

TECHNICAL SPECIFICATIONS FOR HANDLING, ERECTION, TESTING AND COMMISSIONING

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TECHNICAL SPECIFICATIONS FOR HANDLING, ERECTION, TESTING AND COMMISSIONING

1.00 SCOPE

This specification covers the handling, storage of material at site, erection, testing, commissioning, operation and handing over of all the equipment/sub systems/systems and complete sub-station as a whole on turn-key basis. The Bidder shall receive and store all the equipment at site on behalf of the Purchaser in storage yard/stores/sheds and transport the material to erection site and shall carryout erection, testing and commissioning of all equipment and accessory items as required. The Bidder shall be required to complete the work as per the completion schedule defined in the contract and the approved PERT chart.

1.01 In general the scope of work may be grouped as below:

- (a) Design and Engineering, Preparation of layouts/ drawings/ cable schedules/ inter connections etc.
- (b) Unloading, handling and storage of all equipments and materials.
- (c) Erection of 400, 220 & 132kV equipments (i.e. transformers, GIS modules, substation automation system with relay and protection panels etc.) and inter connection with conductors (Jumpering).
- (d) Erection of 630 kVA station transformers and marshalling boxes, along with laying and terminations of power and control cables and XLPE cables.
- (e) Erection of auxiliary power supply system including AC Distribution Boards along with laying and terminations of power cables.
- (f) Erection of 220 Volts batteries, battery charges and D.C. Distribution Boards.
- (g) Erection of Energy Meters
- (h) Erection of illumination system including its cable laying and terminations.
- (i) Erection of Air Conditioning system and ventilation system.
- (j) Erection and commissioning of Diesel Generator set.
- (k) Erection of Fire protection system.
- (l) Power and Control Cables, XLPE Cables and underground Optical Fibre Cables laying and terminations for complete sub-station.
- (m) Complete Civil Works as per civil works specifications.
- (n) Testing and commissioning of complete substation installation, putting into operation.
- (o) Successful operation after erection and commissioning and handing over to UPPTCL.
- (p) Training to Purchaser's personnel including operating staff.
- (q) Any other work required to complete the substation but not specifically mentioned.

1.02 The specific parameters such as ratings, dimensions of equipments/ panels / SAS panels, conductor types, earthing rod / flat sizes etc. given hereinafter are subject to change as per actually procured equipment and approved design/ drawings.

2.00 STANDARDS FOR ERECTION AND COMMISSIONING

The erection, testing and commissioning of equipment covered by this specification shall comply with the latest editions of the relevant standards and code of practice. Some of the applicable standards are given below:

i)	Installation and maintenance of switchyard	IS: 3072
ii)	Porcelain insulators	IS: 731, IS: 2544
iii)	AAC/ ACSR conductors	IS: 398
iv)	Fittings for ACSR conductors	IS: 2121, IS: 731, IS: 2486, IS: 3188
v)	Current transformers	IS: 2705
vi)	Voltage transformers	IS: 3156
vii)	Lightning arresters	IS: 3070
viii)	Power transformers	IS: 2026, IS: 3639
ix)	Code of practice for installation and maintenance of transformers	IS: 10028
x)	Circuit breakers	IS: 13118
xi)	Code of practice of structural steel	IS: 800
xii)	Code of practice of earthing	IS: 3043
xiii)	Code of practice for the protection of buildings and allied structures against lightning	IS: 2309
xiv)	National Electricity Safety code	IEEE: 80
xv)	Guide for safety procedure & Practices in electrical work	

- 2.01** The electrical installation shall meet all requirements of latest Indian Electricity Rules, Fire Insurance Regulations and other rules of local statutory bodies.
- 2.02** The Bidder shall erect, install, site test and place into commercial use all the equipment/ systems in accordance with the manufacturer's specific installation instructions and as per approved drawings/ documents.
- 2.03** Equipment shall be installed in neat, workmanship like manner so that it is level, plumb, square, properly aligned and oriented. Tolerance shall be as specified in manufacturer's drawings or as stipulated by the Engineer. No equipment shall be permanently bolted down to foundation of structure until the alignment has been checked and found acceptable.
- 2.04** Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, erection, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, marring of finish, damaging of delicate instruments or other electrical parts etc. Adjustments shall be made as necessary to the stationary structures for the plumb and level, for the sake of appearance or to avoid twisting of frames or bending of hinged members.

- 2.05** Bidder shall engage manufacturer's Erection Engineers for major equipment to supervise the erection of the relevant equipment. Bidder shall erect and commission the equipment as per approved drawings and shall extend full co-operation to them. The Bidder shall be held responsible for any damage to the equipment consequent to not following manufacturer's instructions correctly.
- 2.06** Where assemblies are supplied in more than one section, bidder shall make all necessary mechanical and electrical connections between sections including the connections between buses. Bidder shall also do necessary adjustments/ alignments for proper operation of GIS equipments i.e. circuit breakers, isolators etc. and their operating mechanisms All insulators and bushing shall be protected against damage during installation. Insulators or bushing chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Bidder at his own expense well in time without affecting completion period.
- 2.07** Bidder shall take utmost care in handling instruments, relays and other delicate mechanisms. The blocking materials/mechanisms employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels had been completely installed and no further movement of the same would be necessary.
- 2.08** Inspection, storage, installation, testing and commissioning of transformer shall be in accordance with the Indian Standard code of practice. IS: 1886 with latest edition and manufacturer's instructions. All commissioning test as applicable, vide appendix C of IS: 1885 with latest edition shall be carried out.
- 2.09** Induction motors shall be installed and commissioned as per IS code of practice IS: 900 with latest edition and manufacturer's instructions.
- 2.10** 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 house shall not be used. Circulation and filtering of oil, heating of oil by regulated short circuit current during drying runs and sampling and testing of oil shall be in accordance with the manufacture's instructions and IS code of practice IS:1866 with latest edition.
- 2.11** Equipment furnished with finished coats of paint shall be touched up by the Bidder, if their surface has become dull or marred while handling.
- 2.12** The Bidder shall provide supervision, labour, tools, equipment, rigging materials and incidental materials, such as bolts, wedges, anchors, concrete, inserts etc. required to completely install, test and adjust the equipment.
- 2.13** The Bidder shall provide and make all necessary arrangement for the safety of his staff and labours at the site of works. The Purchaser will not be in any way responsible for any accident, minor or fatal to any person at the site of works or for any damages arising therefrom, during erection and this shall be the Bidder's responsibility. The staff insurance charges if any shall be borne by the Bidder. All labour rules shall be followed by the Bidder at his own cost.
- 2.14** The Bidder shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments 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 applicable standards, equipment manufacturer/ Purchaser shall be strictly adhered to.

2.15 The Bidder shall ensure that:

- 2.15.1** Modern and best technologies are adopted and latest equipments are used to ensure least pollution during construction activities.
- 2.15.2** The equipments are properly stored, transported, handled and placed in position to eliminate the chances of damages to the equipment.
- 2.15.3** All safety measures are taken for ensuring that no accidents occur during construction activities.
- 2.15.4** Best construction practices/norms are adopted to ensure safety, reliability and stability of substation structures.
- 2.15.5** Due care is taken to prevent erosion and drainage problems due to construction activities.
- 2.15.6** First aid kits are kept in order to tackle accidents.
- 2.15.7** No tree shall be cut until the Bidder has made necessary arrangement with the authorities concerned and permission is given to the Bidder to fell/cut such trees. The Bidder shall arrange to remove the obstacle as soon as possible with prior concurrence of the engineer.
- 2.15.8** Due care is taken to minimize the noise level (below 75 db) by construction equipment. Statutory provisions related to noise level shall be complied.

3.00 ERECTION OF MAIN GALVANISED STEEL STRUCTURES AND AUXILIARY STRUCTURES

- 3.01** All structures shall be erected as per approved drawing. The Bidder shall carefully check the location and layout of anchor bolts embedded on foundations to ensure that structures can be properly erected. Any discrepancy in the anchor bolts/ foundations shall be corrected before erection. Bidder shall carryout erection in the sequence agreed by the Engineer. The method of erection shall be modified whenever required by the Engineer.
- 3.02** After steel structure has been erected all burrs and abraded spots on bolt heads, and nuts shall be spot painted with approved Zinc rich paint compound. Before paint is applied, the surface shall be dry and free from dust, dirt, scales and grease. No cutting, heating or enlarging of the holes shall be carried out without the prior approval of the Engineer.

4.00 STRINGING OF BUSBARS

- 4.01** The Erection and Stringing of main, transfer, jack buses and connections with equipment terminal connectors and feeders shall be done as per the approved layouts/ drawings wherein the bus-sections, spans, jumpering arrangements, conductors etc shall also be specified.

4.02 SAG TENSION REQUIREMENTS

The sag and tension requirements for all the bus bars shall be prepared by the Bidder and detailed calculations and charts shall be submitted to the Purchaser before starting the stringing work.

4.03 The bus bars are divided in sections and each section shall accommodate specified number of bays. The buses shall be continuous and no joints unless specifically approved by the Engineer shall be allowed at any section point between total span.

4.04 Each section of the bus bars shall be strung with special dead end clamps, single insulator strings. The jack buses shall constitute of single specified conductor per phase with single strain insulator fittings at both ends. The required number of Disc Insulators for different type of strings shall also be specified.

4.05 The droppers from bus bars and jack buses to connect the equipment shall be fixed through suitable P.G. clamps as per standard practice.

5.00 ERECTION OF EQUIPMENTS:

5.01 Erection, Testing and commissioning of 400kV, 220kV, 132kV and 33kV equipments shall be done as per the applicable standards, manufacturer's instructions, technical specifications of respective equipment and the associated drawings/ manuals. If services of supplier's engineer are required for erection/ commissioning, purposes, same shall be arranged by the Bidder.

5.02 INTERCONNECTION OF EQUIPMENT

The interconnections of the equipments in the various bays shall be done with the jumpers of conductors as per drawings duly approved by the Purchaser.

All materials required for interconnection (jumping) viz clamps, terminal connectors, fittings, sag compensating springs, conductors, disc insulators, PG clamps and any other required material shall be in the Bidder's scope of supply

The interconnections of equipments in various **GIS bay modules** shall be done as per single line diagrams and layout drawings.

5.03 ERECTION OF CONTROL/ RELAY PANELS

The Bidder shall carryout the erection of all Control/Relay and Protection Panels with distributed type Substation Automation System as per approved design and drawings. The Simplex type Substation Automation System panel, for control and monitoring of all the substation equipments from remote control centre, shall be installed in control room. The arrangement for above will have to be designed and developed by the bidder. These panels shall be erected inside the control room for cable connections.

All these panels shall be provided with a bottom plate with slots for bottom cable entry. The slots shall be covered with a removable cover plate.

5.04 ERECTION OF THE D.C. SYSTEM

The Bidder shall erect the D.C. batteries, D.C. Distribution Boards and the Battery Charges inside the Main Control Room Building. The each D.C. board shall have 1 No. incomer of 100A and 20 Nos. outgoing of 15A. The Bidder shall carryout all the connections of the Batteries to the D.C. Board and D.C. Board to the Control/ Relay and Protection Panels and those of the Battery Charger as per the approved drawings and requirements.

The D.C. Battery sets shall be of 110 cells of 220V, 600AH. Such two sets of batteries shall be erected by the Bidder in the Battery Room adjacent to the Main Control Room in accordance with the supplier's instructions.

6.00 LAYING OF EARTH MAT AND EARTHING OF EQUIPMENT WITH THE MAIN EARTH MAT

- 6.01** Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and regulation existing in the locality where the system is installed. Direct Stroke Lightning Protection (DSLPP) shall normally be provided by Lightning Masts and shield wires using Dr. Razveig's method. The final layout arrangement shall be decided after approval of the DSLPP calculations.
- 6.02** Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal work associated with electric system shall be connected to a single earthing system unless stipulated otherwise.
- 6.03** The lightning protection system shall not be in direct contact with underground metallic service ducts and cab.
- 6.04** The bidders shall provide lightning mast/ GS shield wire at suitable places for protection of whole substation including transformers, GIS cum control room building etc. The riser shall be GS flat of size 75x12mm for outdoor equipments and 50x6mm for indoor equipments.
- 6.05** Earthing conductors and associated hardware material shall be used for the earthing of all GIS equipments, enclosures, control cabinets, supporting structures etc. to the ground bus of GIS. The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. At least two grounding paths shall be provided for each of circuit breaker, transformer terminals, cable terminals, surge arresters, earth switches and at each end of the bus bars, to the main grounding bus. The grounding continuity between each enclosure shall be effectively interconnected with Cu/ Al bonds of suitable size to bridge the flanges.
- 6.06** Each marshalling box, local control panel, power and control cable sheaths and other non current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.
- 6.07** The earthing system shall be designed and provided as per IEEE-80 std 2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

- 6.08** Earthing shall be carried out as per design/ drawings approved by the Purchaser.
- 6.09** The earthmat design shall be made on the basis of actual measured soil resistivity value, fault level and switchyard area. The earthmat shall be required to be laid at least 600 mm depth below ground level.
- 6.10** M.S. rods of 40 mm dia M.S. rod shall be used for the earth mat, to be laid in the total area of the switch yard and 3 meter long M.S. electrodes of 40 mm dia shall be fixed on joints all along the boundary of the switch yard vertically below the earthmat level.
- 6.11** The earthing of all the equipments/ structures placed in the switchyard will be done through suitable size riser of MS flats.
- 6.12** The general norms for earthing conductors and flats shall be as under which are subject to change as per approved design/ drawings:

<u>S.No.</u>	<u>Item</u>	<u>Size</u>	<u>Material</u>
(i)	Main Earthmat Conductor and Earthing Electrode	40 mm dia	MS rod
(ii)	Earthing of Transformer, Circuit Breakers, L.A, Isolator, CVT/PT, CT, Bus Support and Main and Auxiliary structures.	75x12 mm	MS flat
(iii)	Earthing of Pale Fencing, Gate, Lightning mast, Control/ Relay and Protection Panel, ACDB/ DCDB panels, Outdoor Marshalling Boxes, Junction Boxes and Lighting Panels, Distribution Boards, PLCC equipments	50x6 mm	MS flat
(iv)	Cable trenches	25x6 mm	MS flat
(v)	Lighting poles	10 SWG	GS Wire

6.13 EARTHING CONDUCTOR LAYOUT

- (i) Earthing conductors in outdoor areas shall be buried at a suitable depth below ground level as per the approved earth mat design.
- (ii) Wherever earthing conductor crosses cable-trenches, underground service ducts, pipes, tunnels, railway track etc. it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundation.
- (iii) Tap-connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment structure.

- (iv) Earthing conductors or leads along their run on cable trench ladder columns, beams, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- (v) Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building, in case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such locations.
- (vi) Earthing conductors crossing the road shall be laid 300 mm below road or at greater depth to suit the site conditions.
- (vii) Earthing conductors embedded in the concrete shall have approximately 50 mm concrete cover.

6.14 EQUIPMENT AND STRUCTURE EARTHING

- (i) Earthing pads shall be provided for the apparatus/ equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not already provided on any item to be earthed, arrangement for same shall be made by the Bidder.
- (ii) Whether specifically shown in drawings or not, steel/ RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two independent earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rail and metallic stairs.
- (iii) Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.
- (iv) Metallic conduits shall not be used as earth continuity conductor. A separate earthing conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits etc. Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete, it shall be bonded to the same.
- (v) Light poles, junction boxes on the poles, cable and cable boxes/ gland 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.
- (vi) Railway tracks within switchyard area shall be earthed at a spacing of 30m and also at both ends.
- (vii) Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

- (viii) The stone spreading shall also be done 2000 mm outside switchyard fence. The criterion for stone spreading shall be followed in line with requirement specified elsewhere in the specification.
- (ix) Flexible earthing connectors (formed by using lugs at the ends of AAC/ ACSR conductor) shall be provided for the moving parts.
- (x) All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of Indian Electricity Rules.
- (xi) A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.
- (xii) 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Alternatively the earthing conductor shall be welded along the rack supporting flat. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat above ground shall be finally painted with two coats of red oxide primer and two coats of Post Office red enamel paint.

6.15 JOINTING

- (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) Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red lead and afterwards coated with two layers of bitumen compound to prevent corrosion.
- (iii) Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- (iv) Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- (v) 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.
- (vi) Bending of earthing rod shall be done preferably by gas heating.
- (vii) All arc welding with large diameter conductors shall be done with low hydrogen content electrodes.
- (viii) The 75x12mm GS flat shall be clamped with the equipment support structures at 1000 mm interval.

6.16 POWER CABLE EARTHING

- (i) Metallic sheaths, screens or shields and armour of all multi core cable shall be earthed at both end.
- (ii) Metallic sheaths and armour of single core cable shall be earthed only at switch gear end and kept insulated at other end.

6.17 EARTHING FOR GIS

6.17.1 To limit the undesirable effects caused by circulating currents, the following requirements should be met:

- (i) All metallic enclosures should normally operate at ground.
- (ii) When grounded at the designated points, the bus enclosure design should ensure that no significant voltage differences exist between individual enclosure sections and that neither the supporting structures nor any part of the grounding systems is adversely influenced by the flow of induced currents.
- (iii) To avoid the circulation of enclosure currents beyond regular return path within the GIS assembly, power cable sheath grounds should be tied to the ground system via connections that are separated from the GIS enclosures. To facilitate this isolation, the design of cable terminations (pot heads) should be such that an isolating air gap or proper insulation elements are provided.
- (iv) Enclosure return currents also cannot be permitted to flow through any externally mounted current transformers.

6.17.2 Further, GIS manufacturer shall provide and be responsible for:

- (i) Providing the subassembly-to-subassembly bonding to assure safe voltage gradients between all intentionally grounded parts of the GIS assembly and between those parts and the main ground bus of the GIS.
- (ii) Furnishing readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces and normal abuse, and that are capable of carrying the anticipated maximum fault current in that portion of the circuit without overheating.
- (iii) Providing ground pads or connectors, or both, allowing, at least, for two paths to ground from the main bus, or from each metallic enclosure and auxiliary piece of GIS equipment designated for a connection to the station ground if the main ground bus of the GIS assembly does not actually exist. Proposing essential method for connections between different type of metals, typically between a copper cable or a similar ground conductor and aluminium enclosure.

6.17.3 The following points should also be considered for GIS Grounding:

- (i) Precautions should be undertaken to prevent excessive currents from being induced into adjacent frames, structures, or reinforcing steel and to avoid establishment of current loops via other station equipment, such as transformers or separate switchgear. If there is the

possibility of undesirable current loops via ground connections, or if any sustained current path might partially close or pass through grounded structures, the station grounding scheme and the physical layout should be carefully reviewed.

- (ii) Equal care is needed in the proximity of discontinuities in enclosure grounding paths at the transformer connections to GIS and at the interface points to conventional switchgear to prevent circulating currents in the circuit breaker and transformer tank steel.
- (iii) Where applicable, all isolating elements should be able to withstand to full potential difference that may occur between the locally grounded system and that external to GIS. The isolation of metal parts shall be made by means of ceramic or plastic inserts. Adequate creepage distance shall be ensured.

7.00 SPECIFIC REQUIREMENT FOR EARTHING SYSTEM

7.01 TRANSFORMER

- (i) The transformer tank shall be earthed at two distinct specified points provided on the tank with the help of 75x12mm M.S. Flat.
- (ii) The Marshalling box shall be earthed and connected to the earth electrode.
- (iii) The neutral of the transformer shall be solidly earthed, independent of the transformer tank which shall be connected to 40mm MS electrodes separately grounded. The neutral bushing shall be connected with 75x12mm MS Flat using two nos. copper flexible bands fastened with GI nuts and bolts.
- (iv) Each earthing lead from the neutral of power transformer shall be directly connected to two rod electrodes separately, which in turn, shall be connected to the main earth mesh. All accessories associated with transformer like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

7.02 LIGHTING ARRESTER

- (i) For earthing of LA first of all the 6 nos. electrodes shall be grouted and connected in rectangular form with the help of 75x12mm M.S. flat laid on its edge and then this rectangle so formed is connected to main earth grid at two places in opposite direction.
- (ii) The earthing of LA is to be done through discharge counter and shall be connected to earthing electrode.
- (iii) The structure of LA shall be earthed at two points.

7.03 CIRCUIT BREAKER

- (i) The structure of each pole shall be earthed at two diametrically opposite points which shall be connected to nearest main earth grid with the help of 75x12mm M.S. flat.

- (ii) The control box shall be separately earthed and connected to main earth grid.
- (iii) Stiffeners of M.S. Angle 50x50x6 mm shall be used wherever required.

7.04 ISOLATORS

- i) Each pole structure shall be earth at two places.
- (ii) Earth switch of isolator shall be separately earthed with the help of 75x12mm M.S. flat and will be clamped with structure with the help of cleats provided at 750mm distance.
- (iii) Isolator base to pole structure shall be connected with help of flexible bond.
- (iv) Control box for earthing switch shall also be earthed.

7.05 INSTRUMENT TRANSFORMER (CT/CVT/PT)

- (i) The secondary windings of instrument transformers shall be earthed at one point preferably at control panel by 8 SWG galvanized steel wire.
- (ii) The enclosing case and metal supporting frame work shall be earthed by 75x12mm M.S. Flat at two places.
- (iii) Earthing terminal of each capacitor voltage transformer shall be directly connected to rod earth electrode, which in turn, shall be connected to station earthing grid.

7.06 POST INSULATOR

- (i) Metal base of each insulator stack and supporting structure steel shall be earthed using one 75x12mm M.S. Flat.

7.07 SWITCH YARD FENCE AND GATE

- (i) The two angle support of pale fencing gate shall be earthed with 50x6mm flat which will be connected to earthing electrode specially grouted for gate independent of main earth grid electrodes.
- (ii) After that the two electrodes shall be connected with 50x6mm flat which in turn will be connected to main earth grid at two places in opposite direction.
- (iii) The pale fencing and chain link fencing shall be earthed by 50x6mm flat at interval of 6m and connected to nearest main earth grid. This means that every alternate upright support shall be earthed.

7.08 EQUIPMENT STRUCTURE

These will be earthed by 75x12mm M.S. flat at two diametrically opposite points and shall be connected to main earth grid near to it.

7.09 MAIN STRUCTURES WITHOUT LIGHTNING PROTECTION SHIELD WIRE

- (i) Any two diametrically opposite legs of each main structures with or without peak in yard shall be earthed by 50x6mm M.S. flat connected at base of the support which in turn will be connected to main earth grid at two places in opposite direction.

7.10 MAIN STRUCTURES WITH PEAK

- (i) Where peaks is provided on tower and earth wire from line tower inter connecting tower is connected to peak, the earth wire must be connected to earth mat using the same conductor as per earth wire.

7.11 CABLE TRENCH

- (i) M.S. flat of 25x6mm shall continuously run on cable racks grouted in the trench. The flat shall be in contact with one wall after trench.
- (ii) The top rack angle of trench shall be connected with the M.S. flat 25x6mm already running on the bottom rack angle by another 25x6mm flat at every 750mm where the angles are grouted in the wall.
- (iii) The 25x6mm M.S. Flat running over the bottom rack shall be welded with each and every angle piece of bottom rack.
- (iv) The above flat shall be connected to main earth grid at an interval of 30m with 25x6mm M.S. flat.

7.12 LIGHTING POLE

- (i) Each street light pole grouted in yard shall be earthed with the help of 10 SWG galvanized steel wires which will be bolted with the pole 300mm above ground level and the 2nd end shall be connected to main earth grid.
- (ii) Junction Boxes on the poles, flood lighting supporting structures etc. shall also be earthed by 10 SWG galvanized steel wire which shall be run along with the supply cable and shall be connected to main earth grid at two points.

7.13 CONTROL, RELAY AND OTHER PANELS

- (i) All control and relay panels shall be connected first with one M.S. flat of 50x6mm at points marked in panels with the help of nuts and bolts and then the flat 50x6mm shall be connected with main earth grid all around control room building in two opposite direction.

- (ii) Battery chargers and Distribution boards shall also be connected with 50x6mm MS Flat and which in turn shall be connected to main earth grid around control room in two opposite direction.
- (iii) All other panels such as PLCC etc. shall also be earthed with 50x6mm M.S. flat and shall be connected to main earth grid

7.14 MISCELLANEOUS ITEMS

The various other items which are not covered under the various heads as enumerated above shall also be covered under the scope of this work. Their earthing shall be done as directed by Engineer at site.

8.00 GENERAL NOTES ON EARTHING

8.01 LAYING OF M.S. FLAT

- (i) The M.S. rod, MS flat and G.I. Wire shall be laid below the ground level in each area as per drawing.
- (ii) MS Flat shall be laid inside ground on its edge as well as on flat depending upon situation.
- (iii) Wherever the earthing conductor crosses the trench it shall be in the bottom of trench.

8.02 WELDING

- (i) Surfaces to be welded shall be made absolutely free from grease, paint, oil and scales etc.
- (ii) All welds shall be free from defects like blow holes, slug inclusion, lack of penetration etc. welds shall show uniform sections and weld size need not exceed thickness of thinner part joined.
- (iii) Welding electrode used shall be ISI mark only.
- (iv) Earthing strips if crossing each other or any other structure shall be welded on that point.
- (v) The MS flat shall be wrapped around the 40 mm round M.S. bar of main earth grid and shall be welded on both sides and width of flat on top as shown in relevant drawing no. 8/004.
- (vi) M.S. Flat shall be lap jointed with over lapping being 150 mm. The welding shall be done along the length and breath in all direction.

8.03 HOLES

- i) Holes in the M.S. Flat shall be either punched or drilled. However drilled holes shall be preferred.
- (ii) All burrs left after drilling or punching shall be removed completely.

- (iii) Holes adjacent to bends shall be drilled or punched after bending.
- (iv) Holes shall be invariably circular oval or lobbed forms of hle shall not be permitted.
- (v) The size of the hole shall be according to bolt provided in various equipments at the place of earthing. But in all cases the diameter of the hole shall be only 1.5mm more than the diameter of the bolt in place for earthing of equipment.

8.04 CUTTING AND BENDING

- (i) The M.S. Flat shall be given bend of 90° over the foundation of structures while welding it with structure.
- (ii) While bending the M.S. flat, it should be ensured that fracture of material does not take place.
- (iii) Cold bending in case of smaller section such as 25x6 or 50x6mm and hot bending in case of 75x12mm can be done.
- (iv) All cuttings of flat should be done either by punch or by hacksaw blade but in no case there may be any burr on the edge end. It should be properly filed.

8.05 PAINTING

- (i) To avoid rusting all the under ground welds should be cleaned properly and painted with two coats or black bituminous paint.
- (ii) All earthing leads above ground level shall be painted with one coat of red oxide primer and then with two coats of anti corrosive green paint.
- (iii) The G.I. structure at the place of welding shall be painted with zinc rich oxide paint.
- (iv) The M.S. angle wherever used as stiffener shall also be painted with two coats of anti corrosive paint.

8.06 OTHERS

The other technical works shall also be carried out as per UPPTCL practice for 400/220/132kV Substations and as directed by the Engineer.

9.00 EQUIPMENTS ERECTION DETAILS

- (i) For equipment interconnection, the surfaces of equipment terminal pads, Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/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.
- (ii) Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.

- (iii) All support insulators, circuit breaker interrupters/modules and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.
- (iv) The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.
- (v) Handling of equipment shall be done strictly as per manufacturer's/supplier's instructions/instruction manual.
- (vi) Handling equipment, sling ropes etc. should be tested periodically before erection for strength.
- (vii) Bending of Aluminium tube and 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.
- (viii) 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.
- (ix) All equipment, instruments and auxiliaries required for testing and commissioning of equipment shall be arranged at site by the contractor.

10.00 STORAGE

The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments 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/ Purchaser shall be strictly adhered to.

11.00 CABLE LAYING AND TERMINATIONS

11.01 CABLE TAGS AND MARKERS

- (i) Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.
- (ii) The tag shall be of aluminum 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 cable and of circular shape for control cables.
- (iii) Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate.
- (iv) Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joints".
- (v) The marker shall project 150mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.
- (vi) Cable tags shall be provided on all cables at each end (just before entering the equipment

enclosure) on both sides of a wall or floor crossing, on each duct /conduit entry and at each end & turning point in cable tray/ trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cable enter together through a gland plate.

11.02 STORAGE AND HANDLING OF CABLE DRUM

Cable drum shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In the absence of any indication the drums may be rolled in the same direction as it was rolled during taking up the cables.

11.03 CABLE SUPPORTS AND CABLE TRAY MOUNTING ARRANGEMENTS

- (i) The Contractor shall provide embedded steel inserts on concrete floors/ walls to secure supports by welding to these inserts or available building steel structures.
- (ii) The supports shall be fabricated from standard structural steel members.
- (iii) 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.

11.04 CABLE TERMINATION AND CONNECTIONS

- (i) The termination and connection of cables shall be done strictly in accordance with manufacturer's instructions, drawing and/or as directed by the Purchaser.
- (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.
- (iii) Supply of all consumable/ non-consumable materials required for cable laying and terminations shall be included in erection prices.
- (iv) The equipment are 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.
- (v) Control cable cores entering control panel/ switchgear/ MCCB/ Miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.
- (vi) The Contractor shall tag/ ferrule control cable cores at all terminations, as instructed by the Purchaser. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number as well.
- (vii) Spare cores shall be similarly tagged with cable numbers and coiled up.

- (viii) All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.
- (ix) Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Bidder for all power and control cables to provide dust and weather proof terminations.
- (x) The cable glands shall conform to BIS: 6121. They shall comprise of heavy duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.
- (xi) The cable glands shall also be suitable for dust proof and weather proof termination. The test procedure, if required, has to be discussed and agreed to between Purchaser and cable gland manufacturer.
- (xii) 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, as directed by the Purchaser.
- (xiii) Crimping tools used shall be of approved design and make.
- (xiv) Cable lugs shall be tinned copper solder less crimping type conforming to IS-8309 & 8394. Bimetallic lugs shall be used depending upon type of cables used.
- (xv) Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

11.05 STORAGE AND HANDLING OF CABLE DRUMS

Cable drums shall be unloaded, handled and stored in approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

11.06 DIRECTLY BURIED CABLES

- (i) The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers. The bidder shall ascertain the soil conditions prevailing at site, before submitting the bid.
- (ii) The cable (power and control) between LT station, control room, DG set location and fire fighting pump house shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.
- (iii) Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the markers.

11.07 INSTALLATION OF CABLES

- (i) Cabling shall be on cable racks, in built-up trenches, vertical shaft, excavated trenches for direct burial, pulled through pipes and conduit laid in concrete ducts, run bare and clamped on wall/ceiling/steel structures etc., as per approved drawings in detailed Engineering stage. Where specific cable layouts are not shown on drawings, Contractor shall route these as directed by the purchaser.
- (ii) The Contractor shall fabricate and install mounting arrangements for the support and installation of all the cables on angles in the trenches. These mounting structures/cable racks shall be fabricated from structural steel members (channels, angles and flats) of the required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of "Technical Specification Of Main And Auxiliary Structures" in addition to the specification given herein.
- (iii) All interpole cables (power, control and optical fibre) for all equipment, shall be laid in cable trenches conduit pipes as per site requirements of minimum 50 mm nominal outside diameter of class 4 as per IS: 4985 and relevant standards which shall be buried in the ground at a depth of 250 mm below finish formation level. The interpole cabling piping of breakers shall be laid in cable trenches. Separate pipes shall be laid for power, control and optical fibre cables. *Cable pull boxes of adequate size shall be provided if required.* The scope shall include all labour, material, equipment, for transporting, laying, burying etc., including required bends and end seals.
- (iv) Control cable shall be terminated in the local control cubicle of relay and protection panels with SAS system. The optical fibre shall be laid and terminated from LCC to main control panel as per actual requirement.
- (v) Cables shall be generally located adjoining the electrical equipment through the pipe embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as recommended by the cable manufacturer shall be maintained.
- (vi) 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 aluminum paint. The red oxide and zinc chromate shall conform to IS: 2074.
- (vii) Suitable arrangement shall be used between fixed pipe/cable trays and equipment terminal boxes, where vibration is anticipated.
- (viii) Cables from the equipment to trench shall run in conduits. Necessary conduits of adequate sizes and length shall be supplied and installed by the contractor. Flexible conduit should be used between fixed conduit/cable trays (perforated type) and equipment terminal boxes, where vibrations are anticipated. The flexible conduit shall be as per the relevant IS.
- (ix) Power and control cables in the cable trench shall be laid in separate tiers The order of laying of various cables shall be as follows, for cables other than directly buried.
 - a) Power cables on top tiers.

b) Control/ instrumentation and other service cables in bottom tiers.

- (x) Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil center lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables.
- (xi) Trefoil clamps for single core cables shall be of pressure die cast aluminum (LM-6), Nylon-6 or fiber glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 meter of cable runs.
- (xii) Power and control cables shall be securely fixed to the trays/ supports with self locking type nylon ties with de-interlocking facility at every 5 meter interval for horizontal run. Vertical and inclined cable runs shall be secured with 25mm wide and 2mm thick aluminum strip clamps at every 2 m.
- (xiii) Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:

Type of cable	Minimum bending radius.
Power cable	12 x D
Control cable	12 x D

Where D is overall diameter of cable.

- (xiv) Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one meter depth.
- (xv) In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/ two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.
- (xvi) Selection of cable drums for each run shall be so planned as to avoid using, straight through joints. Cable splices will not be permitted except where called for, by the drawings, unavoidable or where permitted by the Purchaser. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputed make.
- (xvii) Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.
- (xviii) Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Purchaser.
- (xix) Rollers shall be used at intervals of about two metres while pulling cables.
- (xx) All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.
- (xxi) Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be

provided underneath the panels.

- (xxii) Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS: 1255/ IS: 7255 and other Indian Standard Codes of practices.
- (xxiii) Wherever cable pass through floor or through wall openings or other partitions, GI/ PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor.
- (xxiv) Contractor shall remove the RCC/ steel trench covers before taking up the work and shall replace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.
- (xxv) Contractor shall furnish three copies of the report on work carried out in a particular week, indicating cable numbers, date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.
- (xxvi) Contractor shall paint the tray identification number on each run of trays at an interval of 10m.
- (xxvii) In case the outer sheath of cable is damaged during handling/ installation, the Contractor shall repair it at his own cost to the satisfaction of the Purchaser. In case any other part of the cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Purchaser, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.
- (xxviii) All the terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs with insulating tape, sleeve or paint.

11.08 CABLE TRAYS

- (i) The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2 mm.
- (ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specifications and materials shall comply with all requirements of the specifications. The tests shall include the following:
 - a) Test for galvanizing (Acceptance test)
The test shall be done as per approved standards.
 - b) Deflection Test (Type Test)

A 2.5 meter straight section of 300mm, 600mm wide cable tray shall be simply supported at two ends. A uniform distributed load 76Kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

11.09 CONDUITS, PIPES AND DUCT INSTALLATION

- (i) Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume

pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland sealing fittings, pull boxes etc as specified and to be shown in detailed drawing.

The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

- (ii) Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.
- (iii) All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.
- (iv) When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on each conduit to facilitate easy dismantling of two conduits.
- (v) Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. GI pull wire of adequate size shall be laid in all conduits before installation.
- (vi) Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.
- (vii) Embedded conduits shall have a minimum concrete cover of 50 mm.
- (viii) Conduit run sleeves shall be provided with the bushings at each end.
- (ix) Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end with the help of bushings. Bushings shall have rounded edges so as not to damage the cables.
- (x) Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half of the arc length of the bend shall be embedded.
- (xi) All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.
- (xii) For underground runs, Contractor shall excavate and back fill as necessary.
- (xiii) Contractor shall supply, unload, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes, ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed male plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits.

- (xiv) All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.
- (xv) Size of conduit for lighting shall be selected by the Contractor during detailed engineering.
- (xvi) Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.
- (xvii) Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.
- (xviii) Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.
- (xix) Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.
- (xx) Spacing of embedded conduits shall be such as to permit flow of concrete between them.
- (xxi) Where conduits are placed alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.
- (xxii) For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.
- (xxiii) Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.
- (xxiv) Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.
- (xxv) Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.
- (xxvi) For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.
- (xxvii) Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.
- (xxviii) Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- (xxix) Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall

be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

- (xxx) The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bonding shall be provided around the joint to ensure a continuous ground circuit.
- (xxxi) After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.
- (xxxii) Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

12.00 JUNCTION BOX

- a) 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.
- b) Junction boxes having volume less than 1600 cubic centimeters may be installed without any support other than that resulting from connecting conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that they are level, plumb and properly aligned to present a pleasing appearance.
- c) Boxes with volumes equal to or greater than 1600 cubic cm, and smaller boxes terminating on less than two rigid metallic conduits or for other reasons not rigidly held, shall be adequately supported by auxiliary steel of standard steel shapes or plates to be fabricated and installed. The Contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment of supports.

13.00 ERECTION OF METERING SYSTEM AND SCADA

The Contractor shall install metering system as per specifications on selected feeders and SCADA (if required) and shall synchronize it with existing RLDS.

14.00 ERECTION OF ASSOCIATED SYSTEMS

The Contractor shall carryout the complete erection of Illumination system, Diesel generating sets, Fire protection system, Oil filtration plant, Air conditioning and ventilation system etc. as per relevant specifications, applicable standards, manufacturer's and Purchaser's instructions.

15.00 TESTING AND COMMISSIONING

- (i) The Contractor shall carryout all the required and/ or specified tests on equipments/ systems before commissioning and putting into operation.
- (ii) An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the instructions of the equipment manufacturer and Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of

instruments to the Purchaser for approval.

15.01 GENERAL CHECKS

- (a) Check for physical damage.
- (b) Visual examination of zinc coating/plating.
- (c) Check from nameplate that all items are as per order/ specification.
- (d) Check for tightness of all bolts, clamps and connecting terminals using torque wrenches.
- (e) For oil filled equipment, check for oil leakage, if any. Also check for oil level and top up wherever necessary.
- (f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.
- (g) Check cleanliness of insulators and bushings.
- (h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.
- (i) Check for surface finish of grading rings (Corona control ring).
- (j) Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted.

15.02 STATION EARTHING

- a) Check soil resistivity.
- b) Check continuity of grid wires.
- c) Check earth resistance of the entire grid as well as various sections of the same.
- d) Check weld joint and application of zinc rich paint on galvanized surface.
- e) Dip test on earth conductor prior to use.

15.03 CONDUCTOR STRINGING WORK, BUS WORK AND POWER CONNECTORS

- a) Physical check for finish.
- b) Electrical clearance check.
- c) Testing of torque by torque wrenches on all bus bar power connectors and other accessories.
- d) Millivolt drop test on all power connectors.
- e) Sag and tension checks on conductors.

15.04 ALUMINIUM TUBE WELDING

- a) Physical check
- b) Millivolt drop test on all joints.

- c) Dye penetration test & Radiography test on 10% sample basis on weld joints.
- d) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

15.05 INSULATORS

Visual examination for finish, damage, creepage distance etc.

15.06 TRANSFORMERS

- a) Dielectric test of oil.
- b) Insulation resistance of all windings.
- c) Voltage ratio test on all taps.
- d) Vector group test.
- e) Operational test of OLTC.
- f) Buchholz relay operation test.
- g) Operation test of cooling equipment.
- h) Operation test of all protective devices and interlocks.
- i) Insulation resistance of control wiring.
- j) Measurement of core loss of all transformers.
- k) Measurement of winding resistance.
- l) Calibration of temperature indicators and temperature relays.

15.07 MOTORS

- a) Insulation resistance.
- b) Phase sequence & proper direction of rotation.
- c) Any motor operating incorrectly shall be checked to determine the cause & the conditions corrected.

15.08 INSULATION RESISTANCE TEST

The insulation resistance test shall also be carried out on the following equipment

- | | |
|-----------------------------------|------------------------------------|
| a) All Bus installations | by 5000 Volt motor operated meggar |
| b) 415 Volt power circuits | by 1000 Volt meggar. |
| c) 110 Volt D.C. Control circuits | by 500 Volt meggar. |

15.09 PHASING OUT

The phasing out of all supplies in the station system shall be carried out.

15.10 ANY OTHER TEST

The Purchaser may ask for such additional tests on sites as in his opinion are necessary to determine that the works comply with the specification, manufacturers' instruction, I.S. Code of installation. The Contractor shall also have to conduct any additional test which Engineer shall deem necessary to satisfy the requirements of the governing parameters and constants of the substations

15.11 The Contractor shall provide all necessary tools, test equipment, test connections, labour and supervision for the above tests.

15.12 The Contractor shall give advance intimation of testing and commissioning program to Consignee division and concerned T&C division. The tests shall be performed in the presence of the authorized representative of the consignee &/or T&C division unless exempted in writing and in presence of manufacturer's Supervisory Engineer if applicable/ available.

15.13 The Contractor shall provide one copy of check lists and formats for general checks, commissioning tests etc to Consignee division and one copy to Test & Commissioning Division of the Purchaser before commencement of such checks & testing. The Contractor shall record all test values and shall provide two copies of the test data to Consignee division as well as to the Test & Commissioning Division of the Purchaser. Electrical circuits and equipment shall be energized or used at nominal operating voltage only after such reports have been accepted as satisfactory by the Purchaser.