

**MADHYA PRADESH POWER TRANSMISSION CO. LTD.**

**SHAKTI BHAWAN RAMPUR: JABALPUR**



**VOLUME –IV**

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**SPECIFICATION FOR ERECTION TESTING  
& COMMISSIONING OF SUB-STATIONS  
AND FEEDER BAYS**

**O/o CHIEF ENGINEER (PROCUREMENT)  
MPPTCL, JABALPUR.**

# VOLUME- IV

## SPECIFICATION & REQUIREMENT FOR INSTALLATION, ERECTION & COMMISSIONING WORK

SECTION	DESCRIPTION	PAGE NO.	
		FROM	TO
I	GENERAL REQUIREMENT OF ERECTION WORK	1	28
	ABBREVIATIONS	29	29

## INDEX

### GENERAL REQUIREMENT OF ERECTION WORK

S. No.	Description	Page No.	
		From	To
1.01	Scope of work	1	1
1.02	Switching scheme	1	1
1.03	Installation of earthing system	2	5
1.04	Erection of Sub station structure	5	7
1.05	Dismantling of Steel works	7	7
1.06	Bay equipments	7	8
1.07	Erection Testing and Commissioning of Plants & equipments	8	14
1.08	Battery and Battery Charger	14	15
1.09	Stringing and Interconnections	15	16
1.10	Cabling Material	16	17
1.11	Installation of Power & Control Cables	17	18
1.12	Detailed Specification for installation of Cables	18	20
1.13	Installation of A.C. Distribution boards	20	20
1.14	Installation of D.C. Distribution boards	20	20
1.15	Erection of Tubular Poles and Lighting Fixtures	20	20
1.16	Installation of Capacitor banks	20	22
1.17	Checks to be carried out	22	24
1.18	Codes and Standards	24	26
1.19	Interconnection of equipment using 4 inch IPS tube	26	28
	Abbreviations	29	29

## GENERAL REQUIREMENT OF ERECTION WORK

**1.01 SCOPE OF WORK:** Few salient points of the Scope of erection work for construction of 400 KV Bus Reactor, 220/132 kV and 132/33 kV sub-stations with capacitor banks. 400/220/33 kV, 400/132 KV, 220/132 kV, 220/33 kV and 132/33 kV additional transformer, augmentation transformer and feeder bays are discussed in this section. The contractor is required to carry-out erection work as stipulated in this specification which involves various construction activities viz. erection of structures, erection & installation of all out-door and in-door equipments laying of control cable, overhead stringing of conductor, ground wire, earthing, testing and commissioning etc. The contractor shall ensure the following for satisfactory execution of the work:

- i. Supervision at all the time during execution of electrical installation works covered under the contract.
- ii. The contractor shall also properly co-ordinate with representative or supervisory staff of MPPTCL and / or various equipment manufacturers, who may be present at site at the time of erection, testing and commissioning of the equipments supplied by them, in order to provide necessary guidance and supervision of erection. The testing and commissioning charges as required shall be borne by the contractor.
- iii. Transportation and unloading of the Sub-station material and equipment at the location shall be done in a safe manner so that they are not damaged or misplaced.
- iv. All the material and equipment shall be checked as per Bill of Material (BOM)
- v. All support insulators, circuit breaker poles, Transformer/reactors bushings and other fragile equipment shall preferably be handled carefully with cranes having suitable boom length and handling capacity.
- vi. Sling ropes, etc. should of sufficient strength to take the load of the equipment to be erected. They should be checked for breakages of strands before being used for the erection of equipments.
- vii. The slings should be of sufficient length to avoid any damage to insulator or other fragile equipments due to excessive swing, scratching by sling ropes, etc.
- viii. Mulmul cloth shall be used for cleaning the inside and outside of hollow insulators.
- ix. Erection of equipment shall be carried out as per and in the manner prescribed in the erection, testing and commissioning manual / instructions procedures of the manufacturer.
- x. The services of the manufacturer's Engineer, wherever necessary, may be utilized for erection, testing and commissioning of Sub-station equipment.
- xi. Wherever it is necessary to avail shut-down of energized circuits for carrying out any work, the Contractor shall submit a requisition to the MPPTCL stating the date, time and duration of the shutdown and the section / portion which is to be kept out of circuit during the shut-down.
- xii. The Contractor shall ensure that the portion of the switchyard under shutdowns has been isolated and that effective earthing of the equipment / bus bar, on which work is to be carried out has been done.

**1.02 SWITCHING SCHEME:** The switching scheme at the proposed 220 kV sub-stations shall be two main and one auxiliary bus scheme. For 132 kV substations the switching scheme shall be one main and auxiliary bus scheme.

### **1.03 INSTALLATION OF EARTHING SYSTEM:**

#### **1.03.1 BASIC REQUIREMENT**

Provision of adequate earthing system in a Substation is extremely important for the safety of the operating personnel as well as for proper system operation and performance of the protective devices. The primary requirements of a good earthing system in a Sub-station are:-

- i) The earth resistance of Substation should be as low as possible but it should not exceeds 1.0 (one) Ohm.
- ii) The Step Potential, which is the maximum value of the potential difference possible of being shunted by a human body between two accessible points on the ground separated by the distance of one pace (which may be assumed to be one metre), should be within safe limits.
- iii) Touch Potential, which is the maximum value of potential difference between a point on the ground and a point on an object likely to carry fault current such that the points can be touched by a person, should also be within safe limits.
- iv) To meet these requirements, an earthed system comprising of an earthing mat buried at a suitable depth below ground and supplemented with ground rods at suitable points is provided in the Sub-stations.
- v) All the structures & equipments in the Sub-station are connected to the earthing mat so as to ensure that under fault conditions, none of these parts is at a potential higher than that of the earthing mat.
- vi) The neutral points of different voltage levels of transformers/reactors are separately earthed at two different points. Each of these earthed points should be interconnected with the station earthing mat.

#### **1.03.2 SCOPE:**

Installation of earthing system for the substation shall be carried out as per the earth mat arrangement drawing enclosed with the bid document. The contractor's scope shall include:

- i. Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.
- ii. Installation of earthing conductor for the main earthing mat/Grid of 40 mm size M.S. round for 400 KV switchyards and welding of joints shall be as per the drawing provided by the MPPTCL.
- iii. For 220/132 KV sub-stations, installation of earthing conductor for the main earthing mat shall be of M.S. flat of size 75 X 8 mm for the 220 KV & 132 KV switchyards and welding of joints shall be as per the drawing provided by the MPPTCL.
- iv. For 132/33 kV sub-stations, installation of earthing conductor for the main earthing mat shall be of M.S. flat of size 65 X 8 mm for the 132 kV & 33 kV switchyards and welding of joints shall be as per the drawing provided by the MPPTCL.
- v. Installation of earth riser (M.S. Flat of size 50X6 mm ) connection leads to the equipments and risers on steel structures etc shall be as per drawings enclosed. The welding/brazing of risers/ leads at regular intervals

as required to the main earth mats and providing bolting joints at the equipment earthing terminals. All welded and brazed joints of riser/conductor shall be coated with bituminous paint. Galvanized steel conductors shall be touched up with the zinc rich paint where holes are drilled at site for bolting to the equipment/structures. The risers should be painted "Green".

- vi. Preparation of earthing pits as per drawing enclosed with the bid document which includes excavation (Irrespective of the soil encountered) embading of 4 No. GI Pipes of size 40 mm Dia, 3 Mtrs. long, back filling with B.C. soil (to be arranged by the contractor) free from boulders and harmful mixture. These GI pipes are to be welded with MS flats by making mesh frame and cutting of pipes as also making holes in the pipe for water seepage. The earth pit is to be connected with equipments and earth mesh at least at two points with MS round or MS flats.
- vii. Installation of galvanized earthing rods (25 mm Dia, 3.0 Mtr length) in earth by making drilling of 6" Dia. and test pits, providing connection to the main earthing grid, excavation and back filling of earthing pits with bentonite soil and all materials as required, placing the rod in position, and connecting to main earth grid conductors.
- viii. The material such as bolts, washers, nuts, screw, clamps, anchors, fasteners, etc. to complete the job in all respect shall be arranged by the contractor.
- ix. It is to be insured that the earth resistance of the sub-station is less then 1.0 (one) Ohm. If the value of earth resistance found more than the above after installation of earthing system, the same shall have to be improved to permissible limit of earth resistance by way of drilling of bore installation of MS flats of size 75x8mm. In case the earth resistance is still not improved to permissible limit, counterpoise earthing shall be provided to limit earth resistance of the sub-station, less then 1.0 (one) Ohm for which bore as specified in the document shall have to provided. The bore shall be thereafter filled with black cotton soil or bantonite clay properly. The connecting earth flat of size 75x8mm shall be buried 500mm deep in ground and BC soil shall be filled around earth flat trench.
- x. Other better way for improving the earth resistance in consultation with MPPTCL can be acceptable.

**10.03.3 DETAILS OF EARTHING SYSTEM:**

**For 400/220/33 KV Sub-Stations:**

S. No.	ITEM	SIZE	MATERIAL
1	Main earthing conductor	40 mm dia M.S. Rod/ 75X8 mm Flats.	Mild steel
2	Earthing of equipments structures, cable trays	50X6 mm Flat	Mild steel
3	Earthing rod electrodes	25 mm dia, 3000 mm long rod	Mild steel (Hot dip galvanized)
4	G.I. Pipe of 40 mm dia. 3000 mm length, 4mm thick	4 Nos. to be used for one earth pit & interconnect to each other	G.I.

**For 220/132 kV Sub-Stations:**

S. No.	ITEM	SIZE	MATERIAL
1	Main earthing conductor	75X8 mm M.S. Flats (in 220 kV & 132 kV yard)	Mild steel
2	Earthing of equipments structures, cable trays	50X6 mm Flat	Mild steel
3	Earthing rod electrodes	25 mm dia, 3000 mm long rod	Mild steel (Hot dip galvanized)
4	G.I. Pipe of 40 mm dia. 3000 mm length, 4mm thick	4 Nos. to be used for one earth pit & interconnect to each other	G.I.

**For 132/33 kV Sub-Stations:**

S. No.	ITEM	SIZE	MATERIAL
1	Main earthing conductor	65X8 mm M.S. Flats (in 132 kV & 33 kV yard)	Mild steel
2	Earthing of equipments structures, cable trays	50X6 mm Flat	Mild steel
3	Earthing rod electrodes	25 mm dia, 3000 mm long rod	Mild steel (Hot dip galvanized)
4	G.I. Pipe of 40 mm dia. 3000 mm length, 4mm thick	4 Nos. to be used for one earth pit & interconnect to each other	G.I.

**10.03.4 DETAILED SPECIFICATION FOR INSTALLATION OF EARTHING SYSTEM:**

- i. The Contractor shall install earthing conductor required for the system and individual equipment earthing. The earth mat arrangement drawing enclosed with the bid document for the purpose shall be referred. All work such as cutting, welding, bending, clamping, bolting and connecting into structures, pipes, equipment frames terminals, rails or other devices shall be in the contractor's scope of work. The contractor shall also carry-out the excavation and trenching work involved. The contractor shall be responsible for maintaining excavation, bracing shoving, pumping and disposal of water without damage to the property. The Contractor shall also back-fill and reinstate the trenches after installation of earthing conductors.
- ii. Earthing shall conform to the latest editions of the Indian Standard code of practice IS:3043 and Indian Electricity Rules Installation work shall be in accordance with the MPPTCL drawings and any change in routing, size of conductors etc. shall be subject to the prior approval of the MPPTCL.
- iii. All earthing conductors to be buried in ground shall be laid 500 mm below ground level, unless otherwise stated in the drawings. Backfill materials to be placed over buried / over earth conductor shall be free from stones and other harmful mixtures. Back fill materials shall be placed in layers of 150 mm, uniformly spread along the ditch, and tempered utilizing tempers or other approved means. Planks or other protections shall be placed over conductors in hazardous areas, after layer of earth has been placed over the conductor, but before placement of balance of backfill. If the excavated soil is found unsuitable for back filling, the contractor shall arrange for suitable soil from outside without any expense to the MPPTCL.

- iv. Metallic frames of all electrical equipments shall be earthed by two separate and distinct connections with earthing system.
- v. Neutral point of EHV transformer/reactors shall be earthed not less than two separate and distinct connections with earthing system. Neutral points of systems of different voltages, metallic enclosures and frame
- vi. Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.
- vii. Cable sheaths and armour shall be bonded to earthing system as stipulated in code of practice IS:1255. Metal pipes and conduit through which cables run shall be sufficiently bonded and earthed. For conduits, armoured cable and metal raceways, the connections to the earthing system shall be as near possible to the point where conductors in the raceways receive supply.
- viii. Flexible earthing connectors shall be provided for the moving parts.
- ix. All lighting panels, junction boxes, fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules
- x. Shield wire in substations shall be connected to the earthing grid at every alternative switchyard postal tower.
- xi. All underground connections for the earthing system shall be brazed/welded, connection to equipments and devices shall be normally of the bolted type.
- xii. All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- xiii. Earthing of portable tools, appliances and welding equipments shall conform to the code of practice for earthing, IS: 3043.
- xiv. Neutral connection shall never be used for the equipments earthing.
- xv. An earthing pad shall be provided under each operating handle of the isolator. Operating handles of the isolator and supporting structure shall be bonded together by a flexible connection and converted to the earthing grid.
- xvi. A separate earth pit shall be provided adjacent to structures supporting lightning arrestor and coupling capacitors. Separate earth connections for each unit shall be provided.
- xvii. The welding equipments and consumable items such as welding rods required for installation of the earthing system shall be arranged by the contractor.
- xviii. On completion of the installation, earth grid integrity test shall be conducted in presence of MPPTCL's representative. The earth resistance of all the earth pits shall also be tested in presence of the MPPTCL's representative. All equipments necessary for the test shall be arranged by the contractor without any extra cost to MPPTCL.

#### **1.04 ERECTION OF SUBSTATION STRUCTURE:**

**1.04.1** Assembly/erection of all type of structures including bolts, nuts, washers, step bolts, shall have to be carried-out by the contractor strictly as per directions given in the structural drawings to be provided by the MPPTCL to the successful bidder.

The work of assembly and erection includes fixing and alignment of templates for grouted/bolted type structure foundations along with tightening of structural parts with nut-bolts and washers including alignment and leveling of structures as stipulated in structural drawings. The punching of bolts shall be carried out by the contractor after



tightening of nuts & bolts. The contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the structures are plumb. Mismatching of holes, if any, noticed in the structural parts by the contractor during assembly/erection shall be rectified by the contractor free of cost by re-punching the holes, as per dimensions and positions indicated in the structural drawing.

Suitable modification shall be carried out in the equipment support structures by the contractor in order to suit fixing of accessories such as marshaling boxes junction box, surge counter etc.

**1.04.2** All steel work shall be efficiently and sufficiently protected against damage in transit from any cause whatsoever. Distorted steel received during the transport to the erection site shall not be used for erection unless the distortion are minor, which in the opinion of MPPTCL can be removed by acceptable methods. The cost of work of all such straightening shall be borne by the contractor within his quoted prices.

**1.04.3** While erection of structures on their foundations, the top surface of base concrete shall be thoroughly cleaned. The top surface of concrete and base plate of structure should match perfectly to avoid any gap in between resulting in pointed loading on foundation.

**1.04.4** The contractor shall arrange, through his own resources, all T&P items used for erection such as derrick, ropes, spanners, crowbars, hooks, tummies, hammers, punches etc. The cranes trailers, tractors, with necessary tools & tackles for loading, unloading, handling and transportation if any fabricators to erection site and erection thereof shall also be arranged by contractor.

**1.04.5** The contractor shall be responsible for the stability of the structures at all stages of its erection at site and shall make all necessary measures by the additions of temporary bracing and guying to ensure adequate resistance to wind and also the loads due to erection of equipment and their operation. Guying and bracing shall be done in such a way that it does not interfere with the movement of working of other agencies working in the area. For the purpose of guying, the contractor shall not use other structures in the vicinity which are likely to be damaged by the guy. The quoted price shall include provision of such bracings and their removal.

**1.04.6** The scope of work also includes dismantling of equipments and associated accessories and re-erection work due to modification as per the layout drawing.

**1.04.7** Contractor shall however not be relieved of his responsibility for the safety of the structures and good connections and any loss or damage occurring due to defective fabrication, erection or workmanship shall be borne by the contractor.

**1.04.8** The measurement of sub-station structures beams, equipment support structures shall be made in per metric tonne basis weight of structure for each type of complete structures excluding foundation bolts, nut and bolts other accessories.

**1.04.9** The contractor shall strictly follow, at all stage of erection of steel structures, the stipulations contained in the latest edition of IS-7205 "Indian Standard Safety code for erection of structural steel work".

**1.04.10 Setting of Foundation Bolts, Leveling and Grouting**

- i) In case of structures with foundation bolts, the template, alongwith the foundation bolts tighten on it with nuts on both sides, shall be placed on the foundation. The length of the foundation bolts above the template shall be sufficient so that all parts of the base plate assembly of the structure, washers, nuts and lock nuts can be tightened fully and 2-2 threads are left above the lock nut.

- ii) The template is leveled & centered with reference to its location on the foundation. The foundation bolts shall thereafter be grouted ensuring that there is no displacement during the placing of the concrete and use of vibrator.
- iii) In case of structures, the template shall be placed on the foundation. In case of structures, the assembled lower part of the structure is placed on the foundation. This is leveled and centered with reference to its location on the foundation. The lowest member shall thereafter be grouted ensuring that there is no displacement during the placing of the concrete and use of vibrator.
- iv) While leveling and centering the structure / template, the following points should be checked:
- v) Level of structure/ template with reference to the finished foundation level or the ground level.
- vi) The level of the structure / template with reference to level of other similar structures
- vii) Distance of centre line of the structure from the center line of other structures or from a reference point.
- viii) Centre to centre distance between structures, particularly structures which are to be connected together, for example, by a common beam.

#### **1.05 DISMANTLING OF STEEL WORKS:**

In case it is found that certain erected structures are to be dismantled for any reason whatsoever, this shall be done only with the written permission of the MPPTCL. Such structures are lowered down to the ground.

The work of additions, alterations and modifications includes cutting out certain portions or gouging of welds, cutting, grinding, fabrication welding, drilling holes, specifically for the work, straightening, removal of bends painting and touch of painting. Additions, alterations and modifications as required either before erection or after erection may have to be carried out at site. The quoted prices shall include these operations.

#### **1.06 BAY EQUIPMENTS:**

The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

- 1.06.1** All the phases are to be identified by Red, Yellow and Blue colour as per as built condition. Phase identification colour is to be provided around the top of the structure with fluorescent colour strips of 100 mm width at a height of approximately 2000mm from the finished ground level.
- 1.06.2** For equipment interconnection, the surfaces of equipment terminal pads, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.
- 1.06.3** Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.
- 1.06.4** All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.
- 1.06.5** Bending of SF6 gas/ compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

- 1.06.6** Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.
- 1.06.7** Handling of equipment shall be done strictly as per manufacturer's/supplier's instructions/instruction manual.
- 1.06.8** Handling equipment, sling ropes etc. should be tested periodically before erection for strength.
- 1.06.9** The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.
- 1.06.10** The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments like control panels AC & DC boards, chargers, PLCC panels shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer shall be strictly adhered to.

**1.07 ERECTION, TESTING AND COMMISSIONING OF PLANTS & EQUIPMENTS:**

**1.07.1** The erection of electrical equipments shall be carried-out strictly as per the instructions of the MPPTCL/ manufacturer. The contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

**1.07.2** The testing and commissioning of all plants & equipments shall be carried out by the contractor in consultation with MPPTCL without any extra cost to the MPPTCL and submit all test report for it's correctness and verification with specification.

**1.07.3** On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the MPPTCL and the contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at site. The bidder shall invariably carry out the various checks to be conducted as per the standards in vogue for commissioning of the equipments under the contract.

**1.07.4** All pre-commissioning tests should be compared with factory test results and should be submitted to MPPTCL.

**1.07.5** The additional field tests not specified in respective sections of the bid document shall be conducted by the contractor as per the instructions of the manufacturers of equipment or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the MPPTCL for approval.

**1.07.6 TRANSFORMERS/ REACTORS :**

The scope of work include supply of 315 MVA, 400/220/33 KV, 160 MVA, 220/132 kV, 100 MVA, 400/220 kV, 50 MVA, 220/33 kV and 63/40 MVA 132/33 kV power transformers & 125 MVAR, 400 KV Bus reactors. The scope of work includes complete assembly and erection 315 MVA, 400/220/33 KV, 160 MVA, 220/132 kV, 100 MVA, 400/220 kV, 50 MVA, 220/33 kV and 63/40 MVA, 132/33 kV power transformers/reactors along with connections etc. including installation of marshalling boxes, air sealing arrangement, radiators, cooling fans, oil circulating pumps & all other accessories etc for transformer/reactors including their preliminary checks, unloading/handling of transformer/reactors accessories, handling & filling of transformer/reactors oil along with associated equipments & filtration. Scope of filtration of oil includes filtration of oil after filling in transformers/reactors and filtration of oil to achieve the value before filling in the transformer/reactor as detailed in Section-I 'General Description of Project and scope of work' of Volume-I, Book-I. The neutral of power transformers/reactors and other earthing points shall be grounded as per manufacture's drawing. The contractor should ensure

that the pressure of nitrogen gas is regularly maintained upto the date of filling of transformer/reactors oil, in case, if the transformers/reactors supplied at site duly nitrogen gas filled with suitable arrangement.

In case of 400 KV Transformer/reactor, as regards tertiary winding, the contractor shall be responsible for erection of 33 KV tertiary bus arrangement & station transformer along with their associated equipments.

It may please be noted that erection of Power transformers and Reactors should be done strictly by employing crane. Contractor has to arrange a suitable crane which is having sufficient tonnage capacity and sufficient length of Boom so that erection of Power Transformer and Reactor can be done safely.

The contractor shall ensure that erection, testing and commissioning of transformers/reactors to be carried out under the supervision of the manufacturer's representative. The erection/ commissioning works shall be got done generally as per the instructions/ procedures prescribed in the Manufacturer's Erection & Installation Manual and Drawings. In this matter it may please be noted that contractor are required to submit a step by step programme for erection of transformer for our approval at the time of drawing approval for Power Transformer.

The commissioning report shall be signed by the manufacturer's representative & contractor representative.

**(A) PRE-COMMISSIONING TESTS:** On delivery /receipt, after erection at site, the transformer shall be subject to the following tests:

- (i) Immediately upon receipt of transformer at site and before unloading of transformer from trailer, core earthing , end frame earthing & tank earthing shall be checked . Only after satisfactory verification that there is no multiple core earthing in transformer, unloading of transformer shall be undertaken.
- ii) Insulation resistance test and polarisation index.
- iii) Ratio and polarity test.
- iv) DGA of oil and Dielectric, Tan-Delta, resistivity & moisture content test of oil .
- v) OLTC operational test at each tap for lower and raise operation of tap changer.
- vi) Magnetic balance test and measurement of magnetizing current.
- vii) Vector group test.
- viii) Percentage Impedance test at all taps.
- ix) Short circuit current measurement at low voltage and at all taps.
- x) Measurement of winding resistance at all taps.
- xi) Tangent – Delta, capacitance and insulations resistance tests of bushings.
- xii) Leakage current between core & tank, core & end frame , end frame & tank and between short circuited links & neutral in grounded and un grounded conditions.
- xiii) Dew point measurement & recording of pressure of Nitrogen gas.
- xiv) SFRA test
- xv) After receipt of transformer at site physical inspection shall be done for checking any physical damage to transformer tank &

accessories. Further data of Impact recorder shall be analysed for any changes before unloading of transformer.

**1.07.7 STATION TRANSFORMERS:**

Erection of 500 KVA and 200 kVA, 33/0.4 kV station transformer which includes connections, cabling, wiring with the main switch/distribution board along with filtration of oil, testing and commissioning without any extra cost to the MPPTCL.

**1.07.8 D.O. SET ASSEMBLY:**

The Erection of supporting structures, installation of D.O. sets along with accessories for protection of station transformer, interconnections etc shall be carried out by the contractor.

**1.07.9 CIRCUIT BREAKER**

It may please be noted that erection of 400 KV, 220 KV & 132 KV Circuit Breakers should be done strictly by employing crane. Contractor has to arrange a suitable crane which is having sufficient tonnage capacity and sufficient length of Boom so that erection of 400 KV, 220 KV & 132 KV Circuit Breakers can be done safely.

**(a) 400KV**

- I Erection of circuit breaker structures to the designated place and placement of all 3 Circuit Breaker poles on structure & leveling alignment.
- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box interconnecting piping works, erection of all accessories of the equipments and making inter connections.(pole to marshaling box & pole to pole).
- III Filling of SF6 for which gas cylinder and filling equipments shall be provided by the contractor.
- IV Preliminary check/test including test for leakage of air/gas.
- V If required, the Contractor shall provide suitable platform with steps on both sides for easy accessibility for monitoring the density/pressure of gas inside operating mechanism. Testing and commissioning of equipment and put it to commercial use.

**(b) 220kV**

- I Erection of circuit breaker structures to the designated place and placement of all 3 Circuit Breaker poles on structure & leveling alignment.
- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box interconnecting piping works, erection of all accessories of the equipments and making inter connections.(pole to marshaling box & pole to pole).
- III Filling of SF6 for which gas cylinder and filling equipments shall be provided by the contractor.
- IV Preliminary check/ test including test for leakage of air/gas.
- V If required, the Contractor shall provide suitable platform with steps on both sides for easy accessibility for monitoring the density/pressure of gas inside operating mechanism. Testing and commissioning of equipment and put it to commercial use.

**(c) 132kV**

- I Erection of circuit breaker structures to the designated place and placement of all 3 Circuit Breaker poles on structure & leveling alignment.

- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box interconnecting piping works, erection of all accessories of the equipments and making inter connections.(pole to marshaling box & pole to pole).
- III Filling of SF6 for which gas cylinder and filling equipments shall be provided by the contractor.
- IV Preliminary check/ test including test for leakage of air/gas.
- V If required, the Contractor shall provide suitable platform with steps on both sides for easy accessibility for monitoring the density/pressure of gas inside operating mechanism. Testing and commissioning of equipment and put it to commercial use.

**(d) 33kV**

- I Erection of vacuum circuit breaker structures to the designated place and placement of circuit breaker poles on structure & leveling alignment.
- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box, erection of all accessories of the equipments and making inter connections.
- III Preliminary check/test including test for leakage of vacuum. Testing and commissioning of equipment to put it to commercial use.

**(e) PRE-COMMISSIONING TESTS:**

1. An indicative list of tests is given below. All routine tests shall be repeated on the completely assembled breaker at site. Pre-commissioning tests, procedures and formats for circuit breakers will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the items as per the instructions of the equipment Supplier or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the MPPTCL for approval.

- a) Insulation resistance of each pole.
- b) Check adjustments, if any suggested by manufacturer.
- c) Breaker closing and opening time.
- d) Slow and Power closing operation and opening.
- e) Trip free and anti pumping operation.
- f) Minimum pick-up voltage of coils.
- g) Dynamic Contact resistance measurement.
- h) Functional checking of compressed air plant and all accessories.
- i) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
- j) Insulation resistance of control circuits, motor etc.
  
- k) Resistance of closing and tripping coils.
- l) SF6 gas leakage check.
- m) Operation check of pressure switches and gas density monitor during gas filling.
- n) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- o) Resistance measurement of main circuit.
- p) Checking of operating mechanisms.
- q) Check for annunciations in control room.

2. The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturer's representative & contractor representative.

**1.07.10 ISOLATOR WITH/ WITHOUT EARTH SWITCH (3-PHASE)**

**(a) 400KV**

- I. Erection of tubular structures for placement of 3-pole pantograph Isolator with single earth switch complete with all the three poles with tubular structure along with individual drive for each pole & earth switch along with suspension arrangement of fixed contact assembly for each pole on quadruple Moose conductor.
- II. Erection of tubular structures for placement of 3-pole pantograph Isolator without single earth switch complete with all the three poles with tubular structure along with individual drive for each pole along with suspension arrangement of fixed contact assembly for each pole on quadruple Moose conductor.
- III. Erection of isolator structure and mounting of Centre break Isolator with/without earth switch having individual drive for each pole/earth blade complete with all accessories in all 3-Phase of Isolator structure.
- IV. Erection/ mounting of control cabinet & mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation.
- V. The isolators should be electrically interlocked with Circuit Breaker.

**(b) 220KV**

- I. Placement of complete Isolator with/without earth switch on all 3-Phase of Isolator structure.
- II. Erection/ mounting of mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation. The operating mechanism of the three poles shall be well synchronized and interlocked.

**(c) 132KV**

- I. Placement of complete Isolator with/without earth switch on all 3-Phase of Isolator structure.
- II. Erection/ mounting of mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation. The operating mechanism of the three poles shall be well synchronized and interlocked.

**(d) 33KV**

- I. Placement of complete Isolator with/without earth switch on all 3-Phase of Isolator structure.
- II. Erection/ mounting of mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation. The operating mechanism of the three poles shall be well synchronized.

**(e) PRE-COMMISSIONING TESTS:**

- I. An indicative list of tests on isolator and earth switch is given below. For pre-commissioning procedures and formats for Isolators and ground switch, document will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the

items as per the instructions of the equipment Supplier or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the MPPTCL for approval.

- a) Insulation resistance of each pole.
- b) Manual and electrical operation and interlocks.
- c) Insulation resistance of control circuits and motors.
- d) Ground connections.
- e) Contact resistance.
- f) Proper alignment so as to minimise vibration during operation.
- g) Measurement of operating Torque for isolator and Earth switch.
- h) Resistance of operating and interlocks coils.
- i) Functional check of the control schematic and electrical & mechanical interlocks.
- j) 50 operations test on isolator and earth switch.
- k) Mechanical interlocked should be checked between Isolator main contacts and earth switch.

#### **1.07.11 CT/ PT/ CVT**

- I. Placement of CT in required orientation for primary connection & PT on structure including fixing of junction box & all accessories, making all inter connectors etc.
- II. Placement of CVT/coupling capacitor on structure including fixing of junction box. The coupling devices shall be mounted on structure including all accessories viz arrester, drainage coil, earth switch etc., making all inter connections between CVT/CC, LMU & PD set etc interposed between the capacitor voltage transformer and coaxial line to the PLCC transmitter/receiver

##### **1.07.11.1.1 Current Transformers:**

- a) Insulation Resistance Test for primary and secondary.
- b) Polarity test.
- c) Ratio and phase angle error identification test - checking of all ratios on all cores by primary injection of current.
- d) Dielectric test of oil (wherever applicable).
- e) Magnetising characteristics test.
- f) Tan delta and capacitance measurement.
- g) Secondary winding resistance measurement.
- h) Contact resistance measurement (wherever possible/accessible).

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere.

##### **1.07.11.1.2 Voltage Transformers/Capacitive Voltage Transformers/Coupling capacitor :**

- a) Insulation Resistance test for primary (if applicable) and secondary winding.
- b) Polarity test.
- c) Ratio test.
- d) Dielectric test of oil (wherever applicable).
- e) Tan delta and capacitance measurement of individual capacitor stacks.
- f) Secondary winding resistance measurement.

The commissioning report shall be signed by the contractor's representative.



### **1.07.12 LIGHTNING/ SURGE ARRESTER :**

Shifting and placement of lightning/surge arrester on structure including all accessories, making all inter connections, checking and installation of insulator base and surge counter.

**1.07.12.1 PRE-COMMISSIONING TESTS:** An indicative list of tests is given below.

- a) Operation checks of LA counter.
- b) Insulation resistance measurement.
- c) Capacitance and Tan delta measurement of individual stacks.
- d) Third harmonic resistive current measurement (to be conducted after energisation.)

The Contractor shall perform any additional test based on specialties of the items as per the Instructions of the equipment manufacturer or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to MPPTCL for approval.

### **1.07.13 PI/ SOLID CORE INSULATOR**

Shifting & Placement of post insulators/ solid core insulators and their connection.

### **1.07.14 WAVE TRAP**

Shifting & erection of wave trap with overhead suspension string as required alongwith other accessories and interconnections.

### **1.07.15 CONTROL & RELAY PANEL/ CARRIER COMMUNICATION PANEL:**

- I The contractor shall carry out placement of C&R panel on MS channel frame and MS channel frame shall be suitably grouted in control room as per drawing. The cutting, welding and fabrication of MS channel frame is to be done as per drawing. Proper alignment of C&R panel to be done. The earthing of C&R panel to be done.

The contractor shall also carry out placement of carrier communication panel complete with all modules and accessories including all connections grouting and earthing of panel at designated place in control room building.

- II Making of all AC/DC interconnections on terminal block for the control & relay panel in accordance with the corresponding equipment manufacturer's drawing. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.
- III Wire termination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from the terminal block.
- IV The Contractor shall be solely responsible for the completeness and correctness of the wiring and for proper functioning of the connected equipments including testing and commissioning.

Contractor shall perform any additional test based on specialties of the items as per the Instructions of the equipment manufacturer or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to MPPTCL for approval.

### **1.08 BATTERY AND BATTERY CHARGER:**

#### **(i) BATTERY:**

All batteries shall be mounted on stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand. The contractor should ensure application of petroleum jelly on the terminals of batteries after making connections.

The installation and commissioning tests of Battery shall be as recommended in Manufacturer's O&M manual/ or relevant standards. We have standard procedure for initial charging of battery set same shall be provided to successful bidder. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by the Contractor & The commissioning report shall be signed by the manufacturers representative & contractor's representative.

**(ii) BATTERY CHARGER:**

DC System shall consist of float- cum-boost charger and battery set for each of 110V and 48 V systems respectively. The following preliminary checks shall be carried out by the contractor.

1. Check name plate details according to specification
2. Check for physical damage.
3. Check connections.
4. Functional check of auxiliary devices such as alarms, indicating lamps etc.
5. Insulation test of all circuits
6. Measurement of voltage regulation
7. Measurement of Ripple voltage.

The installation and commissioning tests of Battery Charger shall be as recommended in Manufacturer's O&M manual/ or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by the Contractor & The commissioning report shall be signed by the manufacturers representative & contractor's representative.

**1.09 STRINGING AND INTERCONNECTIONS:**

**1.09.1** Detailed description of the works to be carried out is indicated in the enclosed schedule. Few important features are reproduced below –

- i. 400 KV Main – I, and Main – II bus shall be constructed with Quadruple Moose ACSR conductor which also involve jumpering, installation of spares etc.
- ii. 400 KV transfer bus shall be constructed with Twin Moose ACSR conductor which also involve jumpering, installation of spacers etc.
- iii. The equipment interconnections in 400 KV yard shall be made with 4 inch IPS tube as per respective sub-station layout/plan drawing.
- iv. Three phase stringing of overhead gantries in 400 KV yard shall be done with Twin Moose ACSR conductor.
- v. Stringing of 220 KV Side of 315 MVA transformer is to be done by twin Moose.
- vi. Stringing of overhead conductor between gantry to gantry, dropout and all jumpers for interconnecting switchyard equipments shall be single Zebra ACSR conductor except for transformer bays and all main bus isolators including fixing of insulator strings, spacers, clamps etc.
- vii. Screening by earth wire including clamps, connectors etc.
- viii. The main buses of 220, 132 & 33 kV shall be strung with twin zebra ACSR conductor (jointless) including fixing of insulator strings, post insulators, spacers, clamps etc.

- ix. Auxiliary buses of 220, 132 & 33 kV shall be strung with single zebra ACSR conductor (jointless) including fixing of insulator strings, post insulators, spacers, clamps etc.
- x. All main bus isolators interconnection shall be with twin zebra ACSR conductor including spacers and clamps etc.
- xi. The LV side of transformer bays, stringing/jumpering & interconnection of equipments upto main bus shall be with twin zebra ACSR conductor. Jumpering of main bus to all isolators (of main bus side) shall be with twin zebra ACSR conductor.

The single line diagrams &, plan and elevation drawings of the substations are given in Volume-II, Part-I/Sec.I

## **1.10 CABLING MATERIAL**

### **1.10.1 CABLE TAGS AND MARKERS**

The cable schedule shall be prepared by the contractor and submitted to MPPTCL for approval. Each cable and conduit run shall be tagged with numbers that appear in the cable schedule.

- i. 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 and of circular shape for control cables.
- ii. Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.
- iii. Cable jointing shall be carried out only if essentially required with the approval of MPPTCL.

### **1.10.2 Cable Supports and Cable Tray Mounting Arrangements:**

#### **1.10.2.1 Cable trays**

- i. The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2mm.
- ii. A 2.5 metre straight section of adequate size cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.
- iii. The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.
- iv. The supports shall be fabricated from standard structural steel members.
- v. Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other places these will be at an interval of 2000 mm.
- vi. All cable trenches should be constructed in such a way that there will not be water logging in the trenches. Also depending on the contour and gradient of the yard. As per actual site conditions.

#### **1.10.2.2 Cable Termination and Connections**

- i. The termination and connection of cables shall be done strictly in accordance with cable termination as per manufacturer's drawing and/or as directed by the MPPTCL. The termination schedule will be prepared by the contractor and it should be approved by MPPTCL.

- ii. The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.
- 1.10.3** Supply of all consumable material shall be in the scope of Contractor.
- 1.10.4** The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.
- 1.10.5** Control cable cores entering control panel/switchgear/MCCB/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.
- 1.10.6** The Contractor shall tag/ferrule control cable cores at all terminations, as instructed by MPPTCL. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.
- 1.10.7** Spare cores shall be similarly tagged with cable numbers and coiled up.
- 1.10.8** All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.
- 1.10.9** Double compression type nickel plated brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.
- 1.10.10** If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor without any extra cost, as directed by MPPTCL.
- 1.10.11** Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.
- 1.11 INSTALLATION OF POWER & CONTROL CABLES :**
- 1.11.1** The cable schedule shall be prepared by the contractor and submitted to MPPTCL for approval. Contractor shall install, connect and test the cables. The details of cables are as under:
- (a) Unarmoured Copper Control Cable:**
    - i. 2 core, 2.5 sq mm.
    - ii. 4 core, 2.5 sq mm.
    - iii. 8 core, 2.5 sq mm.
    - iv. 12 core, 2.5 sq mm.
    - v. 19 core, 2.5 sq mm.
  - (b) Armoured Copper Control Cable:**
    - i. 2 core, 2.5 sq mm,
    - ii. 4 core, 2.5 sq mm,
    - iii. 12 core, 2.5 sq mm.
    - iv. 19 core, 2.5 sq mm.
    - v. 4 core, 4.0 sq mm.
    - vi. 4 core, 10 sq mm
  - (c) Coaxial cables**
  - (d) 3.5 core, 150 Sq. mm Aluminium power cable.**

- 1.11.2 Cabling in the control room and switchyard area shall be done on angles in the trench.
- 1.11.3 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint.
- 1.11.4 The cables shall be laid on cable racks in cable trenches, vertical race ways, pulled through pipes and conduits, clamped on walls/ceilings/steel structures etc.
- 1.11.5 The cable laying shall include laying /pulling at each end shall include dressing and connection of all the cores of the cable, proper dressing of cables on cable trays/racks.
- 1.11.6 The cable termination shall be solder less crimping type, proper crimping tools of Dowell or equivalent shall be used by the contractor. The crimping tools to be used shall be subject to MPPTCL's approval.
- 1.11.7 All cable that will be laid by the contractor shall be connected at both ends to equipments, local instruments or marshalling box terminals as the case may be. The following shall also be included on the scope of work:
- 1.11.8 " Taking out gland plate ,making required number of holes in the gland plates, re-fixing of gland plates, installation of cable glands, fixing the cable gland, putting ferrules according to approved termination schedule, putting cable lugs in each core, crimping of cable lugs and connection to proper terminal as per manufacturer/ company's wiring diagram. The requisite quantity of cable plates, cable glands, cable lugs, ferrules etc. shall be arranged by the contractor at his cost."

## **1.12 DETAILED SPECIFICATION FOR INSTALLATION OF CABLES:**

**1.12.1** The contractor shall supply and install the cables in accordance with the instructions issued by the MPPTCL. The contractor's scope of work includes laying, fixing, jointing, bending and termination of cables. The contractor shall also supply necessary materials for jointing of and termination of cables. Installation and testing of copper insulated cables shall be in accordance with Indian standard code of practice IS:1255.

**1.12.2** All cable work shall be arranged to minimize risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or through wall openings or other partitions, suitable bushes of approved type shall be supplied and put into position by the contractor. If required by the Company, the contractor shall seal the bushes after laying the cable, using fire resistance material to prevent spreading of fire through each partition. Inspection on receipt , unloading, storage and handling of cables shall be in accordance with IS : 1255 and other Indian standards code of practice.

**1.12.3** Standard cable grips and reels shall be utilized for standard cable pulling . In using woven gasket type grips on lead sheathed cable, care shall be taken to avoid damage to the cable and seal , which shall be made up and maintained during cable installation. If unduly difficult pulling occurs, the contractor shall check pull required and shall suspend further pulling, until further procedure has been approved by the purchaser. Maximum full tension shall not exceed recommended value for the cable measured by tension dynamometer.

**1.12.4** After pulling cable, the contractor shall record cable identification and data neatly with water proof ink on lineal tags and shall securely attach such identification tags at such cable and for all cables.

**1.12.5** In lieu thereof, or in addition there to at the option of the MPPTCL, the contractor shall cut the same information with suitable die or stamp on durable fiber cable identification tags. Identification tags shall be attached to each cable with non corrosive wire. Said wire must be on non-ferrous material on single core power cables. Tags may be further required at intervals on long runs of cables, in cable trays and in pull boxes, cable and joint markers and PRC warning covers shall be provided, wherever required.

**1.12.6** Sharp bending and kinking of cables shall be avoided. The bending radius for the PVC insulated 650/1100 V grade, single core/ multi core armored /un-armoured type cables shall not be less than 10 D, where D is the over all diameter of the cable.

If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from MPPTCL.

**1.12.7** Power and control cables shall be laid in separate cable trays, when laid in trenches, the order of laying of cables shall be as specified below :-

- (i) AC power cables and AC control cables on lower most tiers.
- (ii) CT and CVT/PT cables on the next upper tiers.
- (iii) DC and the associated control cable on the top most and the remaining tiers.

**1.12.8** When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation between power and communication cables shall be normally 600 mm. but in any case not less than 460 mm for single core cables and 300 mm for multi core cables. Power and communication cable shall as far as possible cross at right angle to each other.

**1.12.9** Where cables cross roads, the cable shall be laid in reinforced spun concrete or steel pipes. The pipe for the cables shall be buried at not less than one meter depth.

**1.12.10** In each cable run, some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, if the cables develop fault at a later date.

**1.12.11** Jointing of cables shall be in accordance with relevant Indian Standard code of practices and the manufacture's special instructions. Materials and tools required for cable jointing work shall be arranged by the contractor. Cable shall be firmly clamped on either sides of a straight through joint at not more than 300 mm away from the joints, identification tags shall be provided at each tag and at all cable terminations. Single core cable joints shall be marked so that phase identify at each joint and can be determinate easily. The joints shall be located at the most suitable places. There shall be sufficient overlap of cable to allow for the removal of cable ends which may have been damaged.

**1.12.12** Joint holes or pits shall be of sufficient dimensions to allow the jointers to work with a much freedom as possible, when one or more cables are laid together, joints shall be arranged to be staggered by about 3 meters.

**1.12.13** Cables seals shall be examined to ascertain if they are intact and also that cable ends are not damaged. If the seals are found to be broken or lead sheath punctured, the cable ends shall not be jointed until after the due examination and testing by the MPPTCL. Before jointing is commenced, insulation resistance of both sections of cables to be jointed shall be checked to be satisfactory by megger and insulation value recorded.

**1.12.14** Special tools, clips and saddles, glands, seals, PVC sealing compound etc. wherever required shall be arranged by the contractor. The cable shall be bent using

special bending tools, approved by the Company, cable shall not be fastened or clamped close to the point of entry to the equipment which may vibrate severely. Special instructions furnished by the manufacturer shall be strictly followed :-

**1.12.15** Armour of the cables shall be bended to the earthing system of the sub-stations.

**1.12.16** All new cables shall be meggered before commissioning, using a 1000 Volt megger. Repaired cables shall not be accepted.

Cable core shall be tested by the contractor for :-

- (a) Continuity.
- (b) Armour resistance to earth.
- (c) Insulation resistance to earth.
- (d) Insulation resistance between conductors.

**1.12.17** In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall replace it at his own cost to the satisfaction of MPPTCL. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to MPPTCL, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

### **1.13 INSTALLATION OF A.C. DISTRIBUTIOIN BOARDS:**

The contractor shall carryout installation of 415V A.C. distribution board, cabling, termination, connections, tagging, earthing, etc testing and commissioning including all accessories complete in all respect to put it in commercial use without any extra cost to MPPTCL.

### **1.14 INSTALLATION OF D.C. DISTRIBUTIOIN BOARDS:**

The contractor shall carryout installation of 110 V/48 V D.C. distribution board, cabling, termination, connections, tagging, earthing, etc testing and commissioning including all accessories complete in all respect to put it in commercial use without any extra cost to MPPTCL.

The Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

### **1.15 ERECTION OF TUBULAR POLES AND LIGHTING FIXTURES:**

**1.15.1** Installation of lighting fixtures on gantries/ structures including junction boxes, lighting fixtures, AC distribution board, switches, cabling, wiring etc including all accessories complete in all respect to be carried out by the contractor to put it in commercial use.

**1.15.2** Erection of steel tubular lighting poles required for peripheral lighting along with all accessories including junction boxes, lighting fixtures, AC distribution board, switches, cabling, wiring etc including all accessories complete in all respect to put it in commercial use.

### **1.16 INSTALLATION OF CAPACITOR BANKS:**

#### **1.16.1 GENERAL INSTRUCTIONS:-**

**1.16.1.1** During erection work on capacitor banks, the capacitor should be kept shorted and earthed to prevent electric shock due to accumulated charge.

**1.16.1.2** Capacitor banks should not be switched 'on' within 5 minutes of switching off to allow the capacitor units to get discharged.

#### **1.16.2 ERECTION OF STRUCTURES OF CAPACITOR BANKS:**

- 1.16.2.1** If the members of the structures are received in loose condition the structures for the Capacitor Banks and Residual Voltage Transformers / Neutral Current Transformers should be assembled.
- 1.16.2.2** After erection of the supporting structures on the foundation, their leveling, centering and grouting must be carried out and level the top of the already erected supporting structures and should be checked for their verticality.
- 1.16.3** **ERECTION OF CAPACITOR BANKS:**
- 1.16.3.1** Erection of post insulators on the already erected structure(s).
- 1.16.3.2** Erection of the capacitor units on the already erected frames as per the erection plan of the manufacturer so that the capacitances of all the phases are balanced.
- 1.16.3.3** Interconnection of the capacitor units and phases as per manufacturer's general arrangement drawing, including fitting of external fuses if provided.
- 1.16.3.4** Fitting of the post insulators and connecting strips for jumpering as per manufacturer's general arrangement drawing.
- 1.16.4** **ERECTION OF ASSOCIATED EQUIPMENT OF CAPACITOR BANKS:**
- 1.16.4.1** Cleaning of the insulators of the Capacitor Banks and Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.4.2** Measurement of the IR values to earth of Capacitor Banks.
- 1.16.4.3** Measurement of the IR values between primary terminal to earth and primary terminal to secondary terminals of Residual Voltage Transformers/ Neutral Current Transformers.
- 1.16.4.4** Erection of the associated equipments, viz., Capacitor Banks and Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.4.5** Erection of the circuit breaker with supporting structure, current transformers and isolators as per instructions given in the document.
- 1.16.5** **CABLING & WIRING OF CAPACITOR BANKS:**
- 1.16.5.1** Laying of cables between the following:
- a) Residual Voltage Transformers / Neutral Current Transformers and the Marshalling Kiosk / Junction Box.
  - b) Marshalling Kiosk / Junction Box and Control & Relay Panel.
- 1.16.5.2** Fixing of the cables in cable glands and then fixing of the cable glands on cable gland plates in the respective equipment.
- 1.16.5.3** Connection of the cables as per schematic diagram of the Control & Relay Panel.
- 1.16.5.4** Fixing of the cables in cable trays / trenches / supports / brackets.
- 1.16.6** **PRE-COMMISSIONING CHECKS OF CAPACITOR BANKS:**
- 1.16.6.1** Proper connections of Capacitor Bank units as per manufacturer's drawings.
- 1.16.6.2** Setting of timer (5 minutes) for closing interlock for Circuit Breaker (Timer should permit closing of CB only after passage of 5 min.after tripping of CB)



- 1.16.6.3 Healthiness and rating of fuses of units of the Capacitor bank.
- 1.16.6.4 Earthing of the structures and the equipment.
- 1.16.6.5 No shorting and earthing of the Capacitor Units / Banks.
- 1.16.6.6 Oil level in the Residual Voltage Transformers / Neutral Current Transformers (if oil filled).
- 1.16.6.7 Pre-commissioning checks on circuit breaker, current transformers and isolators as per instructions detailed in the document.

**1.16.7 PRE-COMMISSIONING TESTS OF CAPACITOR BANKS:**

- 1.16.7.1 Measurement of capacitance of the three phases of the Capacitor Banks for verifying balancing.
- 1.16.7.2 Measurement of IR values to earth of Capacitor Banks.
- 1.16.7.3 Measurement of IR values between primary terminal to earth and primary terminal to secondary terminals of Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.7.4 Checking of polarity between primary & secondary windings of the Residual voltage Transformers / Neutral Current Transformers.
- 1.16.7.5 Verification of ratio between primary & secondary windings of the Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.7.6 Pre-commissioning tests on circuit breaker, current transformers and isolators as per instructions detailed in the document.

**1.17 CHECKS TO BE CARRIED OUT:**

The following checks shall be carried out as part of the installation work:-

**1.17.1 GENERAL CHECKS:**

- i. Check for physical damage. Any damage to the equipment at the time of receipt shall be reported to the owner/purchaser.
- ii. Check from the name plates/packing list that all items are as per order and specifications.
- iii. Check tightness of all joints, clamps and connecting materials.
- iv. For oil filled equipments, check for oil leakage, if any, also check oil level and top up , wherever necessary.
- v. Check earth connections.
- vi. Check cleanliness of insulator bushings.
- vii. All checks specified by the manufacturers in their drawings and manuals, literatures as well as all in the relevant codes of standards.

**1.17.2 POWER TRANSFORMERS/ REACTORS:**

**(I) PRELIMINARY CHECKS:**

- 1 Compare name plate details with the specifications.
- 2 Checks for any physical damages, in particular of bushings.
- 3 Checks tightness of all bolts, clamps & connecting terminals.
- 4 Check cleanliness of bushings.
- 5 Check of oil leakage & oil level.
- 6 Breather condition, check whether breathing line is free, silica gel is reactivated, oil is available at bottom.
- 7 Checks for clearances, particularly in case of bus ducts.
- 8 Water tightness of terminal boxes & bus ducts.

- 9 Earthing of transformer/reactor tank & neutral bushings.
- 10 Ensure that all cooler & cooler header valves are opened.
- 11 Releasing of Air from bushings, buchholz relay.
- 12 Check and record of gas pressure in conservator as well as in the gas cylinder.
- 13 Check the bushings horn gap.
- 14 Check that the transformer/reactor is correctly installed with reference to its phasing.

**1.17.3 CONTROL PANELS:**

**(I) PRELIMINARY CHECKS:**

- 1 Check name plate details of every associated equipment according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check cleanliness.
- 5 Check earth connections.

**(II) RELAYS:**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Megger all terminals to body.
- 4 Megger AC to DC terminal.

**1.17.4 CIRCUIT BREAKERS:**

**(I) PRELIMINARY CHECKS:**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check oil level, air pressure and leakage (wherever applicable).
- 5 Check of SF6 gas pressure and its leakage (wherever applicable).
- 6 Check earth connections.
- 7 Check cleanliness of insulators and bushings.
- 8 Check all moving parts are properly lubricated.
- 9 Check heaters provided.

**1.17.5 ISOLATORS:**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check cleanliness of insulators.

**1.17.6 VOLTAGE TRANSFORMER / CAPACITIVE VOLTAGE TRANSFORMERS.**

- 1 Check name plate details according to specification.
- 2 Check for any physical damage.
- 3 Check cleanliness of insulators.
- 4 Check tightness of all bolts, clamps and connecting terminals.
- 5 Check earthing connections.

**1.17.7 CURRENT TRANSFORMERS :**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check for oil level and leakages.
- 5 Check cleanliness of insulators and bushings.

**1.17.8 LIGHTENING ARRESTOR:**

- 1 Physical checking of various parts/ equipment.
- 2 Check for connections to ground and line.
- 3 Continuity check (in case of metal oxide silicon type only).
- 4 Operation check of discharge counter.

**1.17.9 CABLES:**

- 1 Check details as per specification.
- 2 Check for physical damage.
- 3 Megger test between each core and armour/sheath.
- 4 Continuity check.
- 5 Connections.

**1.17.10 415 VOLTS AC DISTRIBUTION BOARD**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connection terminals.
- 4 Check cleanliness.
- 5 Check earthing.
- 6 Megger all terminals to body.

**1.17.11 110 VOLTS DC DISTRIBUTION BOARD**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connection terminals.
- 4 Check cleanliness.
- 5 Check earthing
- 6 Megger all terminals to body.

**1.17.12 CARRIER CABINET:**

**(I) PRELIMINARY CHECKS**

- 1 Check name plate details of every associated indoor equipments according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connection terminals.
- 4 Check cleanliness.
- 5 Check earthing
- 6 Megger all terminals to body.

**1.17.13** The above mentioned works are guide line for the contractor .The contractor shall invariably carry out the various checks as proposed to be conducted by him as per the standards in vogue for testing & commissioning of the equipments under the contract.

**1.18 CODES AND STANDARDS:**

Electrical Installation work shall comply with all currently applicable statutes to the Indian Electricity Rules,. Fire Insurance Regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the contractor on this responsibility.

Unless otherwise specified, installation work shall comply with the requirements of latest editions of applicable Indian Standards.

**1.18.1** In accordance with the specific installation instructions, as shown in the manufacturer's drawings or as directed by MPPTCL, the contractor shall erect, install all

the electrical equipment included in the contract. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in the manufacturer's drawings or as stipulated by the MPPTCL. No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by MPPTCL.

**1.18.2** The contractor shall furnish all supervision, labour, erection tools, and equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install and adjust the equipment.

**1.18.3** The manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, setting of all equipment and care shall be exercised in handling to avoid destruction to stationary structures, the marring of finish or damaging of delicate instruments or other electrical parts. Adjustment shall be made as necessary to the stationary structures for plumb and level, for the sake of appearance or to avoid twisting of frames, binding of hinged members etc.

**1.18.4** In case of any doubt / misunderstanding as to correct interpretation of the manufacturer's drawings or instructions, necessary clarifications shall be obtained from the manufacture/MPPTCL. The contractor shall be held responsible for any damage to the equipment consequent to not following the manufacturer's instructions correctly.

**1.18.5** The contractor shall move all equipment into the respective buildings through the regular doors or floor openings provided specifically for lifting the equipment. The contractor shall make his own arrangement for lifting of the equipment. Crane for lifting arrangement shall not be provided by the MPPTCL.

**1.18.6** Where assemblies are supplied in more than one section, the contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. The contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All insulators and bushings shall be protected against damage during handling and installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness of the contractor shall be replaced by him at his own expense.

**1.18.7** Inspection, storage, installation of transformer/reactors shall be in accordance with the Indian Standard Code of practices IS:1866 and the Manufacturer's instructions. All commissioning tests as applicable, shall be carried out by the MPPTCL/ Manufacturer but contractor has to provide skilled / semi skilled and unskilled labourer as required for assistance.

**1.18.8** Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hose shall not be used. Circulation and filtering of oil, the heating of oil by regulated short circuit current during drying runs and sampling and testing of oil shall be in accordance with the manufacturer's instructions and IS code of practice IS:1886.

**1.18.9** Switchgear and control panels/ desks shall be installed in accordance with Indian Standard code of practice IS:3072 and the manufacturer's instructions. The switchgear panels shall be installed on finished surface or concrete or steel sills. The contractor shall installed/ align channel sills forming part of the foundations. In joining shipping sections of the switchgear / panel / control centres together, adjacent housing or panel sections of flanged throat section provided shall be bolted together when alignment has been completed. Power bus, enclosures, ground and control splices of conventional nature shall be cleaned and bolted together, being drawn up with through torque wrench of proper size or by other approved means. Tap or compound shall be applied where called for by the manufacturer's drawings. Bays of out door type unit shall be sealed in an approved manner to prevent increase of moisture.

**1.18.10** The contractor shall take utmost care in handling instruments, relays, other delicate mechanisms & equipments. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panels/ desks have been erected and aligned. The blocking materials/ mechanisms employed for the safe transit of the instruments and relays shall be removed after ensuring that the panel/ desks have been completely installed and no further movement of the same would be necessary any damaged to relays and instruments shall be immediately reported to the Company or its representative.

**1.18.11** The contractor shall under take the work of filling of SF6 gas in the circuit breakers as per the manufacturer's instructions.

**1.18.12** Care shall be taken during handling SF6 gas cylinder/ gas filling trolley. The SF6 gas and gas filling equipment shall be arranged by the contractor.

**1.18.13** The manufacturer's installation tests shall be carried out by the contractor, who shall make all necessary adjustments as specified by the manufacturer for proper functioning of the equipments. The Contractor shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage upto commissioning stage. Pre commissioning Procedures and Formats for substation bay equipment, which will be available in the respective sites and shall be referred by the contractor. However, it is contractor's responsibility to draw up and carry out such a programme duly approved by the MPPTCL.

**1.18.14** Foundation work for transformers/reactors, switchgears and other equipments will be carried out by contractor, in case minor modifications to foundations, wherever found necessary for proper installation, shall be carried out by the contractor at no extra cost.

**1.18.15** Equipment furnished with finished coats of paint shall be touched up by the contractor if their surface is soiled or marred while handling .

**1.18.16** The contractor shall supply the normal consumables, filling compounds, touch up paints etc. where required.

**1.18.17** Petroleum conducting jelly shall be applied for current carrying joints, connections, clamps etc. to avoid corrosion.

**1.18.18** Silicon polish (water repellent) shall be applied on all insulation, stacks, bushings etc. after installation and before commissioning to avoid tracking.

**1.18.19** After installation of all power and control wiring the contractor shall perform operating tests on all switchgear and panels to verify proper operation of switchgear / panels and correctness of the interconnections between various items of the equipments. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipments. Megger tests for insulation, polarity checks on the instruments transformers, operating tests on equipments and the manufacturer's installation tests shall be carried out by the contractor who shall make all necessary adjustment as specified by the contractor for proper functioning of the equipments. The various relay/meter setting adopted in various control/relay panel should be as per recommendations of manufacture and approved by MPPTCL before energizing.

**1.18.20** All switchgear, control panels, desks, etc. shall be made absolutely vermin proof.

#### **1.19 INTERCONNECTION OF EQUIPMENT USING 4 INCH IPS TUBE :**

The work of connection with Aluminum tube involves cutting, welding and jointing of Aluminum tubes available in standard lengths of 6/7 meters. The work of Aluminum bus welding is of specialized natures and shall be done as specified below-

- i. This specification highlights jointing of 4 inch IPS Aluminum Alloy Seamless hard drawn tube. All materials, consumables & non consumables , T&P jointing equipment shall be arranged by the Contractor. For jointing work in SITU trailing cables shall be arranged by the Contractor.
- ii. The welded joints shall be made by adopting the appropriate standard procedure, suitably preheating the jointing surface and creating the necessary inner atmosphere around the molten metal by Argon Gas. The procedure is very briefly described below.
- iii. The ends of the two tubes to be jointed shall be tapered so that when placed facing each other, they shall form-V shape. The angle of the Vee shall be appropriate to match the thickness of the tube and the characteristic of the alloy given above.
- iv. Prior to assembly of the joint all grease, oil, dirt, burs and foreign material shall be removed from mating surface using suitable solvent. Any surface oxide shall be removed from joint and joint are immediately prior to welding.
- v. The jointing sleeves shall be positioned centrally around the ends to be jointed and shall fit tightly inside the tube.
- vi. The jointing shall be done by using either the "Argon Gas – Shielded-Consumable-Electrode Process" or "Gas-Shielded-tungsten-arc welding process".

**1.19.1 BRIEF DESCRIPTION OF ALUMINIUM TUBE WELDING PROCESS:**

- i. Consumable electrode process:
- ii. The welding arc shall be established between the tip of the moving electrode and the work piece. The arc length shall be automatically maintained constant, independent of electrode feed speed. A suitable argon gas-shielding atmosphere shall be created around the electrode to protect the molten metal from getting the oxidized and other harmful effects.
- iii. A suitable welding equipment shall be used which may consist of an appropriate power source, wire drive and welding gun. It shall preferably have self contained water circulating system to obviate long water hoses for cooling of the welding gun and the cable.
- iv. Electrode shall be 0.04 Inch dia 4043 Aluminum alloy wire (5% silicon content). The electrode speed shall be 440 Inch per minute. Welding current shall be 150 Amp. Direct current with electrode positive (reverse polarity). The arc voltage shall be 19 volts (open circuit). Argon gas shall be of welding grade and the equipment may permit flow at a rate of 40 to 50 cubic ft. per hour. However, the flow shall be minimum permissible to produce satisfactory welds.

**1.19.2 TUNGSTON ARC PROCESS:**

- i. In this process the rate shall be struck between the tungsten electrode and the work piece. Filler metal shall be added to molten weld pool where required by the operator. As with consumable electrode process, a suitable argon gas shield shall be provided to protect the molten metal from the harmful effect of atmosphere. The equipment shall consist of a special welding transformer with a preferable minimum current rating of 400 Amps alternating current. A suitable water cooled holder shall be used.

- ii. Electrode shall consist of ¼ Inch dia pure tungsten filler metal shall be of 3/16% or ¼% dia 4043 Aluminium alloy wire. Welding current shall be 350 to 424 Amp. AC a pre-heat of 300 to 700 deg. Fahrenheit. Concurrent heating may be required to ensure that this temperature is maintained in the welding area during the full welding cycle.

**1.19.3 CUTTING AND BENDING OF ALUMINIUM TUBES :**

- i. For each jointing job, cutting of the tube is also involved. This work of cutting the Aluminium tube, welding etc. will be treated as one job per joint. (each IPS tube is in length of 6/7 meters. The tubes may be required to be cut in suitable length by the contractor for jointing jobs.
- ii. Bending of 4 Inch IPS Aluminium Tube-Angular Bends up to 90 deg. Angle bend is also involved in few cases. The Contractor may include in his quoted price the job of bending work also.

All the materials required for completion of above work including all consumable, non-consumable accessories, T&P, welding transformer, welding electrodes, argon gas (for shielding), tungsten arc welding material etc and skilled personnel shall be arranged by the contractor.

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**ABBREVIATIONS**

The following abbreviation, wherever they appear in the bid document, shall have the meaning of implications hereby assigned to them:-

ACDB	Alternate Current Distribution Board	MVA	Mega volt ampere
ACSR	Aluminium conductor steel reinforced	MI	Mild Steel
BOM	Bill of Material	NCT	Neutral Current Transformer
BC	Black Cotton	O&M	Operation and Maintenance
CC	Coupling Capacitor	PIR	Pre insertion resistor
CFL	Compact Fluorescent Lamp	RVT	Residual Voltage Transformer
CB	Circuit Breaker	PI	Post Insulator
CT	Current Transformer	PT	Potential Transformer
CVT	Capacitive Voltage Transformer	PVC	Polyvinyl Chloride
C&R Panel	Control and relay Panel	PLCC	Power line carrier communication
DCDB	Direct Current Distribution Board	RTCC	Remote Terminal Control Cubical
Dia.	Diameter	SF6	Sulfur hexa Fluoride
DO fuse	Drop out fuse	T&P	Tools and Plants
GI	Galvanised Iron		
GS	Galvanised steel		
HV	High Voltage		
IR	Insulation Resistance		
IPS Tube	International Pipe Size Tube		
KV	Kilo Voltage		
KV	Kilo Ampere		
LA	Lightning Arrester		
LV	Low Voltage		



**MADHYA PRADESH POWER TRANSMISSION CO. LTD.**

**SHAKTI BHAWAN RAMPUR: JABALPUR**



**VOLUME –IV**

**Technical Book Serial No.  
MPPTCL/TECH/PROC/11/JULY15**

**SPECIFICATION FOR ERECTION TESTING  
& COMMISSIONING OF SUB-STATIONS  
AND FEEDER BAYS**

**O/o CHIEF ENGINEER (PROCUREMENT)  
MPPTCL, JABALPUR.**

# VOLUME- IV

## SPECIFICATION & REQUIREMENT FOR INSTALLATION, ERECTION & COMMISSIONING WORK

SECTION	DESCRIPTION	PAGE NO.	
		FROM	TO
I	GENERAL REQUIREMENT OF ERECTION WORK	1	28
	ABBREVIATIONS	29	29

## INDEX

### GENERAL REQUIREMENT OF ERECTION WORK

S. No.	Description	Page No.	
		From	To
1.01	Scope of work	1	1
1.02	Switching scheme	1	1
1.03	Installation of earthing system	2	5
1.04	Erection of Sub station structure	5	7
1.05	Dismantling of Steel works	7	7
1.06	Bay equipments	7	8
1.07	Erection Testing and Commissioning of Plants & equipments	8	14
1.08	Battery and Battery Charger	14	15
1.09	Stringing and Interconnections	15	16
1.10	Cabling Material	16	17
1.11	Installation of Power & Control Cables	17	18
1.12	Detailed Specification for installation of Cables	18	20
1.13	Installation of A.C. Distribution boards	20	20
1.14	Installation of D.C. Distribution boards	20	20
1.15	Erection of Tubular Poles and Lighting Fixtures	20	20
1.16	Installation of Capacitor banks	20	22
1.17	Checks to be carried out	22	24
1.18	Codes and Standards	24	26
1.19	Interconnection of equipment using 4 inch IPS tube	26	28
	Abbreviations	29	29

## GENERAL REQUIREMENT OF ERECTION WORK

**1.01 SCOPE OF WORK:** Few salient points of the Scope of erection work for construction of 400 KV Bus Reactor, 220/132 kV and 132/33 kV sub-stations with capacitor banks. 400/220/33 kV, 400/132 KV, 220/132 kV, 220/33 kV and 132/33 kV additional transformer, augmentation transformer and feeder bays are discussed in this section. The contractor is required to carry-out erection work as stipulated in this specification which involves various construction activities viz. erection of structures, erection & installation of all out-door and in-door equipments laying of control cable, overhead stringing of conductor, ground wire, earthing, testing and commissioning etc. The contractor shall ensure the following for satisfactory execution of the work:

- i. Supervision at all the time during execution of electrical installation works covered under the contract.
- ii. The contractor shall also properly co-ordinate with representative or supervisory staff of MPPTCL and / or various equipment manufacturers, who may be present at site at the time of erection, testing and commissioning of the equipments supplied by them, in order to provide necessary guidance and supervision of erection. The testing and commissioning charges as required shall be borne by the contractor.
- iii. Transportation and unloading of the Sub-station material and equipment at the location shall be done in a safe manner so that they are not damaged or misplaced.
- iv. All the material and equipment shall be checked as per Bill of Material (BOM)
- v. All support insulators, circuit breaker poles, Transformer/reactors bushings and other fragile equipment shall preferably be handled carefully with cranes having suitable boom length and handling capacity.
- vi. Sling ropes, etc. should of sufficient strength to take the load of the equipment to be erected. They should be checked for breakages of strands before being used for the erection of equipments.
- vii. The slings should be of sufficient length to avoid any damage to insulator or other fragile equipments due to excessive swing, scratching by sling ropes, etc.
- viii. Mulmul cloth shall be used for cleaning the inside and outside of hollow insulators.
- ix. Erection of equipment shall be carried out as per and in the manner prescribed in the erection, testing and commissioning manual / instructions procedures of the manufacturer.
- x. The services of the manufacturer's Engineer, wherever necessary, may be utilized for erection, testing and commissioning of Sub-station equipment.
- xi. Wherever it is necessary to avail shut-down of energized circuits for carrying out any work, the Contractor shall submit a requisition to the MPPTCL stating the date, time and duration of the shutdown and the section / portion which is to be kept out of circuit during the shut-down.
- xii. The Contractor shall ensure that the portion of the switchyard under shutdowns has been isolated and that effective earthing of the equipment / bus bar, on which work is to be carried out has been done.

**1.02 SWITCHING SCHEME:** The switching scheme at the proposed 220 kV sub-stations shall be two main and one auxiliary bus scheme. For 132 kV substations the switching scheme shall be one main and auxiliary bus scheme.

### **1.03 INSTALLATION OF EARTHING SYSTEM:**

#### **1.03.1 BASIC REQUIREMENT**

Provision of adequate earthing system in a Substation is extremely important for the safety of the operating personnel as well as for proper system operation and performance of the protective devices. The primary requirements of a good earthing system in a Sub-station are:-

- i) The earth resistance of Substation should be as low as possible but it should not exceeds 1.0 (one) Ohm.
- ii) The Step Potential, which is the maximum value of the potential difference possible of being shunted by a human body between two accessible points on the ground separated by the distance of one pace (which may be assumed to be one metre), should be within safe limits.
- iii) Touch Potential, which is the maximum value of potential difference between a point on the ground and a point on an object likely to carry fault current such that the points can be touched by a person, should also be within safe limits.
- iv) To meet these requirements, an earthed system comprising of an earthing mat buried at a suitable depth below ground and supplemented with ground rods at suitable points is provided in the Sub-stations.
- v) All the structures & equipments in the Sub-station are connected to the earthing mat so as to ensure that under fault conditions, none of these parts is at a potential higher than that of the earthing mat.
- vi) The neutral points of different voltage levels of transformers/reactors are separately earthed at two different points. Each of these earthed points should be interconnected with the station earthing mat.

#### **1.03.2 SCOPE:**

Installation of earthing system for the substation shall be carried out as per the earth mat arrangement drawing enclosed with the bid document. The contractor's scope shall include:

- i. Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.
- ii. Installation of earthing conductor for the main earthing mat/Grid of 40 mm size M.S. round for 400 KV switchyards and welding of joints shall be as per the drawing provided by the MPPTCL.
- iii. For 220/132 KV sub-stations, installation of earthing conductor for the main earthing mat shall be of M.S. flat of size 75 X 8 mm for the 220 KV & 132 KV switchyards and welding of joints shall be as per the drawing provided by the MPPTCL.
- iv. For 132/33 kV sub-stations, installation of earthing conductor for the main earthing mat shall be of M.S. flat of size 65 X 8 mm for the 132 kV & 33 kV switchyards and welding of joints shall be as per the drawing provided by the MPPTCL.
- v. Installation of earth riser (M.S. Flat of size 50X6 mm ) connection leads to the equipments and risers on steel structures etc shall be as per drawings enclosed. The welding/brazing of risers/ leads at regular intervals

as required to the main earth mats and providing bolting joints at the equipment earthing terminals. All welded and brazed joints of riser/conductor shall be coated with bituminous paint. Galvanized steel conductors shall be touched up with the zinc rich paint where holes are drilled at site for bolting to the equipment/structures. The risers should be painted "Green".

- vi. Preparation of earthing pits as per drawing enclosed with the bid document which includes excavation (Irrespective of the soil encountered) embading of 4 No. GI Pipes of size 40 mm Dia, 3 Mtrs. long, back filling with B.C. soil (to be arranged by the contractor) free from boulders and harmful mixture. These GI pipes are to be welded with MS flats by making mesh frame and cutting of pipes as also making holes in the pipe for water seepage. The earth pit is to be connected with equipments and earth mesh at least at two points with MS round or MS flats.
- vii. Installation of galvanized earthing rods (25 mm Dia, 3.0 Mtr length) in earth by making drilling of 6" Dia. and test pits, providing connection to the main earthing grid, excavation and back filling of earthing pits with bentonite soil and all materials as required, placing the rod in position, and connecting to main earth grid conductors.
- viii. The material such as bolts, washers, nuts, screw, clamps, anchors, fasteners, etc. to complete the job in all respect shall be arranged by the contractor.
- ix. It is to be insured that the earth resistance of the sub-station is less then 1.0 (one) Ohm. If the value of earth resistance found more than the above after installation of earthing system, the same shall have to be improved to permissible limit of earth resistance by way of drilling of bore installation of MS flats of size 75x8mm. In case the earth resistance is still not improved to permissible limit, counterpoise earthing shall be provided to limit earth resistance of the sub-station, less then 1.0 (one) Ohm for which bore as specified in the document shall have to provided. The bore shall be thereafter filled with black cotton soil or bantonite clay properly. The connecting earth flat of size 75x8mm shall be buried 500mm deep in ground and BC soil shall be filled around earth flat trench.
- x. Other better way for improving the earth resistance in consultation with MPPTCL can be acceptable.

### 10.03.3 DETAILS OF EARTHING SYSTEM:

#### For 400/220/33 KV Sub-Stations:

S. No.	ITEM	SIZE	MATERIAL
1	Main earthing conductor	40 mm dia M.S. Rod/ 75X8 mm Flats.	Mild steel
2	Earthing of equipments structures, cable trays	50X6 mm Flat	Mild steel
3	Earthing rod electrodes	25 mm dia, 3000 mm long rod	Mild steel (Hot dip galvanized)
4	G.I. Pipe of 40 mm dia. 3000 mm length, 4mm thick	4 Nos. to be used for one earth pit & interconnect to each other	G.I.

**For 220/132 kV Sub-Stations:**

S. No.	ITEM	SIZE	MATERIAL
1	Main earthing conductor	75X8 mm M.S. Flats (in 220 kV & 132 kV yard)	Mild steel
2	Earthing of equipments structures, cable trays	50X6 mm Flat	Mild steel
3	Earthing rod electrodes	25 mm dia, 3000 mm long rod	Mild steel (Hot dip galvanized)
4	G.I. Pipe of 40 mm dia. 3000 mm length, 4mm thick	4 Nos. to be used for one earth pit & interconnect to each other	G.I.

**For 132/33 kV Sub-Stations:**

S. No.	ITEM	SIZE	MATERIAL
1	Main earthing conductor	65X8 mm M.S. Flats (in 132 kV & 33 kV yard)	Mild steel
2	Earthing of equipments structures, cable trays	50X6 mm Flat	Mild steel
3	Earthing rod electrodes	25 mm dia, 3000 mm long rod	Mild steel (Hot dip galvanized)
4	G.I. Pipe of 40 mm dia. 3000 mm length, 4mm thick	4 Nos. to be used for one earth pit & interconnect to each other	G.I.

**10.03.4 DETAILED SPECIFICATION FOR INSTALLATION OF EARTHING SYSTEM:**

- i. The Contractor shall install earthing conductor required for the system and individual equipment earthing. The earth mat arrangement drawing enclosed with the bid document for the purpose shall be referred. All work such as cutting, welding, bending, clamping, bolting and connecting into structures, pipes, equipment frames terminals, rails or other devices shall be in the contractor's scope of work. The contractor shall also carry-out the excavation and trenching work involved. The contractor shall be responsible for maintaining excavation, bracing shoving, pumping and disposal of water without damage to the property. The Contractor shall also back-fill and reinstate the trenches after installation of earthing conductors.
- ii. Earthing shall conform to the latest editions of the Indian Standard code of practice IS:3043 and Indian Electricity Rules Installation work shall be in accordance with the MPPTCL drawings and any change in routing, size of conductors etc. shall be subject to the prior approval of the MPPTCL.
- iii. All earthing conductors to be buried in ground shall be laid 500 mm below ground level, unless otherwise stated in the drawings. Backfill materials to be placed over buried / over earth conductor shall be free from stones and other harmful mixtures. Back fill materials shall be placed in layers of 150 mm, uniformly spread along the ditch, and tempered utilizing tempers or other approved means. Planks or other protections shall be placed over conductors in hazardous areas, after layer of earth has been placed over the conductor, but before placement of balance of backfill. If the excavated soil is found unsuitable for back filling, the contractor shall arrange for suitable soil from outside without any expense to the MPPTCL.

- iv. Metallic frames of all electrical equipments shall be earthed by two separate and distinct connections with earthing system.
- v. Neutral point of EHV transformer/reactors shall be earthed not less than two separate and distinct connections with earthing system. Neutral points of systems of different voltages, metallic enclosures and frame
- vi. Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.
- vii. Cable sheaths and armour shall be bonded to earthing system as stipulated in code of practice IS:1255. Metal pipes and conduit through which cables run shall be sufficiently bonded and earthed. For conduits, armoured cable and metal raceways, the connections to the earthing system shall be as near possible to the point where conductors in the raceways receive supply.
- viii. Flexible earthing connectors shall be provided for the moving parts.
- ix. All lighting panels, junction boxes, fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules
- x. Shield wire in substations shall be connected to the earthing grid at every alternative switchyard postal tower.
- xi. All underground connections for the earthing system shall be brazed/welded, connection to equipments and devices shall be normally of the bolted type.
- xii. All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- xiii. Earthing of portable tools, appliances and welding equipments shall conform to the code of practice for earthing, IS: 3043.
- xiv. Neutral connection shall never be used for the equipments earthing.
- xv. An earthing pad shall be provided under each operating handle of the isolator. Operating handles of the isolator and supporting structure shall be bonded together by a flexible connection and converted to the earthing grid.
- xvi. A separate earth pit shall be provided adjacent to structures supporting lightning arrestor and coupling capacitors. Separate earth connections for each unit shall be provided.
- xvii. The welding equipments and consumable items such as welding rods required for installation of the earthing system shall be arranged by the contractor.
- xviii. On completion of the installation, earth grid integrity test shall be conducted in presence of MPPTCL's representative. The earth resistance of all the earth pits shall also be tested in presence of the MPPTCL's representative. All equipments necessary for the test shall be arranged by the contractor without any extra cost to MPPTCL.

#### **1.04 ERECTION OF SUBSTATION STRUCTURE:**

**1.04.1** Assembly/erection of all type of structures including bolts, nuts, washers, step bolts, shall have to be carried-out by the contractor strictly as per directions given in the structural drawings to be provided by the MPPTCL to the successful bidder.

The work of assembly and erection includes fixing and alignment of templates for grouted/bolted type structure foundations along with tightening of structural parts with nut-bolts and washers including alignment and leveling of structures as stipulated in structural drawings. The punching of bolts shall be carried out by the contractor after



tightening of nuts & bolts. The contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the structures are plumb. Mismatching of holes, if any, noticed in the structural parts by the contractor during assembly/erection shall be rectified by the contractor free of cost by re-punching the holes, as per dimensions and positions indicated in the structural drawing.

Suitable modification shall be carried out in the equipment support structures by the contractor in order to suit fixing of accessories such as marshaling boxes junction box, surge counter etc.

**1.04.2** All steel work shall be efficiently and sufficiently protected against damage in transit from any cause whatsoever. Distorted steel received during the transport to the erection site shall not be used for erection unless the distortion are minor, which in the opinion of MPPTCL can be removed by acceptable methods. The cost of work of all such straightening shall be borne by the contractor within his quoted prices.

**1.04.3** While erection of structures on their foundations, the top surface of base concrete shall be thoroughly cleaned. The top surface of concrete and base plate of structure should match perfectly to avoid any gap in between resulting in pointed loading on foundation.

**1.04.4** The contractor shall arrange, through his own resources, all T&P items used for erection such as derrick, ropes, spanners, crowbars, hooks, tummys, hammers, punches etc. The cranes trailers, tractors, with necessary tools & tackles for loading, unloading, handling and transportation if any fabricators to erection site and erection thereof shall also be arranged by contractor.

**1.04.5** The contractor shall be responsible for the stability of the structures at all stages of its erection at site and shall make all necessary measures by the additions of temporary bracing and guying to ensure adequate resistance to wind and also the loads due to erection of equipment and their operation. Guying and bracing shall be done in such a way that it does not interfere with the movement of working of other agencies working in the area. For the purpose of guying, the contractor shall not use other structures in the vicinity which are likely to be damaged by the guy. The quoted price shall include provision of such bracings and their removal.

**1.04.6** The scope of work also includes dismantling of equipments and associated accessories and re-erection work due to modification as per the layout drawing.

**1.04.7** Contractor shall however not be relieved of his responsibility for the safety of the structures and good connections and any loss or damage occurring due to defective fabrication, erection or workmanship shall be borne by the contractor.

**1.04.8** The measurement of sub-station structures beams, equipment support structures shall be made in per metric tonne basis weight of structure for each type of complete structures excluding foundation bolts, nut and bolts other accessories.

**1.04.9** The contractor shall strictly follow, at all stage of erection of steel structures, the stipulations contained in the latest edition of IS-7205 "Indian Standard Safety code for erection of structural steel work".

**1.04.10 Setting of Foundation Bolts, Leveling and Grouting**

- i) In case of structures with foundation bolts, the template, alongwith the foundation bolts tighten on it with nuts on both sides, shall be placed on the foundation. The length of the foundation bolts above the template shall be sufficient so that all parts of the base plate assembly of the structure, washers, nuts and lock nuts can be tightened fully and 2-2 threads are left above the lock nut.

- ii) The template is leveled & centered with reference to its location on the foundation. The foundation bolts shall thereafter be grouted ensuring that there is no displacement during the placing of the concrete and use of vibrator.
- iii) In case of structures, the template shall be placed on the foundation. In case of structures, the assembled lower part of the structure is placed on the foundation. This is leveled and centered with reference to its location on the foundation. The lowest member shall thereafter be grouted ensuring that there is no displacement during the placing of the concrete and use of vibrator.
- iv) While leveling and centering the structure / template, the following points should be checked:
- v) Level of structure/ template with reference to the finished foundation level or the ground level.
- vi) The level of the structure / template with reference to level of other similar structures
- vii) Distance of centre line of the structure from the center line of other structures or from a reference point.
- viii) Centre to centre distance between structures, particularly structures which are to be connected together, for example, by a common beam.

#### **1.05 DISMANTLING OF STEEL WORKS:**

In case it is found that certain erected structures are to be dismantled for any reason whatsoever, this shall be done only with the written permission of the MPPTCL. Such structures are lowered down to the ground.

The work of additions, alterations and modifications includes cutting out certain portions or gouging of welds, cutting, grinding, fabrication welding, drilling holes, specifically for the work, straightening, removal of bends painting and touch of painting. Additions, alterations and modifications as required either before erection or after erection may have to be carried out at site. The quoted prices shall include these operations.

#### **1.06 BAY EQUIPMENTS:**

The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

- 1.06.1** All the phases are to be identified by Red, Yellow and Blue colour as per as built condition. Phase identification colour is to be provided around the top of the structure with fluorescent colour strips of 100 mm width at a height of approximately 2000mm from the finished ground level.
- 1.06.2** For equipment interconnection, the surfaces of equipment terminal pads, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.
- 1.06.3** Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.
- 1.06.4** All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.
- 1.06.5** Bending of SF6 gas/ compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

- 1.06.6** Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.
- 1.06.7** Handling of equipment shall be done strictly as per manufacturer's/supplier's instructions/instruction manual.
- 1.06.8** Handling equipment, sling ropes etc. should be tested periodically before erection for strength.
- 1.06.9** The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.
- 1.06.10** The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments like control panels AC & DC boards, chargers, PLCC panels shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer shall be strictly adhered to.

**1.07 ERECTION, TESTING AND COMMISSIONING OF PLANTS & EQUIPMENTS:**

**1.07.1** The erection of electrical equipments shall be carried-out strictly as per the instructions of the MPPTCL/ manufacturer. The contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

**1.07.2** The testing and commissioning of all plants & equipments shall be carried out by the contractor in consultation with MPPTCL without any extra cost to the MPPTCL and submit all test report for it's correctness and verification with specification.

**1.07.3** On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the MPPTCL and the contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at site. The bidder shall invariably carry out the various checks to be conducted as per the standards in vogue for commissioning of the equipments under the contract.

**1.07.4** All pre-commissioning tests should be compared with factory test results and should be submitted to MPPTCL.

**1.07.5** The additional field tests not specified in respective sections of the bid document shall be conducted by the contractor as per the instructions of the manufacturers of equipment or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the MPPTCL for approval.

**1.07.6 TRANSFORMERS/ REACTORS :**

The scope of work include supply of 315 MVA, 400/220/33 KV, 160 MVA, 220/132 kV, 100 MVA, 400/220 kV, 50 MVA, 220/33 kV and 63/40 MVA 132/33 kV power transformers & 125 MVAR, 400 KV Bus reactors. The scope of work includes complete assembly and erection 315 MVA, 400/220/33 KV, 160 MVA, 220/132 kV, 100 MVA, 400/220 kV, 50 MVA, 220/33 kV and 63/40 MVA, 132/33 kV power transformers/reactors along with connections etc. including installation of marshalling boxes, air sealing arrangement, radiators, cooling fans, oil circulating pumps & all other accessories etc for transformer/reactors including their preliminary checks, unloading/handling of transformer/reactors accessories, handling & filling of transformer/reactors oil along with associated equipments & filtration. Scope of filtration of oil includes filtration of oil after filling in transformers/reactors and filtration of oil to achieve the value before filling in the transformer/reactor as detailed in Section-I 'General Description of Project and scope of work' of Volume-I, Book-I. The neutral of power transformers/reactors and other earthing points shall be grounded as per manufacture's drawing. The contractor should ensure

that the pressure of nitrogen gas is regularly maintained upto the date of filling of transformer/reactors oil, in case, if the transformers/reactors supplied at site duly nitrogen gas filled with suitable arrangement.

In case of 400 KV Transformer/reactor, as regards tertiary winding, the contractor shall be responsible for erection of 33 KV tertiary bus arrangement & station transformer along with their associated equipments.

It may please be noted that erection of Power transformers and Reactors should be done strictly by employing crane. Contractor has to arrange a suitable crane which is having sufficient tonnage capacity and sufficient length of Boom so that erection of Power Transformer and Reactor can be done safely.

The contractor shall ensure that erection, testing and commissioning of transformers/reactors to be carried out under the supervision of the manufacturer's representative. The erection/ commissioning works shall be got done generally as per the instructions/ procedures prescribed in the Manufacturer's Erection & Installation Manual and Drawings. In this matter it may please be noted that contractor are required to submit a step by step programme for erection of transformer for our approval at the time of drawing approval for Power Transformer.

The commissioning report shall be signed by the manufacturer's representative & contractor representative.

**(A) PRE-COMMISSIONING TESTS:** On delivery /receipt, after erection at site, the transformer shall be subject to the following tests:

- (i) Immediately upon receipt of transformer at site and before unloading of transformer from trailer, core earthing , end frame earthing & tank earthing shall be checked . Only after satisfactory verification that there is no multiple core earthing in transformer, unloading of transformer shall be undertaken.
- ii) Insulation resistance test and polarisation index.
- iii) Ratio and polarity test.
- iv) DGA of oil and Dielectric, Tan-Delta, resistivity & moisture content test of oil .
- v) OLTC operational test at each tap for lower and raise operation of tap changer.
- vi) Magnetic balance test and measurement of magnetizing current.
- vii) Vector group test.
- viii) Percentage Impedance test at all taps.
- ix) Short circuit current measurement at low voltage and at all taps.
- x) Measurement of winding resistance at all taps.
- xi) Tangent – Delta, capacitance and insulations resistance tests of bushings.
- xii) Leakage current between core & tank, core & end frame , end frame & tank and between short circuited links & neutral in grounded and un grounded conditions.
- xiii) Dew point measurement & recording of pressure of Nitrogen gas.
- xiv) SFRA test
- xv) After receipt of transformer at site physical inspection shall be done for checking any physical damage to transformer tank &

accessories. Further data of Impact recorder shall be analysed for any changes before unloading of transformer.

**1.07.7 STATION TRANSFORMERS:**

Erection of 500 KVA and 200 kVA, 33/0.4 kV station transformer which includes connections, cabling, wiring with the main switch/distribution board along with filtration of oil, testing and commissioning without any extra cost to the MPPTCL.

**1.07.8 D.O. SET ASSEMBLY:**

The Erection of supporting structures, installation of D.O. sets along with accessories for protection of station transformer, interconnections etc shall be carried out by the contractor.

**1.07.9 CIRCUIT BREAKER**

It may please be noted that erection of 400 KV, 220 KV & 132 KV Circuit Breakers should be done strictly by employing crane. Contractor has to arrange a suitable crane which is having sufficient tonnage capacity and sufficient length of Boom so that erection of 400 KV, 220 KV & 132 KV Circuit Breakers can be done safely.

**(a) 400KV**

- I Erection of circuit breaker structures to the designated place and placement of all 3 Circuit Breaker poles on structure & leveling alignment.
- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box interconnecting piping works, erection of all accessories of the equipments and making inter connections.(pole to marshaling box & pole to pole).
- III Filling of SF6 for which gas cylinder and filling equipments shall be provided by the contractor.
- IV Preliminary check/test including test for leakage of air/gas.
- V If required, the Contractor shall provide suitable platform with steps on both sides for easy accessibility for monitoring the density/pressure of gas inside operating mechanism. Testing and commissioning of equipment and put it to commercial use.

**(b) 220kV**

- I Erection of circuit breaker structures to the designated place and placement of all 3 Circuit Breaker poles on structure & leveling alignment.
- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box interconnecting piping works, erection of all accessories of the equipments and making inter connections.(pole to marshaling box & pole to pole).
- III Filling of SF6 for which gas cylinder and filling equipments shall be provided by the contractor.
- IV Preliminary check/ test including test for leakage of air/gas.
- V If required, the Contractor shall provide suitable platform with steps on both sides for easy accessibility for monitoring the density/pressure of gas inside operating mechanism. Testing and commissioning of equipment and put it to commercial use.

**(c) 132kV**

- I Erection of circuit breaker structures to the designated place and placement of all 3 Circuit Breaker poles on structure & leveling alignment.

- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box interconnecting piping works, erection of all accessories of the equipments and making inter connections.(pole to marshaling box & pole to pole).
- III Filling of SF6 for which gas cylinder and filling equipments shall be provided by the contractor.
- IV Preliminary check/ test including test for leakage of air/gas.
- V If required, the Contractor shall provide suitable platform with steps on both sides for easy accessibility for monitoring the density/pressure of gas inside operating mechanism. Testing and commissioning of equipment and put it to commercial use.

**(d) 33kV**

- I Erection of vacuum circuit breaker structures to the designated place and placement of circuit breaker poles on structure & leveling alignment.
- II Complete assembly of circuit breaker including erection of control cabinet & mechanism box, erection of all accessories of the equipments and making inter connections.
- III Preliminary check/test including test for leakage of vacuum. Testing and commissioning of equipment to put it to commercial use.

**(e) PRE-COMMISSIONING TESTS:**

1. An indicative list of tests is given below. All routine tests shall be repeated on the completely assembled breaker at site. Pre-commissioning tests, procedures and formats for circuit breakers will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the items as per the instructions of the equipment Supplier or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the MPPTCL for approval.

- a) Insulation resistance of each pole.
- b) Check adjustments, if any suggested by manufacturer.
- c) Breaker closing and opening time.
- d) Slow and Power closing operation and opening.
- e) Trip free and anti pumping operation.
- f) Minimum pick-up voltage of coils.
- g) Dynamic Contact resistance measurement.
- h) Functional checking of compressed air plant and all accessories.
- i) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
- j) Insulation resistance of control circuits, motor etc.
  
- k) Resistance of closing and tripping coils.
- l) SF6 gas leakage check.
- m) Operation check of pressure switches and gas density monitor during gas filling.
- n) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- o) Resistance measurement of main circuit.
- p) Checking of operating mechanisms.
- q) Check for annunciations in control room.

2. The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturer's representative & contractor representative.

**1.07.10 ISOLATOR WITH/ WITHOUT EARTH SWITCH (3-PHASE)**

**(a) 400KV**

- I. Erection of tubular structures for placement of 3-pole pantograph Isolator with single earth switch complete with all the three poles with tubular structure along with individual drive for each pole & earth switch along with suspension arrangement of fixed contact assembly for each pole on quadruple Moose conductor.
- II. Erection of tubular structures for placement of 3-pole pantograph Isolator without single earth switch complete with all the three poles with tubular structure along with individual drive for each pole along with suspension arrangement of fixed contact assembly for each pole on quadruple Moose conductor.
- III. Erection of isolator structure and mounting of Centre break Isolator with/without earth switch having individual drive for each pole/earth blade complete with all accessories in all 3-Phase of Isolator structure.
- IV. Erection/ mounting of control cabinet & mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation.
- V. The isolators should be electrically interlocked with Circuit Breaker.

**(b) 220KV**

- I. Placement of complete Isolator with/without earth switch on all 3-Phase of Isolator structure.
- II. Erection/ mounting of mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation. The operating mechanism of the three poles shall be well synchronized and interlocked.

**(c) 132KV**

- I. Placement of complete Isolator with/without earth switch on all 3-Phase of Isolator structure.
- II. Erection/ mounting of mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation. The operating mechanism of the three poles shall be well synchronized and interlocked.

**(d) 33KV**

- I. Placement of complete Isolator with/without earth switch on all 3-Phase of Isolator structure.
- II. Erection/ mounting of mechanism box, interconnection, piping alignment of contacts & all associated activities to make the installation complete including checking of successful mechanical and electrical operation. The operating mechanism of the three poles shall be well synchronized.

**(e) PRE-COMMISSIONING TESTS:**

- I. An indicative list of tests on isolator and earth switch is given below. For pre-commissioning procedures and formats for Isolators and ground switch, document will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the

items as per the instructions of the equipment Supplier or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the MPPTCL for approval.

- a) Insulation resistance of each pole.
- b) Manual and electrical operation and interlocks.
- c) Insulation resistance of control circuits and motors.
- d) Ground connections.
- e) Contact resistance.
- f) Proper alignment so as to minimise vibration during operation.
- g) Measurement of operating Torque for isolator and Earth switch.
- h) Resistance of operating and interlocks coils.
- i) Functional check of the control schematic and electrical & mechanical interlocks.
- j) 50 operations test on isolator and earth switch.
- k) Mechanical interlocked should be checked between Isolator main contacts and earth switch.

#### **1.07.11 CT/ PT/ CVT**

- I. Placement of CT in required orientation for primary connection & PT on structure including fixing of junction box & all accessories, making all inter connectors etc.
- II. Placement of CVT/coupling capacitor on structure including fixing of junction box. The coupling devices shall be mounted on structure including all accessories viz arrester, drainage coil, earth switch etc., making all inter connections between CVT/CC, LMU & PD set etc interposed between the capacitor voltage transformer and coaxial line to the PLCC transmitter/receiver

##### **1.07.11.1.1 Current Transformers:**

- a) Insulation Resistance Test for primary and secondary.
- b) Polarity test.
- c) Ratio and phase angle error identification test - checking of all ratios on all cores by primary injection of current.
- d) Dielectric test of oil (wherever applicable).
- e) Magnetising characteristics test.
- f) Tan delta and capacitance measurement.
- g) Secondary winding resistance measurement.
- h) Contact resistance measurement (wherever possible/accessible).

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere.

##### **1.07.11.1.2 Voltage Transformers/Capacitive Voltage Transformers/Coupling capacitor :**

- a) Insulation Resistance test for primary (if applicable) and secondary winding.
- b) Polarity test.
- c) Ratio test.
- d) Dielectric test of oil (wherever applicable).
- e) Tan delta and capacitance measurement of individual capacitor stacks.
- f) Secondary winding resistance measurement.

The commissioning report shall be signed by the contractor's representative.



### **1.07.12 LIGHTNING/ SURGE ARRESTER :**

Shifting and placement of lightning/surge arrester on structure including all accessories, making all inter connections, checking and installation of insulator base and surge counter.

**1.07.12.1 PRE-COMMISSIONING TESTS:** An indicative list of tests is given below.

- a) Operation checks of LA counter.
- b) Insulation resistance measurement.
- c) Capacitance and Tan delta measurement of individual stacks.
- d) Third harmonic resistive current measurement (to be conducted after energisation.)

The Contractor shall perform any additional test based on specialties of the items as per the Instructions of the equipment manufacturer or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to MPPTCL for approval.

### **1.07.13 PI/ SOLID CORE INSULATOR**

Shifting & Placement of post insulators/ solid core insulators and their connection.

### **1.07.14 WAVE TRAP**

Shifting & erection of wave trap with overhead suspension string as required alongwith other accessories and interconnections.

### **1.07.15 CONTROL & RELAY PANEL/ CARRIER COMMUNICATION PANEL:**

- I The contractor shall carry out placement of C&R panel on MS channel frame and MS channel frame shall be suitably grouted in control room as per drawing. The cutting, welding and fabrication of MS channel frame is to be done as per drawing. Proper alignment of C&R panel to be done. The earthing of C&R panel to be done.

The contractor shall also carry out placement of carrier communication panel complete with all modules and accessories including all connections grouting and earthing of panel at designated place in control room building.

- II Making of all AC/DC interconnections on terminal block for the control & relay panel in accordance with the corresponding equipment manufacturer's drawing. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.
- III Wire termination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from the terminal block.
- IV The Contractor shall be solely responsible for the completeness and correctness of the wiring and for proper functioning of the connected equipments including testing and commissioning.

Contractor shall perform any additional test based on specialties of the items as per the Instructions of the equipment manufacturer or MPPTCL without any extra cost to the MPPTCL. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to MPPTCL for approval.

### **1.08 BATTERY AND BATTERY CHARGER:**

#### **(i) BATTERY:**

All batteries shall be mounted on stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand. The contractor should ensure application of petroleum jelly on the terminals of batteries after making connections.

The installation and commissioning tests of Battery shall be as recommended in Manufacturer's O&M manual/ or relevant standards. We have standard procedure for initial charging of battery set same shall be provided to successful bidder. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by the Contractor & The commissioning report shall be signed by the manufacturers representative & contractor's representative.

**(ii) BATTERY CHARGER:**

DC System shall consist of float- cum-boost charger and battery set for each of 110V and 48 V systems respectively. The following preliminary checks shall be carried out by the contractor.

1. Check name plate details according to specification
2. Check for physical damage.
3. Check connections.
4. Functional check of auxiliary devices such as alarms, indicating lamps etc.
5. Insulation test of all circuits
6. Measurement of voltage regulation
7. Measurement of Ripple voltage.

The installation and commissioning tests of Battery Charger shall be as recommended in Manufacturer's O&M manual/ or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by the Contractor & The commissioning report shall be signed by the manufacturers representative & contractor's representative.

**1.09 STRINGING AND INTERCONNECTIONS:**

**1.09.1** Detailed description of the works to be carried out is indicated in the enclosed schedule. Few important features are reproduced below –

- i. 400 KV Main – I, and Main – II bus shall be constructed with Quadruple Moose ACSR conductor which also involve jumpering, installation of spares etc.
- ii. 400 KV transfer bus shall be constructed with Twin Moose ACSR conductor which also involve jumpering, installation of spacers etc.
- iii. The equipment interconnections in 400 KV yard shall be made with 4 inch IPS tube as per respective sub-station layout/plan drawing.
- iv. Three phase stringing of overhead gantries in 400 KV yard shall be done with Twin Moose ACSR conductor.
- v. Stringing of 220 KV Side of 315 MVA transformer is to be done by twin Moose.
- vi. Stringing of overhead conductor between gantry to gantry, dropout and all jumpers for interconnecting switchyard equipments shall be single Zebra ACSR conductor except for transformer bays and all main bus isolators including fixing of insulator strings, spacers, clamps etc.
- vii. Screening by earth wire including clamps, connectors etc.
- viii. The main buses of 220, 132 & 33 kV shall be strung with twin zebra ACSR conductor (jointless) including fixing of insulator strings, post insulators, spacers, clamps etc.

- ix. Auxiliary buses of 220, 132 & 33 kV shall be strung with single zebra ACSR conductor (jointless) including fixing of insulator strings, post insulators, spacers, clamps etc.
- x. All main bus isolators interconnection shall be with twin zebra ACSR conductor including spacers and clamps etc.
- xi. The LV side of transformer bays, stringing/jumpering & interconnection of equipments upto main bus shall be with twin zebra ACSR conductor. Jumpering of main bus to all isolators (of main bus side) shall be with twin zebra ACSR conductor.

The single line diagrams &, plan and elevation drawings of the substations are given in Volume-II, Part-I/Sec.I

## **1.10 CABLING MATERIAL**

### **1.10.1 CABLE TAGS AND MARKERS**

The cable schedule shall be prepared by the contractor and submitted to MPPTCL for approval. Each cable and conduit run shall be tagged with numbers that appear in the cable schedule.

- i. 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 and of circular shape for control cables.
- ii. Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.
- iii. Cable jointing shall be carried out only if essentially required with the approval of MPPTCL.

### **1.10.2 Cable Supports and Cable Tray Mounting Arrangements:**

#### **1.10.2.1 Cable trays**

- i. The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2mm.
- ii. A 2.5 metre straight section of adequate size cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.
- iii. The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.
- iv. The supports shall be fabricated from standard structural steel members.
- v. Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other places these will be at an interval of 2000 mm.
- vi. All cable trenches should be constructed in such a way that there will not be water logging in the trenches. Also depending on the contour and gradient of the yard. As per actual site conditions.

#### **1.10.2.2 Cable Termination and Connections**

- i. The termination and connection of cables shall be done strictly in accordance with cable termination as per manufacturer's drawing and/or as directed by the MPPTCL. The termination schedule will be prepared by the contractor and it should be approved by MPPTCL.

- ii. The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.
- 1.10.3** Supply of all consumable material shall be in the scope of Contractor.
- 1.10.4** The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.
- 1.10.5** Control cable cores entering control panel/switchgear/MCCB/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.
- 1.10.6** The Contractor shall tag/ferrule control cable cores at all terminations, as instructed by MPPTCL. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.
- 1.10.7** Spare cores shall be similarly tagged with cable numbers and coiled up.
- 1.10.8** All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.
- 1.10.9** Double compression type nickel plated brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.
- 1.10.10** If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor without any extra cost, as directed by MPPTCL.
- 1.10.11** Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.
- 1.11 INSTALLATION OF POWER & CONTROL CABLES :**
- 1.11.1** The cable schedule shall be prepared by the contractor and submitted to MPPTCL for approval. Contractor shall install, connect and test the cables. The details of cables are as under:
- (a) Unarmoured Copper Control Cable:**
    - i. 2 core, 2.5 sq mm.
    - ii. 4 core, 2.5 sq mm.
    - iii. 8 core, 2.5 sq mm.
    - iv. 12 core, 2.5 sq mm.
    - v. 19 core, 2.5 sq mm.
  - (b) Armoured Copper Control Cable:**
    - i. 2 core, 2.5 sq mm,
    - ii. 4 core, 2.5 sq mm,
    - iii. 12 core, 2.5 sq mm.
    - iv. 19 core, 2.5 sq mm.
    - v. 4 core, 4.0 sq mm.
    - vi. 4 core, 10 sq mm
  - (c) Coaxial cables**
  - (d) 3.5 core, 150 Sq. mm Aluminium power cable.**

- 1.11.2 Cabling in the control room and switchyard area shall be done on angles in the trench.
- 1.11.3 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint.
- 1.11.4 The cables shall be laid on cable racks in cable trenches, vertical race ways, pulled through pipes and conduits, clamped on walls/ceilings/steel structures etc.
- 1.11.5 The cable laying shall include laying /pulling at each end shall include dressing and connection of all the cores of the cable, proper dressing of cables on cable trays/racks.
- 1.11.6 The cable termination shall be solder less crimping type, proper crimping tools of Dowell or equivalent shall be used by the contractor. The crimping tools to be used shall be subject to MPPTCL's approval.
- 1.11.7 All cable that will be laid by the contractor shall be connected at both ends to equipments, local instruments or marshalling box terminals as the case may be. The following shall also be included on the scope of work:
- 1.11.8 " Taking out gland plate ,making required number of holes in the gland plates, re-fixing of gland plates, installation of cable glands, fixing the cable gland, putting ferrules according to approved termination schedule, putting cable lugs in each core, crimping of cable lugs and connection to proper terminal as per manufacturer/ company's wiring diagram. The requisite quantity of cable plates, cable glands, cable lugs, ferrules etc. shall be arranged by the contractor at his cost."

## **1.12 DETAILED SPECIFICATION FOR INSTALLATION OF CABLES:**

**1.12.1** The contractor shall supply and install the cables in accordance with the instructions issued by the MPPTCL. The contractor's scope of work includes laying, fixing, jointing, bending and termination of cables. The contractor shall also supply necessary materials for jointing of and termination of cables. Installation and testing of copper insulated cables shall be in accordance with Indian standard code of practice IS:1255.

**1.12.2** All cable work shall be arranged to minimize risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or through wall openings or other partitions, suitable bushes of approved type shall be supplied and put into position by the contractor. If required by the Company, the contractor shall seal the bushes after laying the cable, using fire resistance material to prevent spreading of fire through each partition. Inspection on receipt , unloading, storage and handling of cables shall be in accordance with IS : 1255 and other Indian standards code of practice.

**1.12.3** Standard cable grips and reels shall be utilized for standard cable pulling . In using woven gasket type grips on lead sheathed cable, care shall be taken to avoid damage to the cable and seal , which shall be made up and maintained during cable installation. If unduly difficult pulling occurs, the contractor shall check pull required and shall suspend further pulling, until further procedure has been approved by the purchaser. Maximum full tension shall not exceed recommended value for the cable measured by tension dynamometer.

**1.12.4** After pulling cable, the contractor shall record cable identification and data neatly with water proof ink on lineal tags and shall securely attach such identification tags at such cable and for all cables.

**1.12.5** In lieu thereof, or in addition there to at the option of the MPPTCL, the contractor shall cut the same information with suitable die or stamp on durable fiber cable identification tags. Identification tags shall be attached to each cable with non corrosive wire. Said wire must be on non-ferrous material on single core power cables. Tags may be further required at intervals on long runs of cables, in cable trays and in pull boxes, cable and joint markers and PRC warning covers shall be provided, wherever required.

**1.12.6** Sharp bending and kinking of cables shall be avoided. The bending radius for the PVC insulated 650/1100 V grade, single core/ multi core armored /un-armoured type cables shall not be less than 10 D, where D is the over all diameter of the cable.

If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from MPPTCL.

**1.12.7** Power and control cables shall be laid in separate cable trays, when laid in trenches, the order of laying of cables shall be as specified below :-

- (i) AC power cables and AC control cables on lower most tiers.
- (ii) CT and CVT/PT cables on the next upper tiers.
- (iii) DC and the associated control cable on the top most and the remaining tiers.

**1.12.8** When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation between power and communication cables shall be normally 600 mm. but in any case not less than 460 mm for single core cables and 300 mm for multi core cables. Power and communication cable shall as far as possible cross at right angle to each other.

**1.12.9** Where cables cross roads, the cable shall be laid in reinforced spun concrete or steel pipes. The pipe for the cables shall be buried at not less than one meter depth.

**1.12.10** In each cable run, some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, if the cables develop fault at a later date.

**1.12.11** Jointing of cables shall be in accordance with relevant Indian Standard code of practices and the manufacture's special instructions. Materials and tools required for cable jointing work shall be arranged by the contractor. Cable shall be firmly clamped on either sides of a straight through joint at not more than 300 mm away from the joints, identification tags shall be provided at each tag and at all cable terminations. Single core cable joints shall be marked so that phase identify at each joint and can be determinate easily. The joints shall be located at the most suitable places. There shall be sufficient overlap of cable to allow for the removal of cable ends which may have been damaged.

**1.12.12** Joint holes or pits shall be of sufficient dimensions to allow the jointers to work with a much freedom as possible, when one or more cables are laid together, joints shall be arranged to be staggered by about 3 meters.

**1.12.13** Cables seals shall be examined to ascertain if they are intact and also that cable ends are not damaged. If the seals are found to be broken or lead sheath punctured, the cable ends shall not be jointed until after the due examination and testing by the MPPTCL. Before jointing is commenced, insulation resistance of both sections of cables to be jointed shall be checked to be satisfactory by megger and insulation value recorded.

**1.12.14** Special tools, clips and saddles, glands, seals, PVC sealing compound etc. wherever required shall be arranged by the contractor. The cable shall be bent using

special bending tools, approved by the Company, cable shall not be fastened or clamped close to the point of entry to the equipment which may vibrate severely. Special instructions furnished by the manufacturer shall be strictly followed :-

**1.12.15** Armour of the cables shall be bended to the earthing system of the sub-stations.

**1.12.16** All new cables shall be meggered before commissioning, using a 1000 Volt megger. Repaired cables shall not be accepted.

Cable core shall be tested by the contractor for :-

- (a) Continuity.
- (b) Armour resistance to earth.
- (c) Insulation resistance to earth.
- (d) Insulation resistance between conductors.

**1.12.17** In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall replace it at his own cost to the satisfaction of MPPTCL. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to MPPTCL, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

### **1.13 INSTALLATION OF A.C. DISTRIBUTIOIN BOARDS:**

The contractor shall carryout installation of 415V A.C. distribution board, cabling, termination, connections, tagging, earthing, etc testing and commissioning including all accessories complete in all respect to put it in commercial use without any extra cost to MPPTCL.

### **1.14 INSTALLATION OF D.C. DISTRIBUTIOIN BOARDS:**

The contractor shall carryout installation of 110 V/48 V D.C. distribution board, cabling, termination, connections, tagging, earthing, etc testing and commissioning including all accessories complete in all respect to put it in commercial use without any extra cost to MPPTCL.

The Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

### **1.15 ERECTION OF TUBULAR POLES AND LIGHTING FIXTURES:**

**1.15.1** Installation of lighting fixtures on gantries/ structures including junction boxes, lighting fixtures, AC distribution board, switches, cabling, wiring etc including all accessories complete in all respect to be carried out by the contractor to put it in commercial use.

**1.15.2** Erection of steel tubular lighting poles required for peripheral lighting along with all accessories including junction boxes, lighting fixtures, AC distribution board, switches, cabling, wiring etc including all accessories complete in all respect to put it in commercial use.

### **1.16 INSTALLATION OF CAPACITOR BANKS:**

#### **1.16.1 GENERAL INSTRUCTIONS:-**

**1.16.1.1** During erection work on capacitor banks, the capacitor should be kept shorted and earthed to prevent electric shock due to accumulated charge.

**1.16.1.2** Capacitor banks should not be switched 'on' within 5 minutes of switching off to allow the capacitor units to get discharged.

#### **1.16.2 ERECTION OF STRUCTURES OF CAPACITOR BANKS:**

- 1.16.2.1** If the members of the structures are received in loose condition the structures for the Capacitor Banks and Residual Voltage Transformers / Neutral Current Transformers should be assembled.
- 1.16.2.2** After erection of the supporting structures on the foundation, their leveling, centering and grouting must be carried out and level the top of the already erected supporting structures and should be checked for their verticality.
- 1.16.3** **ERECTION OF CAPACITOR BANKS:**
- 1.16.3.1** Erection of post insulators on the already erected structure(s).
- 1.16.3.2** Erection of the capacitor units on the already erected frames as per the erection plan of the manufacturer so that the capacitances of all the phases are balanced.
- 1.16.3.3** Interconnection of the capacitor units and phases as per manufacturer's general arrangement drawing, including fitting of external fuses if provided.
- 1.16.3.4** Fitting of the post insulators and connecting strips for jumpering as per manufacturer's general arrangement drawing.
- 1.16.4** **ERECTION OF ASSOCIATED EQUIPMENT OF CAPACITOR BANKS:**
- 1.16.4.1** Cleaning of the insulators of the Capacitor Banks and Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.4.2** Measurement of the IR values to earth of Capacitor Banks.
- 1.16.4.3** Measurement of the IR values between primary terminal to earth and primary terminal to secondary terminals of Residual Voltage Transformers/ Neutral Current Transformers.
- 1.16.4.4** Erection of the associated equipments, viz., Capacitor Banks and Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.4.5** Erection of the circuit breaker with supporting structure, current transformers and isolators as per instructions given in the document.
- 1.16.5** **CABLING & WIRING OF CAPACITOR BANKS:**
- 1.16.5.1** Laying of cables between the following:
- a) Residual Voltage Transformers / Neutral Current Transformers and the Marshalling Kiosk / Junction Box.
  - b) Marshalling Kiosk / Junction Box and Control & Relay Panel.
- 1.16.5.2** Fixing of the cables in cable glands and then fixing of the cable glands on cable gland plates in the respective equipment.
- 1.16.5.3** Connection of the cables as per schematic diagram of the Control & Relay Panel.
- 1.16.5.4** Fixing of the cables in cable trays / trenches / supports / brackets.
- 1.16.6** **PRE-COMMISSIONING CHECKS OF CAPACITOR BANKS:**
- 1.16.6.1** Proper connections of Capacitor Bank units as per manufacturer's drawings.
- 1.16.6.2** Setting of timer (5 minutes) for closing interlock for Circuit Breaker (Timer should permit closing of CB only after passage of 5 min.after tripping of CB)



- 1.16.6.3 Healthiness and rating of fuses of units of the Capacitor bank.
- 1.16.6.4 Earthing of the structures and the equipment.
- 1.16.6.5 No shorting and earthing of the Capacitor Units / Banks.
- 1.16.6.6 Oil level in the Residual Voltage Transformers / Neutral Current Transformers (if oil filled).
- 1.16.6.7 Pre-commissioning checks on circuit breaker, current transformers and isolators as per instructions detailed in the document.

**1.16.7 PRE-COMMISSIONING TESTS OF CAPACITOR BANKS:**

- 1.16.7.1 Measurement of capacitance of the three phases of the Capacitor Banks for verifying balancing.
- 1.16.7.2 Measurement of IR values to earth of Capacitor Banks.
- 1.16.7.3 Measurement of IR values between primary terminal to earth and primary terminal to secondary terminals of Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.7.4 Checking of polarity between primary & secondary windings of the Residual voltage Transformers / Neutral Current Transformers.
- 1.16.7.5 Verification of ratio between primary & secondary windings of the Residual Voltage Transformers / Neutral Current Transformers.
- 1.16.7.6 Pre-commissioning tests on circuit breaker, current transformers and isolators as per instructions detailed in the document.

**1.17 CHECKS TO BE CARRIED OUT:**

The following checks shall be carried out as part of the installation work:-

**1.17.1 GENERAL CHECKS:**

- i. Check for physical damage. Any damage to the equipment at the time of receipt shall be reported to the owner/purchaser.
- ii. Check from the name plates/packing list that all items are as per order and specifications.
- iii. Check tightness of all joints, clamps and connecting materials.
- iv. For oil filled equipments, check for oil leakage, if any, also check oil level and top up , wherever necessary.
- v. Check earth connections.
- vi. Check cleanliness of insulator bushings.
- vii. All checks specified by the manufacturers in their drawings and manuals, literatures as well as all in the relevant codes of standards.

**1.17.2 POWER TRANSFORMERS/ REACTORS:**

**(I) PRELIMINARY CHECKS:**

- 1 Compare name plate details with the specifications.
- 2 Checks for any physical damages, in particular of bushings.
- 3 Checks tightness of all bolts, clamps & connecting terminals.
- 4 Check cleanliness of bushings.
- 5 Check of oil leakage & oil level.
- 6 Breather condition, check whether breathing line is free, silica gel is reactivated, oil is available at bottom.
- 7 Checks for clearances, particularly in case of bus ducts.
- 8 Water tightness of terminal boxes & bus ducts.

- 9 Earthing of transformer/reactor tank & neutral bushings.
- 10 Ensure that all cooler & cooler header valves are opened.
- 11 Releasing of Air from bushings, buchholz relay.
- 12 Check and record of gas pressure in conservator as well as in the gas cylinder.
- 13 Check the bushings horn gap.
- 14 Check that the transformer/reactor is correctly installed with reference to its phasing.

### **1.17.3 CONTROL PANELS:**

#### **(I) PRELIMINARY CHECKS:**

- 1 Check name plate details of every associated equipment according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check cleanliness.
- 5 Check earth connections.

#### **(II) RELAYS:**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Megger all terminals to body.
- 4 Megger AC to DC terminal.

### **1.17.4 CIRCUIT BREAKERS:**

#### **(I) PRELIMINARY CHECKS:**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check oil level, air pressure and leakage (wherever applicable).
- 5 Check of SF6 gas pressure and its leakage (wherever applicable).
- 6 Check earth connections.
- 7 Check cleanliness of insulators and bushings.
- 8 Check all moving parts are properly lubricated.
- 9 Check heaters provided.

### **1.17.5 ISOLATORS:**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check cleanliness of insulators.

### **1.17.6 VOLTAGE TRANSFORMER / CAPACITIVE VOLTAGE TRANSFORMERS.**

- 1 Check name plate details according to specification.
- 2 Check for any physical damage.
- 3 Check cleanliness of insulators.
- 4 Check tightness of all bolts, clamps and connecting terminals.
- 5 Check earthing connections.

### **1.17.7 CURRENT TRANSFORMERS :**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connecting terminals.
- 4 Check for oil level and leakages.
- 5 Check cleanliness of insulators and bushings.

**1.17.8 LIGHTENING ARRESTOR:**

- 1 Physical checking of various parts/ equipment.
- 2 Check for connections to ground and line.
- 3 Continuity check (in case of metal oxide silicon type only).
- 4 Operation check of discharge counter.

**1.17.9 CABLES:**

- 1 Check details as per specification.
- 2 Check for physical damage.
- 3 Megger test between each core and armour/sheath.
- 4 Continuity check.
- 5 Connections.

**1.17.10 415 VOLTS AC DISTRIBUTION BOARD**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connection terminals.
- 4 Check cleanliness.
- 5 Check earthing.
- 6 Megger all terminals to body.

**1.17.11 110 VOLTS DC DISTRIBUTION BOARD**

- 1 Check name plate details according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connection terminals.
- 4 Check cleanliness.
- 5 Check earthing
- 6 Megger all terminals to body.

**1.17.12 CARRIER CABINET:**

**(I) PRELIMINARY CHECKS**

- 1 Check name plate details of every associated indoor equipments according to specification.
- 2 Check for physical damage.
- 3 Check tightness of all bolts, clamps and connection terminals.
- 4 Check cleanliness.
- 5 Check earthing
- 6 Megger all terminals to body.

**1.17.13** The above mentioned works are guide line for the contractor .The contractor shall invariably carry out the various checks as proposed to be conducted by him as per the standards in vogue for testing & commissioning of the equipments under the contract.

**1.18 CODES AND STANDARDS:**

Electrical Installation work shall comply with all currently applicable statutes to the Indian Electricity Rules,. Fire Insurance Regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the contractor on this responsibility.

Unless otherwise specified, installation work shall comply with the requirements of latest editions of applicable Indian Standards.

**1.18.1** In accordance with the specific installation instructions, as shown in the manufacturer's drawings or as directed by MPPTCL, the contractor shall erect, install all

the electrical equipment included in the contract. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in the manufacturer's drawings or as stipulated by the MPPTCL. No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by MPPTCL.

**1.18.2** The contractor shall furnish all supervision, labour, erection tools, and equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install and adjust the equipment.

**1.18.3** The manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, setting of all equipment and care shall be exercised in handling to avoid destruction to stationary structures, the marring of finish or damaging of delicate instruments or other electrical parts. Adjustment shall be made as necessary to the stationary structures for plumb and level, for the sake of appearance or to avoid twisting of frames, binding of hinged members etc.

**1.18.4** In case of any doubt / misunderstanding as to correct interpretation of the manufacturer's drawings or instructions, necessary clarifications shall be obtained from the manufacture/MPPTCL. The contractor shall be held responsible for any damage to the equipment consequent to not following the manufacturer's instructions correctly.

**1.18.5** The contractor shall move all equipment into the respective buildings through the regular doors or floor openings provided specifically for lifting the equipment. The contractor shall make his own arrangement for lifting of the equipment. Crane for lifting arrangement shall not be provided by the MPPTCL.

**1.18.6** Where assemblies are supplied in more than one section, the contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. The contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All insulators and bushings shall be protected against damage during handling and installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness of the contractor shall be replaced by him at his own expense.

**1.18.7** Inspection, storage, installation of transformer/reactors shall be in accordance with the Indian Standard Code of practices IS:1866 and the Manufacturer's instructions. All commissioning tests as applicable, shall be carried out by the MPPTCL/ Manufacturer but contractor has to provide skilled / semi skilled and unskilled labourer as required for assistance.

**1.18.8** Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hose shall not be used. Circulation and filtering of oil, the heating of oil by regulated short circuit current during drying runs and sampling and testing of oil shall be in accordance with the manufacturer's instructions and IS code of practice IS:1886.

**1.18.9** Switchgear and control panels/ desks shall be installed in accordance with Indian Standard code of practice IS:3072 and the manufacturer's instructions. The switchgear panels shall be installed on finished surface or concrete or steel sills. The contractor shall installed/ align channel sills forming part of the foundations. In joining shipping sections of the switchgear / panel / control centres together, adjacent housing or panel sections of flanged throat section provided shall be bolted together when alignment has been completed. Power bus, enclosures, ground and control splices of conventional nature shall be cleaned and bolted together, being drawn up with through torque wrench of proper size or by other approved means. Tap or compound shall be applied where called for by the manufacturer's drawings. Bays of out door type unit shall be sealed in an approved manner to prevent increase of moisture.

**1.18.10** The contractor shall take utmost care in handling instruments, relays, other delicate mechanisms & equipments. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panels/ desks have been erected and aligned. The blocking materials/ mechanisms employed for the safe transit of the instruments and relays shall be removed after ensuring that the panel/ desks have been completely installed and no further movement of the same would be necessary any damaged to relays and instruments shall be immediately reported to the Company or its representative.

**1.18.11** The contractor shall under take the work of filling of SF6 gas in the circuit breakers as per the manufacturer's instructions.

**1.18.12** Care shall be taken during handling SF6 gas cylinder/ gas filling trolley. The SF6 gas and gas filling equipment shall be arranged by the contractor.

**1.18.13** The manufacturer's installation tests shall be carried out by the contractor, who shall make all necessary adjustments as specified by the manufacturer for proper functioning of the equipments. The Contractor shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage upto commissioning stage. Pre commissioning Procedures and Formats for substation bay equipment, which will be available in the respective sites and shall be referred by the contractor. However, it is contractor's responsibility to draw up and carry out such a programme duly approved by the MPPTCL.

**1.18.14** Foundation work for transformers/reactors, switchgears and other equipments will be carried out by contractor, in case minor modifications to foundations, wherever found necessary for proper installation, shall be carried out by the contractor at no extra cost.

**1.18.15** Equipment furnished with finished coats of paint shall be touched up by the contractor if their surface is soiled or marred while handling .

**1.18.16** The contractor shall supply the normal consumables, filling compounds, touch up paints etc. where required.

**1.18.17** Petroleum conducting jelly shall be applied for current carrying joints, connections, clamps etc. to avoid corrosion.

**1.18.18** Silicon polish (water repellent) shall be applied on all insulation, stacks, bushings etc. after installation and before commissioning to avoid tracking.

**1.18.19** After installation of all power and control wiring the contractor shall perform operating tests on all switchgear and panels to verify proper operation of switchgear / panels and correctness of the interconnections between various items of the equipments. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipments. Megger tests for insulation, polarity checks on the instruments transformers, operating tests on equipments and the manufacturer's installation tests shall be carried out by the contractor who shall make all necessary adjustment as specified by the contractor for proper functioning of the equipments. The various relay/meter setting adopted in various control/relay panel should be as per recommendations of manufacture and approved by MPPTCL before energizing.

**1.18.20** All switchgear, control panels, desks, etc. shall be made absolutely vermin proof.

#### **1.19 INTERCONNECTION OF EQUIPMENT USING 4 INCH IPS TUBE :**

The work of connection with Aluminum tube involves cutting, welding and jointing of Aluminum tubes available in standard lengths of 6/7 meters. The work of Aluminum bus welding is of specialized natures and shall be done as specified below-

- i. This specification highlights jointing of 4 inch IPS Aluminum Alloy Seamless hard drawn tube. All materials, consumables & non consumables , T&P jointing equipment shall be arranged by the Contractor. For jointing work in SITU trailing cables shall be arranged by the Contractor.
- ii. The welded joints shall be made by adopting the appropriate standard procedure, suitably preheating the jointing surface and creating the necessary inner atmosphere around the molten metal by Argon Gas. The procedure is very briefly described below.
- iii. The ends of the two tubes to be jointed shall be tapered so that when placed facing each other, they shall form-V shape. The angle of the Vee shall be appropriate to match the thickness of the tube and the characteristic of the alloy given above.
- iv. Prior to assembly of the joint all grease, oil, dirt, burs and foreign material shall be removed from mating surface using suitable solvent. Any surface oxide shall be removed from joint and joint are immediately prior to welding.
- v. The jointing sleeves shall be positioned centrally around the ends to be jointed and shall fit tightly inside the tube.
- vi. The jointing shall be done by using either the "Argon Gas – Shielded-Consumable-Electrode Process" or "Gas-Shielded-tungsten-arc welding process".

**1.19.1 BRIEF DESCRIPTION OF ALUMINIUM TUBE WELDING PROCESS:**

- i. Consumable electrode process:
- ii. The welding arc shall be established between the tip of the moving electrode and the work piece. The arc length shall be automatically maintained constant, independent of electrode feed speed. A suitable argon gas-shielding atmosphere shall be created around the electrode to protect the molten metal from getting the oxidized and other harmful effects.
- iii. A suitable welding equipment shall be used which may consist of an appropriate power source, wire drive and welding gun. It shall preferably have self contained water circulating system to obviate long water hoses for cooling of the welding gun and the cable.
- iv. Electrode shall be 0.04 Inch dia 4043 Aluminum alloy wire (5% silicon content). The electrode speed shall be 440 Inch per minute. Welding current shall be 150 Amp. Direct current with electrode positive (reverse polarity). The arc voltage shall be 19 volts (open circuit). Argon gas shall be of welding grade and the equipment may permit flow at a rate of 40 to 50 cubic ft. per hour. However, the flow shall be minimum permissible to produce satisfactory welds.

**1.19.2 TUNGSTON ARC PROCESS:**

- i. In this process the rate shall be struck between the tungsten electrode and the work piece. Filler metal shall be added to molten weld pool where required by the operator. As with consumable electrode process, a suitable argon gas shield shall be provided to protect the molten metal from the harmful effect of atmosphere. The equipment shall consist of a special welding transformer with a preferable minimum current rating of 400 Amps alternating current. A suitable water cooled holder shall be used.

- ii. Electrode shall consist of ¼ Inch dia pure tungsten filler metal shall be of 3/16" or ¼" dia 4043 Aluminium alloy wire. Welding current shall be 350 to 424 Amp. AC a pre-heat of 300 to 700 deg. Fahrenheit. Concurrent heating may be required to ensure that this temperature is maintained in the welding area during the full welding cycle.

**1.19.3 CUTTING AND BENDING OF ALUMINIUM TUBES :**

- i. For each jointing job, cutting of the tube is also involved. This work of cutting the Aluminium tube, welding etc. will be treated as one job per joint. (each IPS tube is in length of 6/7 meters. The tubes may be required to be cut in suitable length by the contractor for jointing jobs.
- ii. Bending of 4 Inch IPS Aluminium Tube-Angular Bends up to 90 deg. Angle bend is also involved in few cases. The Contractor may include in his quoted price the job of bending work also.

All the materials required for completion of above work including all consumable, non-consumable accessories, T&P, welding transformer, welding electrodes, argon gas (for shielding), tungsten arc welding material etc and skilled personnel shall be arranged by the contractor.

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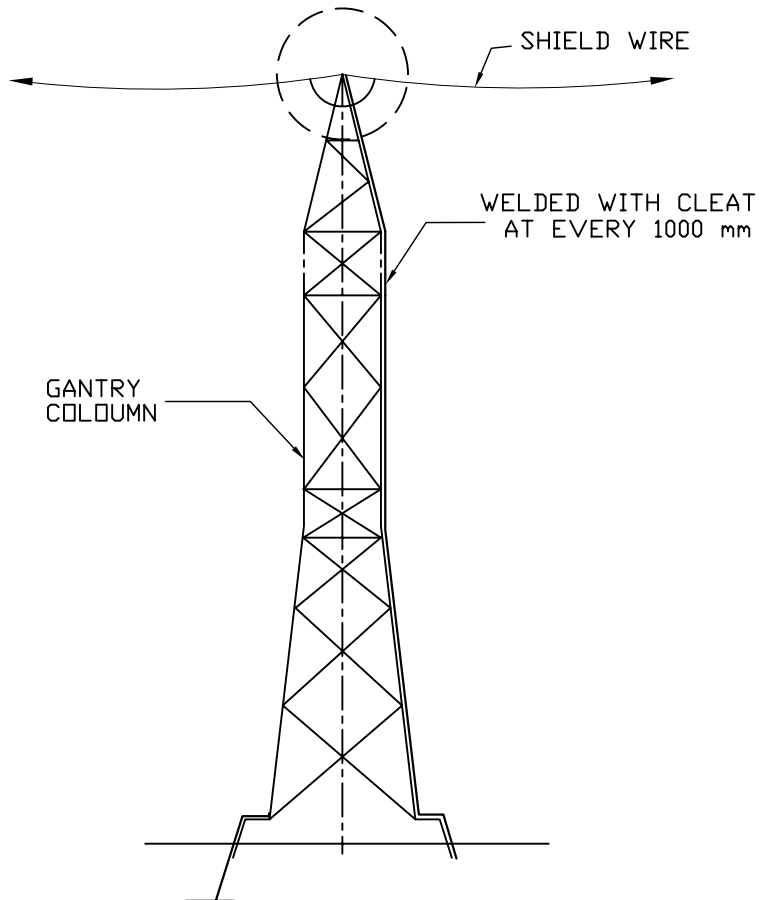
**ABBREVIATIONS**

The following abbreviation, wherever they appear in the bid document, shall have the meaning of implications hereby assigned to them:-

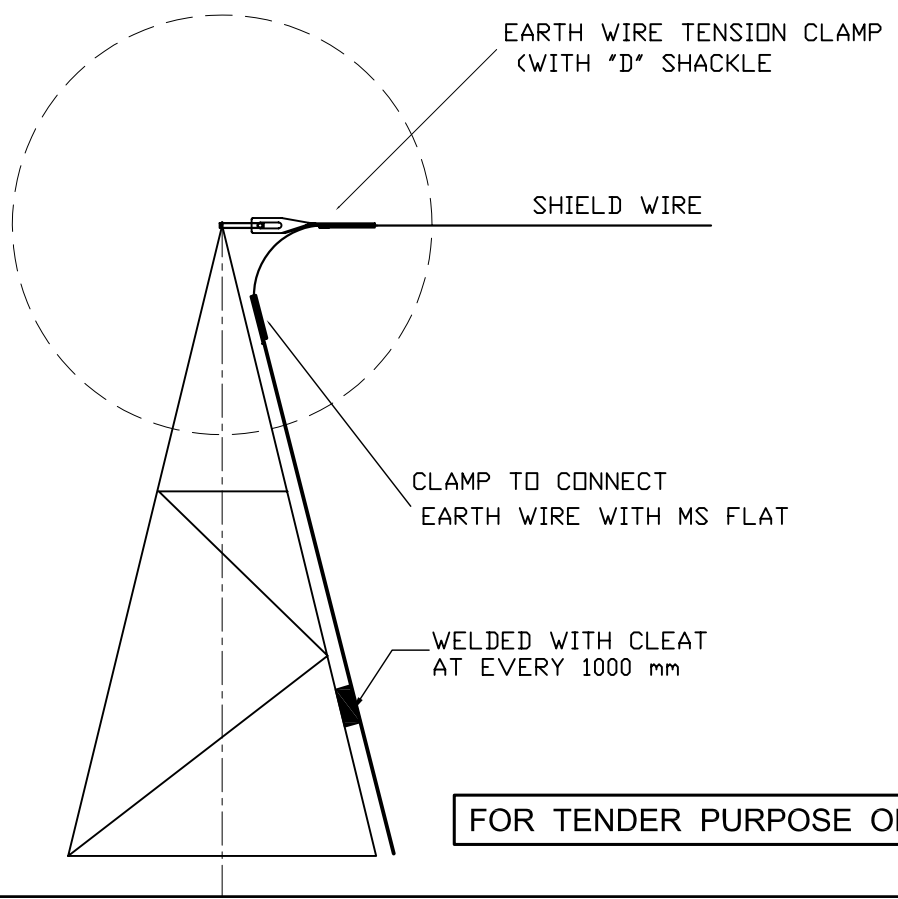
ACDB	Alternate Current Distribution Board	MVA	Mega volt ampere
ACSR	Aluminium conductor steel reinforced	MI	Mild Steel
BOM	Bill of Material	NCT	Neutral Current Transformer
BC	Black Cotton	O&M	Operation and Maintenance
CC	Coupling Capacitor	PIR	Pre insertion resistor
CFL	Compact Fluorescent Lamp	RVT	Residual Voltage Transformer
CB	Circuit Breaker	PI	Post Insulator
CT	Current Transformer	PT	Potential Transformer
CVT	Capacitive Voltage Transformer	PVC	Polyvinyl Chloride
C&R Panel	Control and relay Panel	PLCC	Power line carrier communication
DCDB	Direct Current Distribution Board	RTCC	Remote Terminal Control Cubical
Dia.	Diameter	SF6	Sulfur hexa Fluoride
DO fuse	Drop out fuse	T&P	Tools and Plants
GI	Galvanised Iron		
GS	Galvanised steel		
HV	High Voltage		
IR	Insulation Resistance		
IPS Tube	International Pipe Size Tube		
KV	Kilo Voltage		
KV	Kilo Ampere		
LA	Lightning Arrester		
LV	Low Voltage		



# EARTHING ARRANGEMENT FOR OVERHEAD SHIELDING WIRE

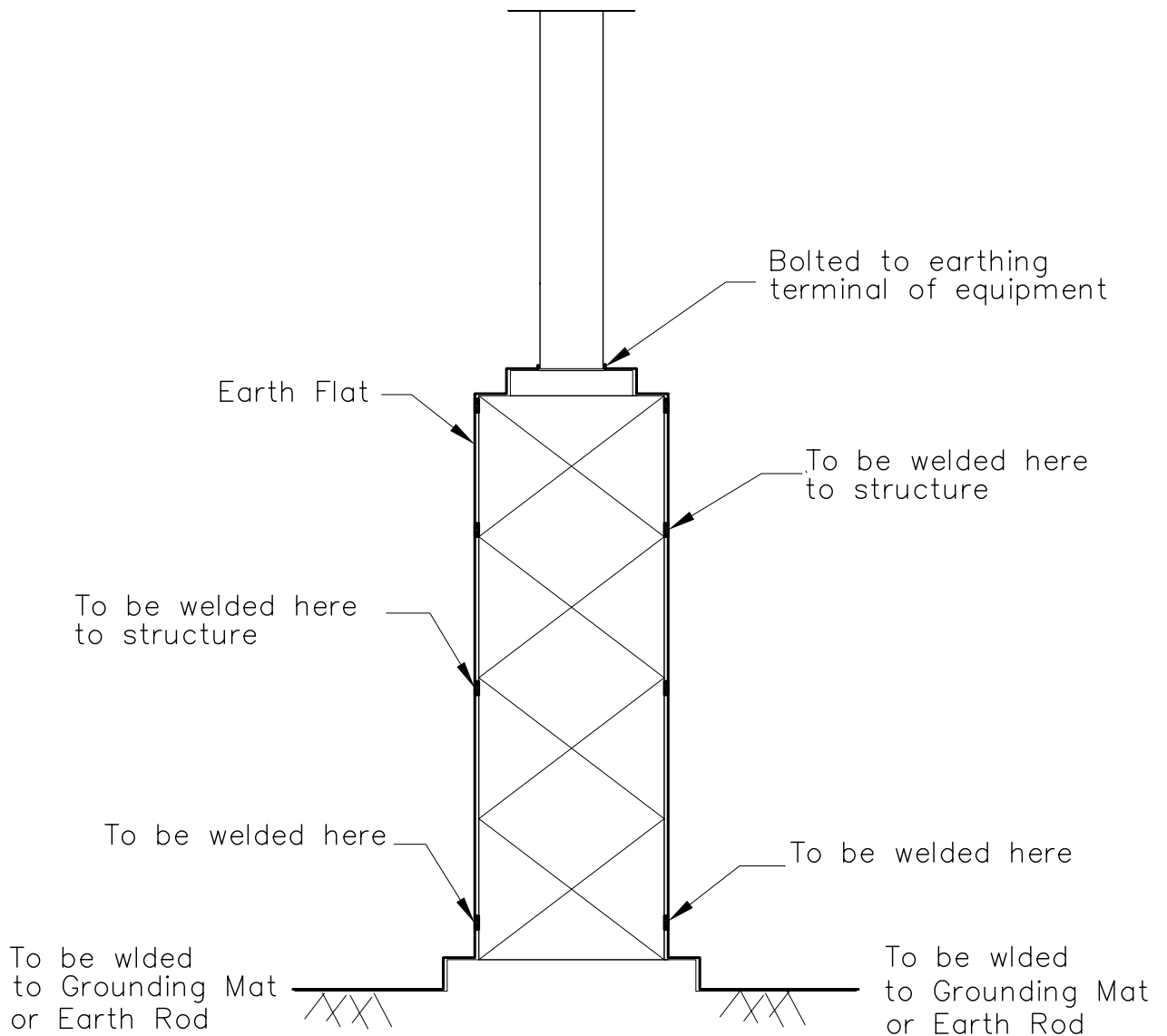


## ENLARGED VIEW



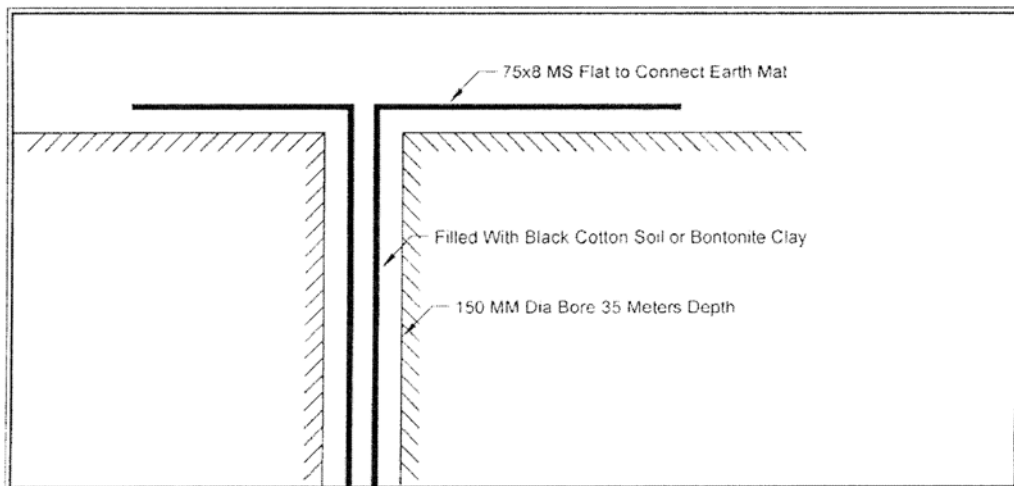
FOR TENDER PURPOSE ONLY.

# Earthing Arrangement for Equipments



FOR TENDER PURPOSE ONLY.

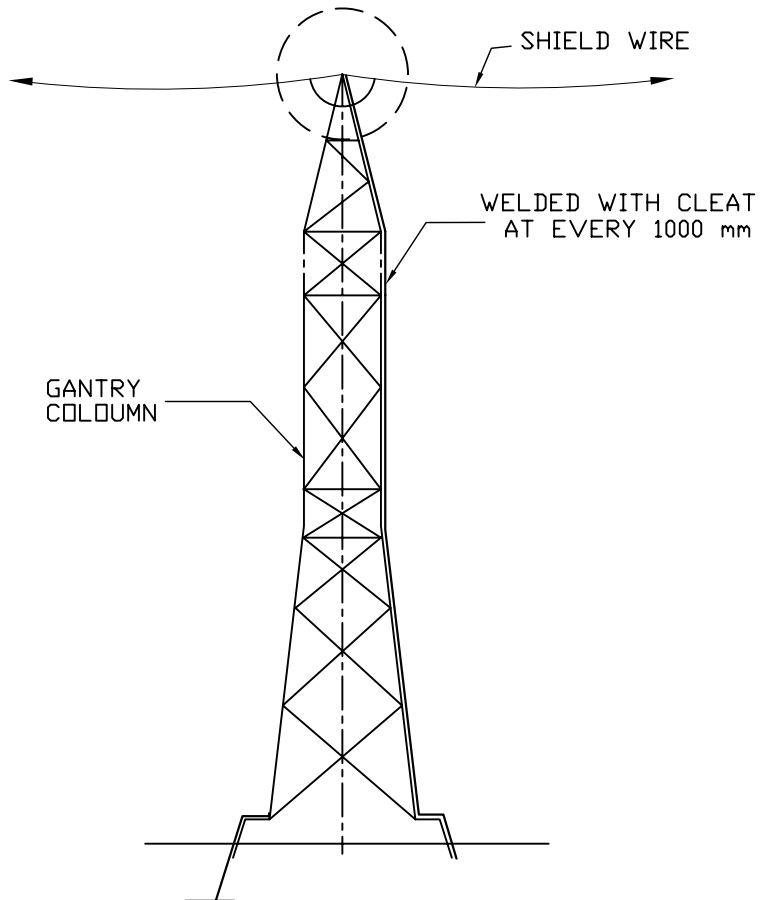
ARRANGEMENT FOR DEEP DRIVEN EARTH RODS  
TO ACHIEVE EARTH RESISTANCE LESS THEN One ohm.



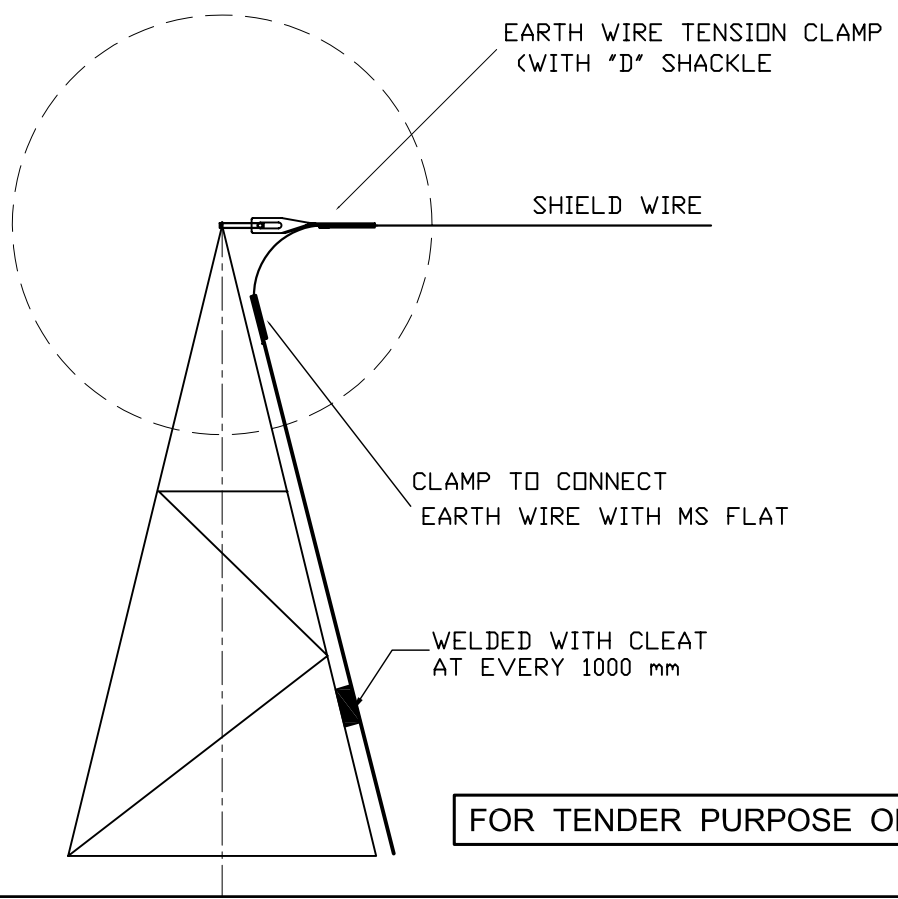
FOR TENDER PURPOSE ONLY



# EARTHING ARRANGEMENT FOR OVERHEAD SHIELDING WIRE

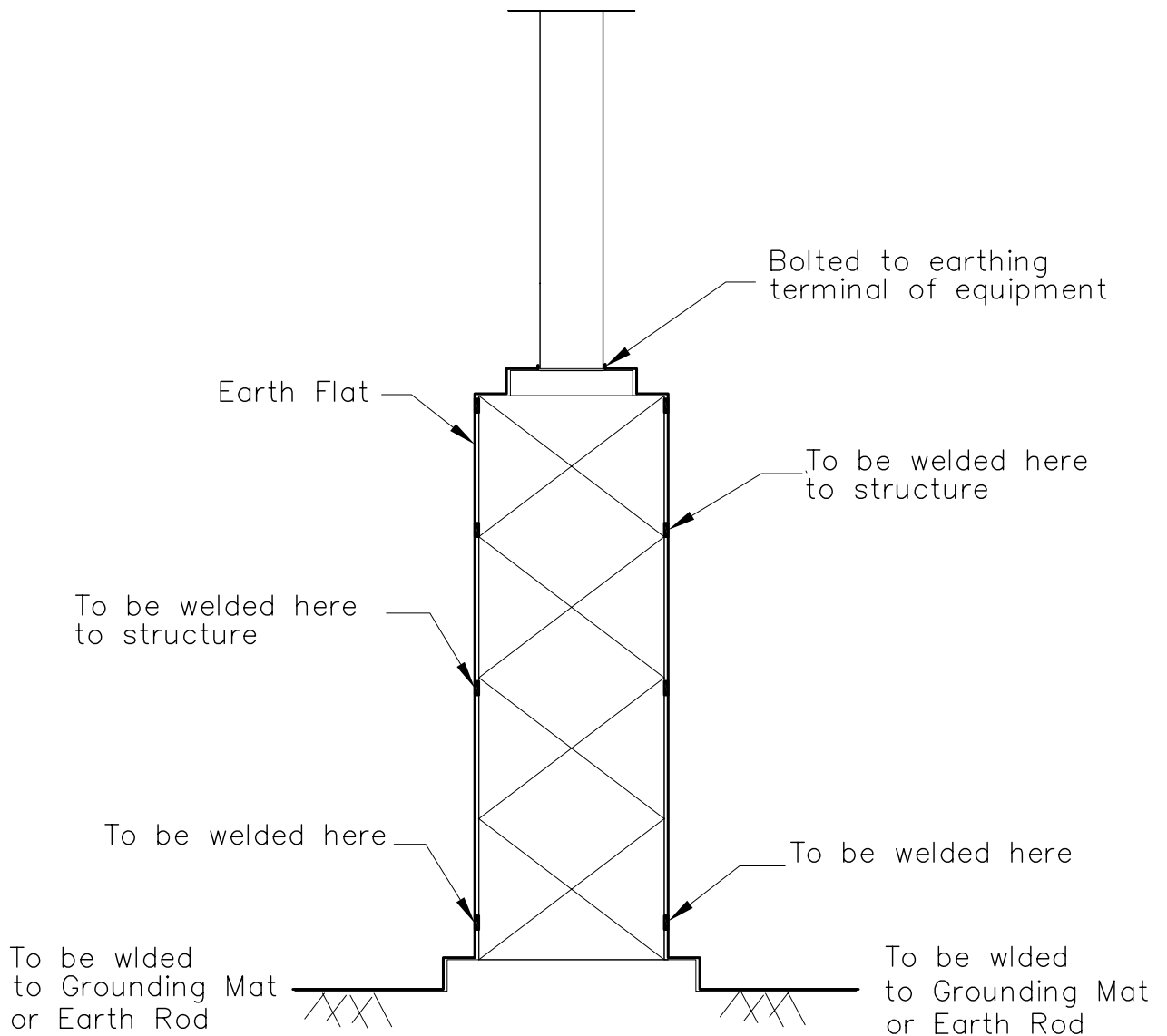


## ENLARGED VIEW



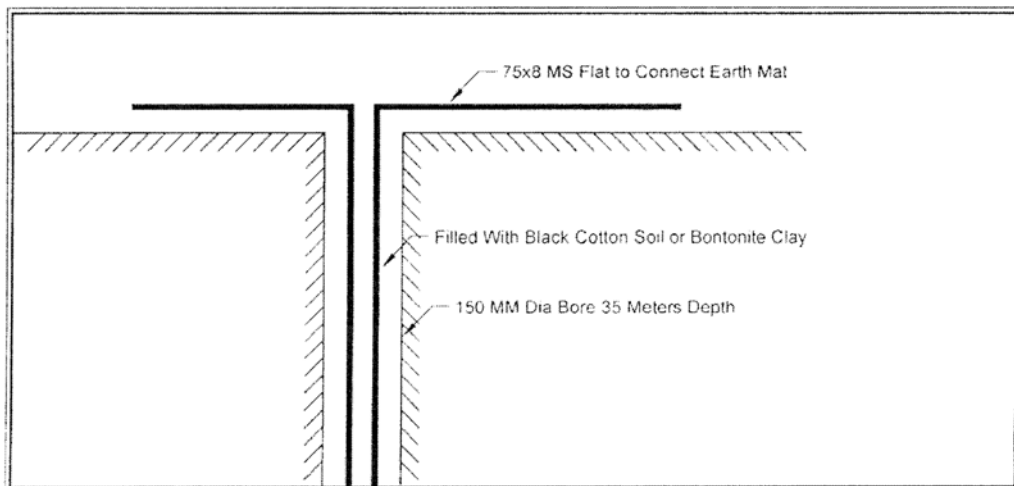
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# Earthing Arrangement for Equipments



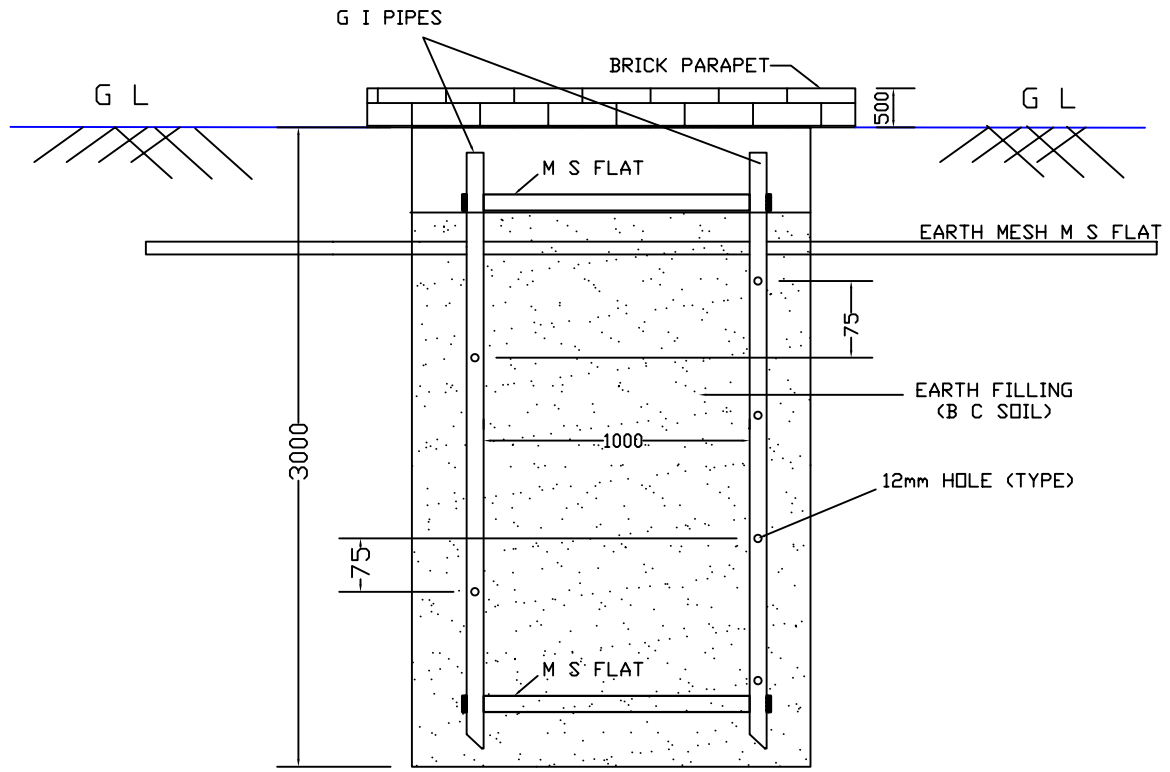
FOR TENDER PURPOSE ONLY.

ARRANGEMENT FOR DEEP DRIVEN EARTH RODS  
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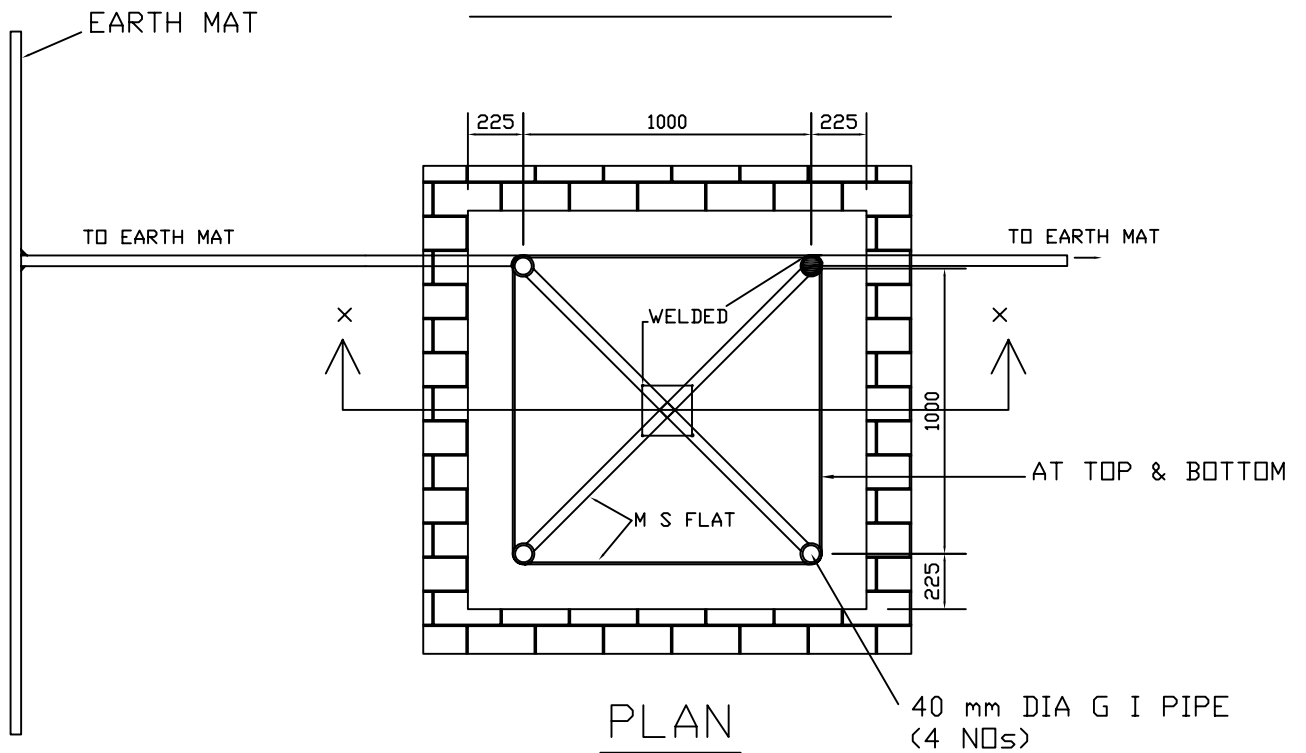


FOR TENDER PURPOSE ONLY

# DETAILS OF EARTH PIT



SECTION AT X-X



PLAN

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