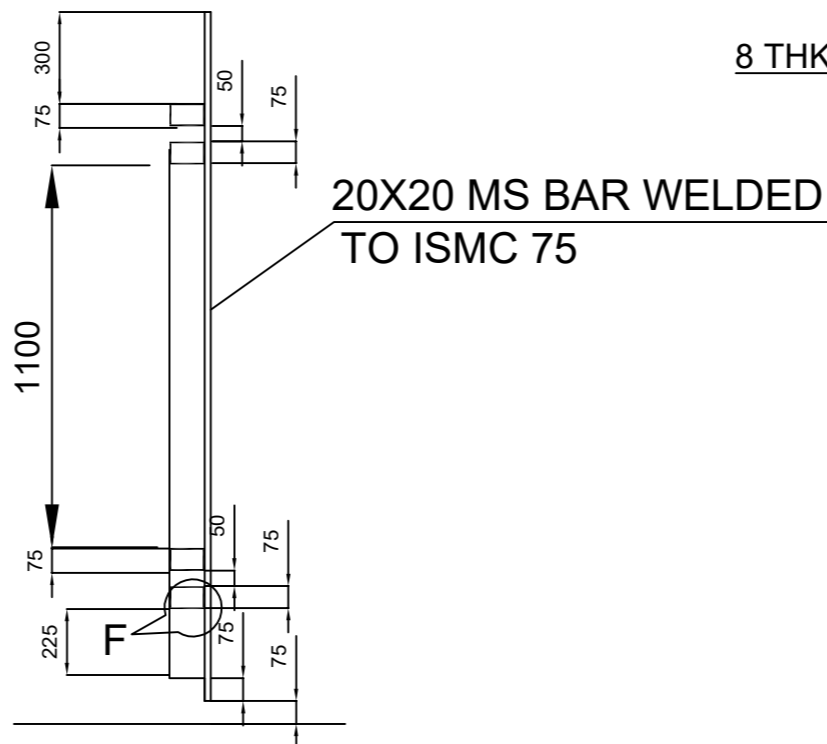
TITLE: DETAILS OF BOUNDARY WALL

DRAWING NO.	C/ENGG/MAHATRANSCO/BW/01	SCALE	REV
	(SHEET 06 OF 07)	1:100	0

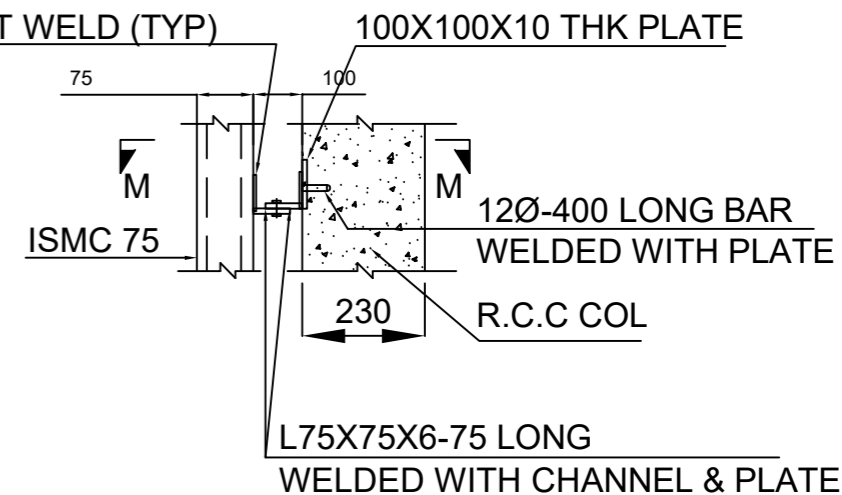
REV.	DESCRIPTION	CIVIL	REVD.	REVD.	APPD. DATE
0	RELEASED FOR TENDER/CONSTRUCTION				



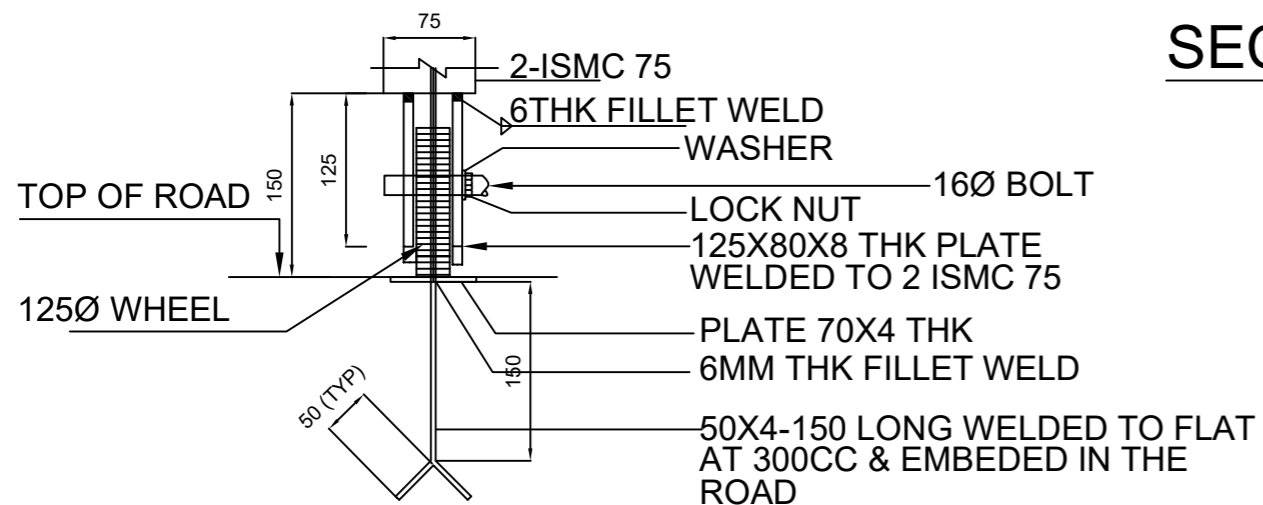
**TYPICAL LOCKING ARRANGEMENT  
DETAIL-A**



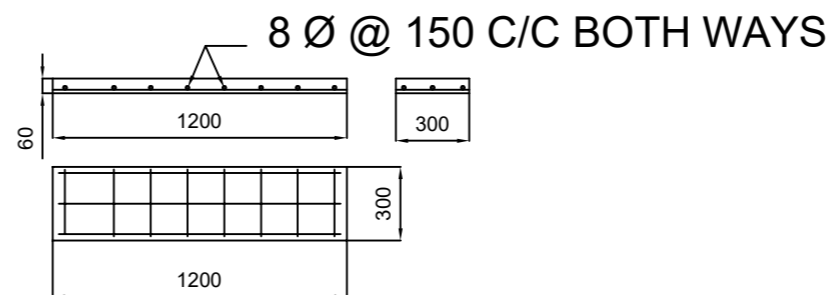
**SECTION 7-7**



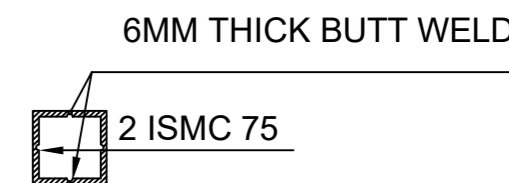
**DETAIL-B & C**



**DETAIL-E**



**PRECAST COVER SLAB**

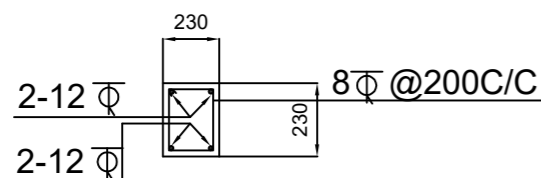


**DETAIL-F**

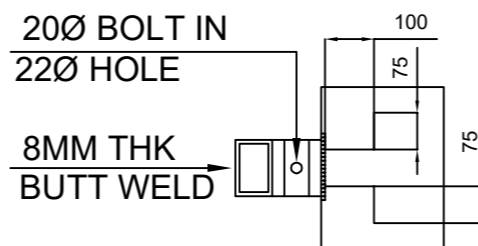
- NOTES:**
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
  2. STRUCTURAL STEEL USED SHALL CONFORM TO IS:2062, AND SHALL BE PAINTED WITH TWO OR MORE COATS OF ENAMEL PAINT OF APPROVED BRAND OVER A PRIMING COAT OF APPD. PRIMER

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**CROSS SEC. OF LINTEL**



**SECTION M-M**

REV.	DESCRIPTION	CIVIL	REVD.	REVD.	APPD. DATE
0	RELEASED FOR TENDER/CONSTRUCTION				

MAHARASHTRA ELECTRICITY TRANSMISSION CORPORATION  


PROJECT :  
 SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH (+/-)500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK

TITLE: DETAILS OF BOUNDARY WALL

DRAWING NO.	SCALE	REV.
C/ENGG/MAHATRANSCO/BW/01	1:100	0

(SHEET 07 OF 07)

# **SECTION-3**

## **PROJECT DETAILS AND GENERAL SPECIFICATIONS**

## SECTION - 3

### PROJECT DETAILS AND GENERAL SPECIFICATIONS

#### 1.0 GENERAL

This section stipulates the General Technical Requirements under the contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and is not exclusive. However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

#### 1.1 SITE INFORMATION

SL.NO.	DESCRIPTION	
<b>3.1</b>	<b>PROJECT INFORMATION</b>	
	a) Customer	MSETCL (MAHATRANSCO)
	b) Project	SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH $\pm 500$ KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK
	c) Project location	The Malegaon Earth electrode terminal is located about 40km from Padghe HVDC terminal in Maharashtra. The nearest railway station is Padghe (approx. 40km) and nearest airport is Mumbai (approx. 100km). The coordinates of the site location is 19.08.34.53N, 73.24.01.47E. The size of the land is 400 m X 400m.
	d) Transport facilities <ul style="list-style-type: none"><li>• Nearest Railway Station</li><li>• Nearest Airport</li></ul>	PADGHE (approx. 40km) BADLAPUR (approx. 20km) MUMBAI (approx. 100km)
<b>3.2</b>	<b>SITE CONDITIONS</b>	
3.2.1	Ambient Temp.	
	a) Maximum Design Ambient air temp. (Max.) °C	50 deg.
	b) Minimum Design Ambient air temp. (Max.) °C	0 deg.
3.2.2	Height above mean sea level	155 mtr
3.2.3	Coastal area consideration	yes
3.2.4	Earth quake data	
	a) Seismic zone	As per IS 1893
3.2.5	Wind data	
	a) Wind zone	As per IS 875 part-3

## 1.2 STANDARDS

The Works covered by the Specification shall be designed, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India. The Equipment(s) shall also conform to the general requirements detailed in the following standards, which shall form an integral part of the Specification, in addition to meeting the specific requirements called for elsewhere in the Specification.

The Bidder shall note that the standards mentioned herein are not mutually exclusive or complete in themselves, but are intended to complement each other, with minimum repetition, to define the requirements of the Specification.

When specific requirements stipulated in the Specification exceed or change those required by the applicable standards, the stipulations of the Specification shall take precedence.

Unless specifically agreed to by the Employer prior to Award of Contract, the Work shall be in accordance with the standards indicated and the requirements of the Specification. The Bidder shall be held responsible for any deviation.

In case of conflict between the various standards, the decision of Employer shall be binding & final.

All equipment and materials, unless otherwise specifically required in the Specification, shall conform to latest revisions of the standards listed in the Specification, in force 15 days before the originally scheduled deadline for submission of bid at the time of signing of the contract for this project.

IEC/TS 62344	Design of earth electrode stations for high-voltage direct current (HVDC) links.
IS-1893	Criteria for Earthquake Resistant Design of Structures
IEC 60076-6	Air core reactors
IEC-60871	Shunt capacitors
IEC 62271-102	High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches
IEC-60099-9	Metal-oxide surge arresters without gaps for HVDC converter stations
IEC-60270	Partial Discharge measurements
IS-7098-Part 1,2,3	XLPE insulated cables
IS-8130	Conductors for Insulated cables
IS-1554(1)	PVC Insulated cables
IS-15910	Geotextiles
IS-5561	Clamp and connectors
IS-1892	Code of practice for subsurface investigation for foundations
IS-1080	Code of Practice For Design And Construction Of Shallow Foundations In Soils (Other Than Raft, Ring And Shell)
IS-9451	Guidelines for lining of canals in expansive soils
IS: 456	Plain and Reinforced Concrete
IS: 10262	Concrete Mix Proportioning — Guidelines
IS: 1786	High Strength Deformed Steel Bars and Wires for Concrete reinforcement
IS:875	Code of practice for design loads (Other than earthquake) For buildings and structures
IS: 1893	Criteria for Earthquake Resistant Design of structures
IS: 3370	Concrete structures for storage of liquids
IS: 1200	Methods of measurement of building and civil engineering works
IS:1489 or IS: 4926 or IS: 4925	IS: 269 or IS:8112 or IS: 12269 or IS: 455 Cement Concrete mix
IS: 3812	Pulverized fuel ash
IS: 800	General construction in steel
IS: 2911	Design and construction of pile foundations
IS: 2720	Soil testing

### **1.3 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice, snow & sea, (wherever applicable) short circuit etc for the equipment.

### **1.4 ENGINEERING DATA**

The contactor shall necessarily submit all the drawings/ documents unless anything is waived. The contactor shall submit drawings/ design documents/ data/ test reports as may be required for the approval of the BHEL/MSETCL. All drawings submitted by the Manufacturer including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. the dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Manufacturer shall be clearly marked with the name of the BHEL/MSETCL, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

Further work by the Manufacturer shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the BHEL/MSETCL, if so required.

The review of these data by the Owner will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. Owner may not indicate a thorough review of all dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and /or approval by the Owner shall not be considered by the Manufacturer, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Manufacturer's risk. The Manufacturer may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the BHEL/MSETCL. Approval of Manufacturer's drawing or work by the BHEL/MSETCL shall not relieve the manufacturer of any of his responsibilities and liabilities under the Contract

All engineering data submitted by the Manufacturer after final process including review and approval by the Owner shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Owner in Writing.

The title block of drawings shall contain the following information incorporated in all contract drawings

Title block for \_\_\_\_\_ project:

<b>Customer</b>	<b>MAHARASTRA STATE ELECTRICITY TRANSMISSION Co. Ltd. (MSETCL)</b>
<b>Project</b>	<b>SHALLOW TYPE GROUND ELECTRODE STATION AT MALEGAON (PADGHE TERMINAL) ASSOCIATED WITH ±500KV 1500MW CHANDRAPUR-PADGHE HVDC BIPOLE LINK</b>
<b>Contract No./LOA No.</b>	
<b>Contractor</b>	<b>Bharat Heavy Electricals Limited</b>

## **1.5 Quality Inspection and testing**

All equipment being supplied shall conform to type tests as per technical specification/ relevant IEC/IS and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

The reports for all type tests as per technical specification shall be furnished by the Bidder along with equipment / material drawings. However, type test reports of similar equipment/ material already accepted by Employer shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) /representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable. Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within 10 years from the date of Award. In case the test reports are of the test conducted earlier than the years specified below from the date of Award, the Bidder shall repeat these test(s) at no extra cost to the Employer. Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to noncompliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Bidder shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

The Employer reserves the right to witness any or all the type tests. The Employer shall bear all expenses for deputation of Employer's representative(s) for witnessing the type tests except in the case of re-deputation if any, necessitated due to no fault of the Employer.

Routine tests shall however be done freshly on sample basis. The Type test and Routine test report clearance procedure shall be as per the Employer's prevailing Quality management practice. However, the Type and Routine test reports clearance shall be subject to Employer's approval.

## **1.6 MATERIAL/ WORKMANSHIP**

### **General Requirement**

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

Incase where the equipment, materials or components are indicated in the specification as 'similar' to any special standard, the BHEL/MSETCL shall decide upon the question of

similarity. When required by the specification or when required by the BHEL/MSETCL the Bidder shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Bidder.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the BHEL/MSETCL.

Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and/ or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

The Bidder shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Bidder shall apply all operational lubricants to the equipment installed by him.

All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Bidder has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help BHEL/MSETCL in establishing equivalent Indian make and Indian Bidder. The same shall be applicable to other consumables too.

A cast iron or welded steel base plate shall be provided for all rotating equipment which are to be installed on a concrete base unless otherwise agreed to by the BHEL/MSETCL. Each base plate shall support the unit and its drive assembly, shall be of design with pads for anchoring the units, shall have a raised up all around and shall have threaded in air connections, if so required.

### **Provisions for Exposure to Hot and Humid climate & costal area**

Outdoor equipment supplied under the specification shall be suitable for service storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipments located in non-air-conditioned areas shall also be of same type.

## **1.7 PACKING AND STORAGE**

All the equipments shall be suitably protected (bubble-wrap for fragile items as needed), coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. On request of the BHEL/MSETCL, the manufacturer shall also submit packing details/ associated drawing for any equipment/ material at a later date, in case the need arises.

All coated surfaces shall be protected against abrasions, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device.

Supplier shall ensure that equipment shall be properly packed, blocked, padded, coated and protected so that it is not damaged due to possible mishandling. Storage requirements shall be clearly defined by the supplier. Packing shall be such that if required, long time storage at site should not deteriorate the performance of the equipment.

**TRANSMISSION BUSINESS GROUP  
(Subcontracts Management)**

Doc. No. TBSM/Std-Spec/Cov-Str/01

Rev. 01

**SPECIFICATION FOR COVERED STORE FOR SWITCHYARD**

1. The covered store shall be constructed of adequately designed steel columns and tubular trusses (span 10m) placed at an interval of 5.00m centre to centre with suitable purlins and runners provided to support the roofing & cladding. The length of the store shall be 20.00/15.00/10.00m. depending on the requirement as indicated in the BOQ.
2. The roofing and side cladding shall be of GS corrugated sheets (0.8mm thick) fixed to purlins & runners with suitable polymer/GI coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. Limpet washers or with G.I limpet washers filed with white lead and including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to a pitch of 60 degrees).. The roof shall be made with proper arrangements to prevent water leakage.
3. The bottom of the truss shall be 4.50m. above FFL (Finished floor level).
4. The steel columns shall be supported on adequately designed concrete pedestals & footings. The following minimum requirements shall be ensured..
  - Depth of footing below existing ground level = 1.00m
  - Size of footing = 1.50m X 1.50m
  - Depth of footing = 0.30m
  - Reinforcement in footing = 12dia @ 150 c/c bothways, top & bottom.
  - Size of pedestal = 0.50m X 0.50m
  - Reinforcement in pedestal – Longitudinal = 8 Nos 16dia
    - Ties = 8dia @ 200c/c
5. 230mm thick brick walls in cement mortar 1:6 shall be provided all along the periphery and shall be 1.50m above the FFL. This shall rest on suitable brick masonry foundation which shall extend to minimum 500mm below the FFL. 12/15mm plaster in cement mortar 1:6 shall be provided on the walls which shall be finally painted with 3 coats of colourwash.
6. The floor of the store shall be made with 100mm thick PCC 1:4:8 neatly finished and laid over 150mm thick boulder soling with interstices filled with suitable material. The area below this upto the natural ground level shall be filled with well compacted earth.
7. The store shall be provided with a 4.00m wide X 4.50m high lockable & painted rolling shutter with all accessories, as required. In addition, painted steel ventilators of size 1.20m wide X 0.50m high shall be provided between each span and along both longitudinal

directions and at a height of 4 Mts above FFL. In front of the rolling shutter, suitable ramp shall be provided for material entry.

8. Adequate no. of fire extinguishers (min. 4 nos. CO<sub>2</sub> and 2 nos. foam type) and sand & water buckets shall be provided in the store area.
9. Adequate illumination arrangements shall be made inside the store - comprising of min. of 4 tube light fittings and a 15Amp. power socket and suitable switchboard at the entrance to the stores. The switch board shall also serve as the controlling point for illumination of open store yard. Providing of incomer cable and giving supply to the switchboard is NOT in the scope of store construction.
10. All materials shall conform to IS and shall be procured from approved sources & reputed manufacturer(s). The execution of work shall be as per latest CPWD/IS specifications & directions of Engineer-in-Charge.

**TRANSMISSION BUSINESS GROUP  
(Subcontracts Management)**

Doc. No. TBSM/Std-Spec/Open-Str/02

Rev. 01

**SPECIFICATION FOR OPEN STORE FOR SWITCHYARD**

1. The area of the open store shall be as indicated in the BOQ.
2. The area identified for the open store shall be enclosed with barbed wire fencing-1.8 M high above ground level with 8 strands of horizontal and two diagonal barbed wires (between 2 posts). The posts shall be of medium M.S tubes of 50mm dia or angle 50x50x6 and shall be spaced 3.0m centre to centre. Inclined post supports shall be provided at all corners and at every 10<sup>th</sup> post. All posts shall be embedded at least 0.4m in PCC 1:2:4 block of size 0.40x0.40x0.6m. 75mm thick PCC 1:4:8 shall be provided below concrete block.
3. One 5m wide X 1.8m high (2 leaf) gate suitable for truck/ trailer entry and one 1m wide X 1.8m high wicket gate suitable for personnel entry shall be provided. The gate shall be of pipe framework (having suitable stiffness) with welded mesh suitably fixed on it.. The gate shall be provided with suitable locking arrangement.
4. The area of the open store shall be raised minimum 150mm above the surrounding ground level with compacted earth. Over this, flat brick soling or some other suitable alternative material of minimum thickness 75mm shall be provided.
5. One central road 3.75 mts. wide located centrally along the long axis of the stores shall be constructed with 150mm compacted thickness boulder soling interstices filled with moorum and adequately rolled and compacted. The top of the road shall be 150mm above the yard soling level. The total area of the road shall be maximum 15% of the area of the open store.
6. One security cabin of size 2.0m x 2.0m shall be provided inside the fence adjacent to the gate. Four nos. of sand and water buckets on suitable stand shall be provided adjacent to the cabin.
7. The area shall be adequately illuminated with min. 4 nos. of halogen lamps at the four corners of the stores and 1 tube light in the security cabin. The scope includes cabling from the main switch in the covered stores and interconnected cabling. Where the scope includes only the open store, the main switch shall be provided inside the security cabin
8. All materials shall conform to IS and shall be procured from approved sources & reputed manufacturer(s). The execution of work shall be as per latest CPWD/IS specifications & directions of Engineer-in-Charge.

**INTEGRITY PACT****Between**

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi - 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

**and**

\_\_\_\_\_, (description of the party along with address), hereinafter referred to as "The Bidder/ Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

**Preamble**

The Principal intends to award, under laid-down organizational procedures, contract/s for \_\_\_\_\_

\_\_\_\_\_ (hereinafter referred to as "Contract"). The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint panel of Independent External Monitor(s) (IEMs), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

**Section 1- Commitments of the Principal**

- 1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles: -
  - 1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
  - 1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential/ additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.
  - 1.1.3, The Principal will exclude from the process all known prejudiced persons.
- 1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

**Section 2 - Commitments of the Bidder(s)/ Contractor(s)**

- 2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. The Bidder(s)/ Contractor(s) commits himself to observe the following principles during participation in the tender process and during the contract execution.



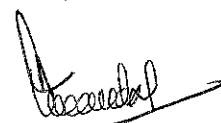
- 2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he/ she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.
- 2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.
- 2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant Indian Penal Code (IPC) and Prevention of Corruption Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.
- 2.1.4 Foreign Bidder(s)/ Contractor(s) shall disclose the name and address of agents and representatives in India and Indian Bidder(s)/ Contractor(s) to disclose their foreign principals or associates. The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
- 2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.
- 2.3 The Bidder(s)/ Contractor(s) shall not approach the Courts while representing the matters to IEMs and shall await their decision in the matter.

### Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/ Contractor(s) from the tender process, terminate the contract, if already awarded, exclude from future business dealings and/ or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

### Section 4 - Compensation for Damages

- 4.1 If the Principal has disqualified the Bidder (s) from the tender process before award / order acceptance according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/ Bid Security.
- 4.2 If the Principal is entitled to terminate the Contract according to Section 3, or terminates the Contract in application of Section 3 above, the Bidder(s)/ Contractor (s) transgression through a violation of Section 2 above shall be construed breach of contract and the Principal shall be entitled to demand and recover from the Contractor an amount equal to 5% of the contract value or the amount equivalent to Security Deposit/ Performance Bank Guarantee, whichever is higher, as damages, in addition to and without prejudice to its right to demand and recover compensation for any other loss or damages specified elsewhere in the contract.



**Section 5 - Previous Transgression**

- 5.1 The Bidder declares that no previous transgressions occurred in the last 3 (three) years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.
- 5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason or action can be taken as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

**Section 6 - Equal treatment of all Bidder (s)/ Contractor (s) / Sub-contractor (s)**

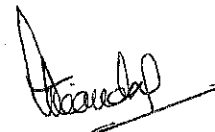
- 6.1 The Principal will enter into Integrity Pacts with identical conditions as this Integrity Pact with all Bidders and Contractors.
- 6.2 In case of Sub-contracting, the Principal Contractor shall take the responsibility of the adoption of Integrity Pact by the Sub-contractor(s) and ensure that all Sub-contractors also sign the Integrity Pact.
- 6.3 The Principal will disqualify from the tender process all Bidders who do not sign this Integrity Pact or violate its provisions.

**Section 7 - Criminal Charges against violating Bidders/ Contractors /Subcontractors**

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

**Section 8 -Independent External Monitor(s)**

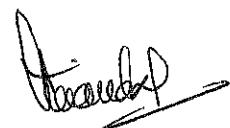
- 8.1 The Principal appoints competent and credible panel of Independent External Monitor (s) (IEMs) for this Integrity Pact. The task of the IEMs is to review independently and objectively, whether and to what extent the parties comply with the obligations under this Integrity Pact.
- 8.2 The IEMs are not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.
- 8.3 The IEMs shall be provided access to all documents/ records pertaining to the Contract, for which a complaint or issue is raised before them as and when warranted. However, the documents/records/information having National Security implications and those documents which have been classified as Secret/Top Secret are not to be disclosed.
- 8.4 The Principal will provide to the IEMs sufficient information about all meetings among the parties related to the Contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the IEMs the option to participate in such meetings.



- 8.5 The advisory role of IEMs is envisaged as that of a friend, philosopher and guide. The advice of IEMs would not be legally binding and it is restricted to resolving issues raised by a Bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some Bidders. At the same time, it must be understood that IEMs are not consultants to the Management. Their role is independent in nature and the advice once tendered would not be subject to review at the request of the organization.
- 8.6 For ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process or during execution of Contract, the matter should be examined by the full panel of IEMs jointly, who would look into the records, conduct an investigation, and submit their joint recommendations to the Management.
- 8.7 The IEMs would examine all complaints received by them and give their recommendations/ views to the CMD, BHEL at the earliest. They may also send their report directly to the CVO, in case of suspicion of serious irregularities requiring legal/ administrative action. Only in case of very serious issue having a specific, verifiable Vigilance angle, the matter should be reported directly to the Commission. IEMs will tender their advice on the complaints within 30 days.
- 8.8 The CMD, BHEL shall decide the compensation to be paid to the IEMs and its terms and conditions.
- 8.9 IEMs should examine the process integrity, they are not expected to concern themselves with fixing of responsibility of officers. Complaints alleging mala fide on the part of any officer of the Principal should be looked into by the CVO of the Principal.
- 8.10 If the IEMs have reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant Indian Penal Code / Prevention of Corruption Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the IEMs may also transmit this information directly to the Central Vigilance Commissioner, Government of India.
- 8.11 After award of work, the IEMs shall look into any issue relating to execution of Contract, if specifically raised before them. As an illustrative example, if a Contractor who has been awarded the Contract, during the execution of Contract, raises issue of delayed payment etc. before the IEMs, the same shall be examined by the panel of IEMs. Issues like warranty/ guarantee etc. shall be outside the purview of IEMs.
- 8.12 However, the IEMs may suggest systemic improvements to the management of the Principal, if considered necessary, to bring about transparency, equity and fairness in the system of procurement.
- 8.13 The word 'Monitor' would include both singular and plural.

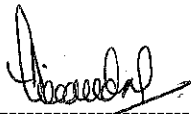
#### Section 9 - Pact Duration

- 9.1 This Integrity Pact shall be operative from the date this Integrity Pact is signed by both the parties till the final completion of contract for successful Bidder, and for all other Bidders 6 months after the Contract has been awarded. Any violation of the same would entail disqualification of the bidders and exclusion from future business dealings.
- 9.2 If any claim is made/ lodged during currency of this Integrity Pact, the same shall be binding and continue to be valid despite the lapse of this Pact as specified above, unless it is discharged/ determined by the CMD, BHEL.



**Section 10 - Other Provisions**

- 10.1 This Integrity Pact is subject to Indian Laws and exclusive jurisdiction shall be of the competent Courts as indicated in the Tender or Contract, as the case may be.
- 10.2 Changes and supplements as well as termination notices need to be made in writing.
- 10.3 If the Bidder(s)/ Contractor(s) is a partnership or a consortium or a joint venture, this Integrity Pact shall be signed by all partners of the partnership or joint venture or all consortium members.
- 10.4 Should one or several provisions of this Integrity Pact turn out to be invalid, the remainder of this Integrity Pact remains valid. In this case, the parties will strive to come to an agreement to their original intentions.
- 10.5 Only those bidders / contractors who have entered into this Integrity Pact with the Principal would be competent to participate in the bidding. In other words, entering into this Integrity Pact would be a preliminary qualification.
- 10.6 In the event of any dispute between the Principal and Bidder(s)/ Contractor(s) relating to the Contract, in case, both the parties are agreeable, they may try to settle dispute through Mediation before the panel of IEMs in a time bound manner. In case, the dispute remains unresolved even after mediation by the panel of IEMs, either party may take further action as the terms & conditions of the Contract. The fees/expenses on dispute resolution through mediation shall be shared by both the parties. Further, the mediation proceedings shall be confidential in nature and the parties shall keep confidential all matters relating to the mediation proceedings including any settlement agreement arrived at between the parties as outcome of mediation. Any views expressed, suggestions, admissions or proposals etc. made by either party in the course of mediation shall not be relied upon or introduced as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the dispute that is the subject of mediation proceedings. Neither of the parties shall present IEMs as witness in any Alternative Dispute Resolution or judicial proceedings in respect of the dispute that was subject of mediation.



-----  
 For & On behalf of the Principal  
 (Office Seal)

Place NOIDA(UP)  
 Date \_\_\_\_\_

Witness: \_\_\_\_\_  
 (Name & Address) \_\_\_\_\_

\_\_\_\_\_

-----  
 For & On behalf of the Bidder/ Contractor  
 (Office Seal)

Witness: \_\_\_\_\_  
 (Name & Address) \_\_\_\_\_

\_\_\_\_\_

**FORMAT OF NO DEVIATION CERTIFICATE  
(To be submitted in the bidder's letter head)**

REF: .....

Dated.....

**BHARAT HEAVY ELECTRICALS LIMITED,  
TRANSMISSION BUSINESS GROUP,  
Plot No- 25, Sector- 16A, Noida,  
Distt. Gautambudh Nagar, UP-201301**

**SUB.: Tender for "Execution and handing over of Civil works, Erection, Testing & Commissioning of 1650ADC Shallow type Earth Electrode including stores works for Padghe HVDC terminal station pertaining to +/-500kV 1500MW Chandrapur-Padghe HVDC Bipolar Link at Malegaon in Maharashtra".**

**TENDER NO.: - TBSM/MALEGAON/GES/CIVIL-ETC/TENDER/23-24**

**DATE: 10.11.2023**

Dear Sir,

With reference to above, this is to confirm that as per tender conditions, we have visited subject site before submission of our offer and noted the job content & site conditions etc.

We also confirm that we have not changed / modified the tender documents as appeared in the website and in case of observance at any stage, it shall be treated as null and void. We hereby confirm that we have not taken any deviation from tender clauses together with other references as enumerated in the above referred NIT and we hereby convey our unqualified acceptance to all terms and conditions as stipulated in the tender and NIT. In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null & void.

We confirm to have submitted offer strictly in accordance with tender instructions.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized representative of the bidder)

## DECLARATION FOR RELATION IN BHEL

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder failing which the offer of Bidder is liable to be summarily rejected)

**Ref:**

**Date.....**

**To,  
AGM/TBSM  
BHARAT HEAVY ELECTRICALS LIMITED,  
TRANSMISSION BUSINESS GROUP,  
PLOT NO.-25, SECTOR-16A,  
NOIDA - 201301 (U.P.)**

Dear Sir,

Sub: Declaration for relation in BHEL

Ref: 1) NIT/Tender Specification No. **TBSM/MALEGAON/GES/CIVIL-ETC/TENDER/23-24**  
DATE: 10.11.2023

I/We hereby submit the following information pertaining to relation/relatives of Proprietor/  
Partner(s)/Director(s) employed in BHEL

**Tick (✓) any one as applicable:**

1. The Proprietor, Partner(s), Director(s) of our Company/Firm DO NOT have any relation or  
relatives employed in BHEL

OR

2. The Proprietor, Partner(s), or Director(s) of our Company / Firm HAVE relation / relatives  
employed in BHEL and their particulars are as below:

a)

b)

Signature of the Authorized Signatory

**Note:**

- 1) Attach separate sheet, if necessary.
- 2) If BHEL Management comes to know at a later date that the information furnished by the Bidder is false, BHEL reserves the right to take suitable against the Bidder/ Contractor.

