SECTION – 2.23

INSTALLATION

1.0.0 INTRODUCTION

This section covers the requirements of erection, testing and commissioning of all the equipment being supplied by the Bidder the for the BESS plant and associated buildings, MCR, Switchyards and related equipment.

The scope of this specification is to cover the minimum installation guidelines including handling, Unloading, Storage, loading and erection, testing and commissioning of each equipment for BESS Plant Construction.

Bidder shall follow the equipment manufacturer procedures with best engineering practices for installation of every equipment.

2.0.0 CODES AND STANDARDS

Some of the applicable standards, codes and regulations are listed below.

a) IS 10028 Installation and maintenance of transformers
b) IS 10118 Installation and maintenance of switchgear
c) IS 900 Installation and maintenance of induction motors
d) IS 1646 Fire safety of buildings (General) – Electrical installations
e) IS 1255 Code of practice for installation and maintenance of power cables up to and including 33 kV rating
f) IS 732 Electrical wiring installation (system voltage not exceeding 650 V)
g) IS 5216 Guide for safety procedures and practices in electrical works
h) IS 3043 Code of practice for earthing
i) Indian Electricity Act and Rules
j) Fire Insurance Regulations
k) Regulations laid down by the Chief Electrical Inspector of the State
l) Regulations laid down by local authorities

3.0.0 GENERAL REQUIREMENTS

3.1.0 The work shall be carried out in the best workman like manner in conformity with the latest editions / amendments of relevant specifications / codes / standards / regulations.

3.2.0 Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, erecting, testing and commissioning of all items / equipment and care shall be exercised in handling to avoid distortion to stationary structures, marring to finish, or damaging of delicate instruments or other electrical parts.

3.3.0 All the equipment covered under this specification shall be installed in neat, professional manner such that the structures and equipment are level, plumb, squat, properly aligned and oriented. Tolerances shall be as established in the manufacturer's drawings. Clearance around electrical panels and all equipment in Substation shall be as per relevant standards.

3.4.0 The Bidder shall be fully and finally responsible for proper erection and safe and satisfactory operation of the equipment under his scope of work to the complete satisfaction of the Owner. Equipment and material, which are wrongly installed, shall be removed and re-installed to comply with the design requirement at the Bidder's expense, to the satisfaction of the Owner.

3.5.0 The installation shall be carried out in such a manner as to provide access to other equipment installed. The Bidder shall restore floor / wall chipping, road cuttings and other such works done including replacement of equipment removed back to its place and make good damages done to original.

3.6.0 The Bidder shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering. Finished work where required shall be suitably covered to keep it clean and free from defacement or injury. Bidder shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to Contract.

3.7.0 All safety rules and codes as applicable to work shall be followed without exception. All safety appliance and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Bidder for his personnel.

3.8.0 The Bidder shall provide guards and prominently display caution notices if access to any equipment / area is considered unsafe and hazardous. In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation, before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.

3.9.0 The Bidder shall have a separate cleaning gang to clean all equipment under erection as well as the work area and the project site at regular intervals to the satisfaction of Owner. In case this is not done, the Owner will have the right to carry out the cleaning operation and any expenditure incurred in this regard will be to the Bidder account.

3.10.0 The Bidder shall ensure that instruments and gauges to be used for testing and inspection have valid calibration and the accuracy can be traced to National Standards. Valid calibration certificate shall be readily available.

3.11.0 It shall be the Bidder's responsibility to obtain approval from local statutory authorities including Electrical Inspector / CEA, wherever applicable, for carrying out any work or for installation carried out which comes under the purview of such authorities. All such documents and certificates shall be handed over to Owner which then shall be property of the Owner.

3.12.0 The Bidder shall furnish the organisation chart of his site office indicating names, designation, experience of Site-in-charge, supervising staff etc., who will be posted at site for the following within 15 days from the placement of Order:

- Day to day execution of work and supervision
- Testing and commissioning
- For coordination with Owner's representative

The Bidder shall indicate particular activity In-Charge in organization chart & changes it at regular intervals in case a person is on leave or replaced by another person.

3.13.0 Bidder shall furnish a detailed bar chart, a programme of erection and commissioning from equipment delivery and sequence of erection citing various milestones and get them approved by Owner / GIPCL at least four (04) weeks prior to commencement of work at site. The Bidder shall furnish updated bar chart time to time in case of any delay observed against planned activity with catch up plan to complete the overall package in stipulated time.

3.14.0 The Bidder will be required to carry out at site complete erection as well as start up commissioning including performance testing of equipment supplied by him under scope of this tender based on approved drawings, specification and bill of quantities to be submitted by him and got approved by Owner / GIPCL.

3.15.0 For complete erection, testing and commissioning, the Bidder shall be responsible for providing at his cost all necessary tools, tackles and instruments as required. All the required tools, tackles and instruments shall be available on time at site before commencement of the activity in adequate quantity for timely completion of the job.

3.16.0 The installation shall be carried out by electrical license holder, issued by relevant authorities for carrying out installation work of the voltage classes involved, under the direct supervision

of a person holding valid certificates of competency for the same voltage classes, issued or recognized by the state Government. The tenderer shall furnish with his tender the particulars of the license held by him / the electrical Bidder he proposes to engage for carrying out the installation work. The Bidder shall furnish to the Owner the names and particulars of certificates of competency of the supervisors and workmen to be engaged for carrying out the installation work

3.17.0 The installation shall have to be approved by the concerned statutory government authorities like Electrical Inspector (e.g. CEA, CEIG , office of concern electrical inspector etc.), Factory Inspector, Insurance Officials etc. It shall be the responsibilities of Bidder to prepare and submit all necessary drawings (including but not limited to existing switchyard, transformer yard) calculations and test certificates to electrical inspectorate and obtain approval prior to installation and commissioning work and also arrange inspection by them after installation. After inspection, any modification in the equipment of installation that may be demanded by them shall have to be carried out by the Bidder in a stipulated time frame at no extra cost to the Owner. The Bidder shall take all necessary steps to enable the Owner to get the installation approved by the above authorities and shall render all necessary assistance to the Owner in the matter. All above approvals are to be taken by EPC contractor. Payment of any statutory charges, fees, levies shall be reimburse by GIPCL against submission of original receipt. In case of online process of getting approval, EPC contractor shall share user ID, password, registered mail id, registered mobile number to GIPCL. Registration of mobile number and e-mail id shall be finalized in consultation with GIPCL. Submission of any data, documents required for statutory approval process shall be submitted to the concerned authority only after confirmation / concurrence of GIPCL.

3.18.0 The Bidder shall submit at such times and in such forms as may be requested by the Owner, schedule showing the programme and the order in which the Bidder proposes to carry out the work with dates and estimated time for various parts of the work. Such schedules shall be approved by the Owner prior to starting the erection. The Bidder shall adhere to this approved programme for all practical purposes. If, for any reason, the work is held up, the Bidder shall bring it to the attention of the Owner in writing without any delay. During the progress of work, the Bidder shall submit monthly progress report.

3.19.0 For equipment interconnection, the surfaces of equipment terminal pads, aluminium tube, conductor and 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.

3.20.0 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators. All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

3.21.0 Bending of aluminium tube and compressed air piping if any, shall be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. Cutting of the pipes wherever required shall be by a proper pipe cutting tool so as to avoid flaring of the ends. Hack saw shall not be used.

3.22.0 Handling of equipment shall be done strictly as per manufacturers' / suppliers' instructions / instruction manual. Handling equipment, sling ropes etc. shall be tested periodically before erection for strength. The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

3.23.0 All boards shall be made completely rodent & vermin-proof.

3.24.0 Bidder shall take utmost care in holding instruments, relays and other delicate mechanisms wherever these are supplied separately. They shall be installed only after the associated

panels have been erected and aligned. The packing materials employed for safe transit of these shall be removed after ensuring that panel have been completely installed and no further movement of the same are necessary. Any damage shall be immediately reported to Owner.

3.25.0 Equipment furnished with finished coats of paint shall be touched up by Bidder if their surface is scratched or marred while handling.

3.26.0 After installation of panels, power and control wiring and connections, Bidder shall perform operational tests on all switchboards, to verify proper operation of switchboards / panels and correctness of all equipment in each and every respect.

3.27.0 The cable opening and cables entries for cables terminating to the panels shall be sealed with approved fire rated silicon / PU foam type sealant.

3.28.0 All doors of all substation cubicles, operating cabinets, terminal boxes etc. shall be provided with locking facility. Three sets of keys shall be handed over to the Owner after installation.

3.29.0 Typical electrical installation details for cabling, illumination system, earthing and lightning protection system are covered in the drawings enclosed with this specification.

4.0.0 EQUIPMENT INSTALLATION AND STRENGTHENING WORKS

4.1.0 Circuit Breakers / Isolators / CT / CVT / Surge Arrester

4.1.1 Equipment shall be erected by the Bidder in accordance with specified code of practice and manufacturer's instructions.

4.1.2 The circuit breaker, isolator, CT, CVT / VT and surge arrester shall be erected on support structures. The support structure shall be first assembled in position. The equipment shall then be jacked up and fixed on the support frame.

4.1.3 The insulators shall be lifted by using the lifting eyes and soft manila ropes.

4.1.4 The line connection shall be tight and shall not strain the terminals.

4.1.5 Breaker shall be assembled with its pipe work etc. making sure that all gasketed joints are tight and the pipe work is clean and free from moisture.

4.2.0 Switchboards and Panels

4.2.1 All the switchboards and panels shall be installed in accordance with specified codes of practice, drawings furnished and manufacturers' instructions. The switchboards / panels shall be installed on finished surfaces or concrete or steel sills. These panels may be bolted on to the foundation pockets or welded to base frame members.

4.2.2 The Bidder shall be required to install and align any channel sills, which form part of the foundations. Proper aligning, joining of various vertical shipping sections, bus bar connections, inter-panel wiring etc. shall be the responsibility of the Bidder. In joining shipping sections of the switchboards / panels together, adjacent housing or panel sections provided shall be bolted together after alignment has been completed. Power bus enclosures, ground and control splices of conventional nature shall be cleaned and bolted together, being drawn up with torque wrench of proper size or by other approved means.

4.3.0 Battery and Chargers

Battery racks and other supporting / interconnecting accessories shall be installed as per layout arrangement. Each cell of the battery bank shall be inspected for breakage and condition of cover seals as soon as received at site. Each cell shall be filled with electrolyte in accordance with the manufacturer's instructions. Battery shall be set up on racks as soon as possible after receipt, utilizing lifting devices supplied by the manufacturer. The cells shall not be lifted by the terminals. Lead coated copper connectors of rigid flat type shall be used for connectors. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. All the terminals and cell interconnections shall be fully insulated or have insulation shrouds / covers. Interconnectors and studs shall have pre applied manufacturer approved jelly. The cell terminals shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion.

4.4.0 **Lighting System**

4.4.1 The lighting system installation work shall conform to the latest applicable electricity rules, all currently applicable standards, codes of practice, regulations and safety codes of the locality where the installation is to be carried out.

4.4.2 After installation of lighting fixtures / receptacles, panel number and circuit number shall be painted on them at suitable place. Nomenclature for source of supply and outgoing feeders shall be provided and subject to approval of GIPCL.

4.4.3 Mounting height of centre line of the various lighting equipment from FFL / working platforms or finished grade level shall be as noted below unless otherwise specified in corresponding lighting layout drawings:

- Lighting panels / control gear boxes 1500mm
- Receptacle boxes (outdoor) 1000mm
- JB on poles / masts 750mm

4.4.4 Fixture locations shall be coordinated with other work in the same area to prevent interference between lighting fixtures, cranes, monorails, ductwork and piping or other equipment. Any fixture shall be relocated if, after installation, it is found to interfere with other equipment or is so located to prevent its practical and intended use. No fixture shall be located to prevent the full use of any access way beneath a removable grating or slab.

4.4.5 Wooden plugs in walls and ceilings for fixing of lighting fixtures and accessories are not acceptable. A suitable fool-proof method (preferably using nylon rawl plug) of fixing these shall be offered and this shall be subject to Owner's approval.

4.4.6 A four (4) way terminal junction box shall be provided near each lighting fixture, for loop-in, loop-out and connection of lighting wires.

4.4.7 To distinguish emergency AC (UPS) (if applicable) from normal AC fixtures, red painted circular mark of 10mm diameter shall be provided on AC emergency fixtures.

4.5.0 **Conduit Installation**

4.5.1 All conduits not located in finished areas or cast in concrete shall be routed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings.

4.5.2 Conduits supports shall be provided at an interval of 1000mm for horizontal runs and 750mm for vertical runs. Conduit shall be clamped on to 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.

4.5.3 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less then 40mm.

4.5.4 For long conduit runs, junction / pull boxes shall be provided at suitable intervals (not exceeding 10m) to facilitate wiring.

4.5.5 Conduits shall be securely terminated at LPs / junction boxes or lighting fixtures by proper fastening with a lock put on inside and outside. The number of conduits terminating at LPs shall not exceed the permissible number considering the glanding area of lighting panel. Conduit terminations shall be made water and vermin-proof.

4.5.6 The entire FRPVC conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly earthed. Where slip joints are used, suitable bending shall be provided around the joint to ensure a continuous earth circuit. GI pull wire of adequate size shall be laid in all conduits before installation.

4.5.7 Flexible conduits shall be used between fixed conduits and equipment terminal boxes, where vibration is anticipated. Flexible conduit shall be terminated using suitable end coupler and check nut at both ends.

4.5.8 All conduits installed outdoor shall be sloped towards pull boxes, hand holes / manholes for drainage. Low points of conduits not terminating in pull boxes or handholes / manholes shall be provided with weep holes for drainage. Care shall be taken to see that no rough edge is left around the weep holes. Where no provision for drainage can be made, both ends of conduits shall be sealed after cable is laid through. Minimum slope of 1 in 400 shall be provided.

4.5.9 There shall be separate conduits for AC, UPS, Fire System, CCTV, and Communication circuits.

4.6.0 **Installation of Lighting Poles / Masts**

4.6.1 After the pole / mast has been installed and aligned, the luminaire, control gear box and cable shall be assembled and installed, cable connections completed, and the pole / mast, lighting fixture, junction box shall be connected to earth.

4.6.2 The cable from junction box at the bottom of pole / mast upto the lighting fixture shall be supplied by the Bidder.

4.7.0 **Cable Tray Installation**

4.7.1 Pre-installation checks for cable tray installation shall be as under:

- Availability of clear passage / path for the cable tray network as per approved drawings
- Cold galvanization / paint treatment for all damaged portions of galvanization due to cutting, repairs etc
- Correctness of installation of number and type of tray / tray accessories / support material as per approved drawings
- Firmness / tightness of all bolted joints
- Alignment / inter tray separation as per approved layout drawings
- Earthing connections for trays / cable boxes / marshalling boxes

4.7.2 The Bidder shall install galvanized MS sheet covers over top most tray of outdoor cable trays. The width of the covers shall be same as that of cable trays. Bolting shall be done to fasten covers to the cable trays, elbows, reducers, tees, crosses etc.

4.7.3 Straight pieces of standard MS angles / channels shall be used for fabrication of supports / racks. All welded joints shall be smooth enough to provide a good appearance and shall not cause injury to working personnel. Zinc based coating shall be used as a protective coating for welded joints.

4.7.4 Cable trays / racks shall be so arranged that they do not obstruct or impair clearances of passage way and maintenance of adjacent equipment, if any.

4.8.0 **Cabling Work**

4.8.1 Laying, dressing, clamping and jointing / termination process of power, control and instrumentation cables shall follow the requirements of IS 1255. All cables shall be checked by megger and core identification shall be done.

4.8.2 Suitable extra length of cables shall be provided for all feeders for any future contingency. Additional lengths shall be as under:

- Power cables: one loop with permissible bending radius
- Control cables: 1 -1.5 meter

4.8.3 Cable runs shall be uniformly spaced, properly supported and protected in an approved manner. All bends in runs shall be well defined and made with due consideration to avoid sharp bending and kinking of cable. The bending radius of various types of cables shall not be less than those specified by cable manufacturers and that specified in IS 1255.

4.8.4 All cables and conduit runs shall be provided with identification tags indicating the cable numbers in accordance with the cable & conduit schedule.

4.8.5 The tag shall be of SS-304 / SS-316 / Aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of non-corrosive stainless steel tie / nylon tie conforming to IS: 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Minimum thickness of cable tag shall be 4.0 mm. Size of the cable tag shall be minimum 89mm x 19mm and text shall be engraved on the tag plate in such a manner that the same is readable & visible. Text size shall be minimum 12mm.

4.8.6 Cable tags shall be fixed at terminal ends, at tray intersection / bend, at each side of floor / wall / duct crossings etc. and at every 20m in cable trench / tray.

4.8.7 Single core cables for AC circuits shall form a complete circuit in trefoil formation supported by means of trefoil clamps of non-magnetic material.

4.8.8 Segregation of cables on the basis of their types and their functions shall be as under for horizontal formations:

a) HT power cables
b) LT power cables
c) UPS LT Cables
d) Non-shielded control cables
e) Instrumentation (shielded control), thermocouple extension and special noise sensitive cables.
f) Fiber optic cables

4.8.9 In case of duplicate feeders to essential loads, the respective cables shall be laid through separate raceways. Alternatively, such cables shall be laid on the opposite sides of a trench / tunnel / basement.

4.8.10 For directly buried cables, construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or

concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Before the cables are placed, the excavated portion shall be filled with a layer of sand. This sand layer shall be leveled and the cables laid over it. The cables shall then be covered with 150mm sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering with 70mm thick bricks shall then be provided on top. The remaining portion of the excavated trench shall then be back filled with soil, rammed and leveled.

4.8.11 RCC cable route and RCC joint markers shall be provided for HV cables. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint'. The marker shall project 150mm above ground and shall be spaced at an interval of 30m and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker / joint marker shall be sloped to avoid accumulation of water / dust on marker.

4.8.12 Where a cable route crosses a permanent road / railway line, cables shall be drawn through hume pipes or GI pipes. In case high density polyethylene (HDPE) pipes are used, a concrete encasing shall be required. Pipes shall be laid in a straight configuration. Filling criteria in any pipe shall not be more than 40%.

4.9.0 **Cable Termination and Jointing**

4.9.1 All cable entries in the equipment shall be sealed by cable glands.

4.9.2 Adequate length of cables shall be pulled inside the switchboards, control panels, terminal boxes etc so as to permit neat termination of each core / conductor.

4.9.3 Power cable terminations shall be carried out in a manner such as to avoid strain on the terminals by providing suitable clamps near the terminals. Anti-corrosive paste shall be applied to lug before cable crimping.

4.9.4 Control cable cores entering switchboard or control panels shall be neatly bunched and strapped with PVC perforated tapes / nylon ties and suitably supported to keep them in position at the terminal block. All spare cores shall be connected to spare terminals, wherever possible. If spare terminals are not available, spare cores shall be neatly dressed and suitably taped at both ends.

4.9.5 Screened control cables of small cross sectional area, e.g. 0.5mm^2, shall be terminated by means of maxi-termi termination system. Bidder shall ensure the availability of all tools, tackles and accessories such as maxi-termi guns, clips, wire etc. required for the termination of small cross section screened control cables by this method. Compressed air supply for maxi-termi guns shall also be the responsibility of Bidder.

4.9.6 Individual cores of control cables shall have ferrules for identification. Ferrule numbers shall be provided as per control schemes and other related documents.

4.9.7 Fiber optic termination and splicing equipment shall be used for cutting, finishing and joining fiber optic cables. An optical fiber tool shall be used to slice into the cable's outer coating and unpack the fibers without damaging them. Fiber optic cleaners, cleaning chemicals or solvents and cleaner dispensers shall be used for preparation of the cut and polished joint or splice. Fiber optic cables shall be terminated by using connectors to couple the cable to network devices. Fiber optic connectors shall be specifically designed to limit light loss and provide a secure connection to a device. The fiber optic termination connectors shall have a bayonet mount and a cylindrical ferrule to hold the fiber in place.

4.10.0 **Earthing and Lightning Protection System**

4.10.1 Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth upto 600mm deep and 450mm wide, laying of conductor at 600mm depth, brazing / welding / cad welding, if required, of main grid conductor, joints as well as risers of length 500mm above ground at required locations and then backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Bidder shall arrange for suitable soil from outside.

4.10.2 Installation of earth connection leads to equipment and risers on steel structures / walls shall include laying the conductors, welding / cleating at specified intervals, welding / brazing to the main earth grids, risers, bolting at equipment terminals and coating welded / brazed joints by bitumastic paint. Galvanised conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment / structure.

4.10.3 Installation of earth pit shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on pipe / rod / plate electrodes in test pits and connecting to main earth grid conductors.

4.10.4 Installation of lightning conductors on the roofs of buildings shall include construction of upstands, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the downcomers on the walls / columns of the building and connection to the test links to be provided above ground level.

4.10.5 Each lighting poles and lighting / lighting mast junction box shall be earthed by 25 x 3mm GS flat bonded to one (1) 20mm diameter MS earth electrode of 3m length driven vertically in the ground. The flat and electrode shall be supplied by the Bidder and price of these shall be included in the erection price of individual pole / mast. 14 SWG GI wire shall be taken from fixture to JB.

4.11.0 Overhead Line Stringing Work

4.11.1 Stringing work shall mean the activities of fixing of insulator and insulator hardware, jointing, tensioning, clamping with armour rod, providing dampers, repairing of conductors (if any), fixing the conductor at tension hardware etc.

4.11.2 The stringing work shall be carried out with the help of tensioner and puller machine. Manual stringing will not be allowed. Stringing work shall be carried out as per approved sag tension chart.

4.11.3 Sufficient numbers of aluminum snatch blocks shall be used for paying out the conductors. Necessary precautions shall be taken to avoid conductor rubbing on the ground by providing adequate ground roller, rollers on supports etc. Additional rollers shall also be provided to cross thorny hedges, footing and other obstructions to avoid scratching of conductor.

4.11.4 The conductor and earth wire shall be made to sag correctly as per stringing charts, before they are finally transferred to the hardware for conductors and to clamps for earth wire. No joint shall be made at less than 30m from the tower end and no joint shall be permitted in road and other important crossings spans. There shall not be more than one joint in a span of each conductor.

4.11.5 Dynamometers shall be used in tensioning the conductors. All conductors shall be stressed to their maximum working load at the time of stringing, as per approved stringing charts. The minimum clearance between the lowest point of conductor and ground shall not be less than required.

4.11.6 The stringing sheaves, when suspended on the transmission structure for sagging, shall be so adjusted that the conductor will be on the sheaves at the same height as the suspension clamp to which it is to be secured.

4.11.7 Proper guys shall be provided to counter balance the paving out tension of conductor / earth wire at the tension locations, to avoid damage to towers and / or accident.

5.0.0 TESTING AND COMMISSIONING

5.1.0 The Bidder shall take full responsibility of testing at erection, pre-commissioning and commissioning stages of all the equipment / system being installed by him. The Bidder shall submit to the Owner a checklist for testing and commissioning and the activities shall be carried out in accordance with the checklist. The Bidder shall carry out the commissioning tests and checks after erection at site as per applicable standards and also as recommended by manufacturers.

5.2.0 On completion of erection work, the Bidder shall request the Owner for inspection and test. The Owner shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Bidder. The installation shall be then tested and commissioned in the presence of the Owner and put on trial run for stipulated contract period.

5.3.0 The Bidder shall arrange for inspection of his installation work by Electrical Inspector and shall obtain necessary approval certificate for his installation work and charging. Any modification work required by Electrical Inspector must be undertaken by the Bidder at no cost to owner. All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Bidder without any extra cost.

5.4.0 Following successful inspection and testing, all the equipment shall be commissioned and put on trial run in a manner mutually agreed upon based on the commissioning schedule.

5.5.0 The Bidder shall have to bring all testing equipment and instruments in sufficient numbers to carry out the job simultaneously in more than one area. Tests shall be conducted by qualified and experienced personnel. Valid calibration certificates for the testing equipment shall be produced.

5.6.0 All documents / records regarding test data and all other measured values shall be submitted to Owner for approval and subsequent record and reference. The results of all tests shall conform to the specification requirements as well as any specific performance data guaranteed during finalization of Contract.

5.7.0 All checks and tests as per manufacturer's drawings / manuals, relevant codes of installation and commissioning checklists for various electrical equipment such as transformers, breakers, motors, switchgear, relays, meters etc. shall be carried out.

5.8.0 The Bidder shall perform operating tests on all switchgear and panels to verify operation of switchgear / panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment for functional checking of all control circuits, e.g. closing, tripping, control interlock, supervision circuits, alarm circuits etc. All connections in the switchgear shall be tested from point to point for possible earth or phase faults.

5.9.0 Bidder shall submit specified copies of site testing procedures, test formats along with details of site test instruments proposed to be deployed at site along with respective valid calibration certificates, six weeks prior to commencement of site testing, for approval by Owner. Only procedures and test formats approved by Owner shall be used for site testing. After completion of commissioning of all equipment and prior to handing over, six sets of such

signed test data in the agreed / approved formats shall be furnished prior to issue of provisional acceptance of the equipment / installation.

5.10.0 The testing of all electrical equipment as well as the system as a whole shall be carried out at site to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards as well as accepted codes of practice.

5.11.0 All tests shall be carried out by the Bidder using his own instruments, testing equipment as well as qualified testing personnel.

5.12.0 The results of all tests shall conform to the specification requirements as well as any specific performance data guaranteed during finalization of the Contract.

5.13.0 At site, all equipment shall be energized only after certification by the personnel performing the test that the equipment is ready for energizing and with concurrence of the Owner.

5.14.0 The various commissioning checks / tests to be carried out on the various equipment shall be in accordance with applicable standards, CEA guidelines and equipment supplier's recommendation.

5.15.0 The following tests shall be carried out before and during erection, testing and commissioning:

- Check for physical damage
- Visual examination of zinc coating / plating
- Check from name plate that all items are as per order / specification
- Check tightness of all bolts, clamps and connecting terminals using torque wrenches
- For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary
- Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces
- Check cleanliness of insulator and bushings
- Dry film thickness (DFT) checks for painting
- All checks and tests specified by manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection
- Check for surface finish of grading rings (corona control ring)
- Electrical clearance check
- Testing of torque by torque wrenches on all bus bar power connectors and other accessories
- Millivolt drop test on all power connectors
- Sag and tension check on conductors
- Millivolt drop test on all joints
- Dye penetration test and radiography test on 10% sample basis on weld joints
- Test check on 5% sample joints after cutting the weld piece to observe any voids etc
- Visual examination for finish, damage, creepage distance etc. for insulators

5.16.0 All equipment and accessories included in the scope of this contract shall be tested at site after installation during commissioning. The tests and pre-commissioning checks shall include but not limited to the following:

5.16.1 **Lightning Arrester**

a) Leakage current measurement
b) Resistance of earth connection
c) Counter operation

d) Earth continuity
e) IR measurement of stacks

5.16.2 **Switchgear**

a) Check name plate details according to the specification
b) Check for physical damage
c) Check tightness of all bolts, clamps, joints and connecting terminals
d) Check earth connection
e) Check settings of all relays
f) Each wire shall be traced by continuity tests and it shall be made sure that the wiring is as per relevant drawing. All interconnections between panels / equipment shall be similarly checked
g) All wires shall be meggered to earth
h) Functionally, check all control circuits e.g. closing, tripping, control, interlock, supervision and alarm circuit
i) Check connections and wiring
j) Megger all terminals to body
k) Megger AC to DC terminals
l) Test protective relays
m) Test CTs & VTs
n) Test lighting transformer
o) Measure timing and contact resistance of CBs, if any
p) Mili Volt Drop Test
q) Overall scheme testing with alarms / tripping on annunciator and SAS.

5.16.3 **Battery**

a) Check name plate details according to the specification
b) Check for physical damage
c) Check tightness of all bolts, clamps, joints and connecting terminals
d) Check for electrolyte level
e) Check for correct polarity
f) Check charging and discharging cycle (cell volts and specific gravity of all cells)

5.16.4 **Battery Charger / UPS**

a) Check name plate details according to the specification
b) Check for physical damage
c) Check tightness of all bolts, clamps, joints and connecting terminals
d) Check earth connection and earth continuity
e) Check for polarity
f) Functionally check all control circuits
g) Check connections and wiring
h) Megger all terminals to body
i) Test relay cards
j) Test CTs and VTs
k) Test rectifier transformer

5.16.5 **Relay Panels**

a) Check name plate details according to the specification
b) Check for physical damage
c) Check earth connection and earth continuity
d) Check for correct CT/VT terminals
e) Functionally check all control circuits including change over scheme and interlocks
f) Check connections and wiring
g) Megger all terminals to body

h) Test relays and its settings
i) Test communication link

5.16.6 **SCADA SYSTEM**

a) Check name plate details according to the specification
b) Check for physical damage
c) Check earth connection and earth continuity
d) Check for correct CT/PT terminals
e) Functionally check all control circuits
f) Check connections and wiring
g) Megger all terminals to body
h) Test BCUs and their settings
i) Test communication links
j) Carry out functional check
k) Loop testing of all measurement signals and control loops
l) Test protection interlocks
m) Carry out cable continuity checks
n) Carry out functionality of all displays and alarms
o) Check operation of VDUs
p) Check operation of printers
q) Check functioning of all software

5.16.7 **Earthing**

- Check soil resistivity
- Check continuity of grid wires
- Check earth resistance of the entire grid as well as various sections of the same
- Check for weld joint and application of zinc rich paint on galvanised surfaces
- Carry out dip test on earth conductor prior to use
- Check individual earth pit resistance

5.16.8 **Inverter Duty and Auxiliary Transformer**

- Check foundation, its cleanliness, level and centre lines, anchor bolts their positions and straightness, flatness of contacting surface for Transformer skid.
- Check the transformer no and rating as per drawing
- Check availability of all accessories
- Check bushing for cracks, presence of paint or dirt. Bushing to be cleaned as per Bidders instructions
- Ensure the cable connection at the cable box, their tagging and tightness
- Check equipment earthing, connections, tightness and earth resistance value
- Check IR value and winding resistance, ratio test, vector group test

6.0.0 SAFETY REQUIREMENTS

6.1.0 Provisions of Indian Electricity Rules in respect of various safety requirements (specially as provided at Rule 29, 35, 36, 42, 43, 44, 64, 74 to 80, 87 & 92) shall be complied with.

6.2.0 The minimum safety working clearances shall be maintained for the bare conductors or live parts of any apparatus in outdoor substations as per IE rule 64 (2) a) ii).

6.3.0 All practical steps shall be taken to prevent operating the earth moving, lifting and housing machinery in dangerous proximity to a live overhead power line.

6.4.0 Suitable tie ropes shall be used to maintain control of tower sections being raised and positioned wherever possible and proper care shall be taken to see that they do not create any

hazard. The wire rope used for carrying the section shall not be detached before the section is adequately secured.

6.5.0 The erection or maintenance work shall not be carried out during high wind, thunderstorms and heavy rainfall, which would make the work hazardous, except during emergency restoration procedure.

6.6.0 Barricades or barriers shall be installed to prevent accidental contact with energized lines or equipment. Where appropriate, signs indicating the hazard shall be pasted near the barricade or barrier.

6.7.0 Rubber gloves and insulated shoes shall invariably be worn in all cases while operating gang operating switches controlling high tension lines and equipment where accidental contact of operating personnel with live parts are likely. While working near live lines and equipment and working on live low-tension lines and equipment, gloves shall be worn.

6.8.0 Safety belts shall invariably be used in all cases while working on overhead systems like lines, bus bars, substation equipment etc.

6.9.0 Tested insulating mats of suitable voltage grade as per IS specified elsewhere in this tender document shall be kept in front & back of operating panels / switches etc. They shall be checked for condition periodically and replaced as necessary.

6.10.0 Grass, tree, and shrubs etc. shall not be allowed to grow in the yard. The yard shall be laid with stone gravel layer of 100 –150mm thick with grit of 25 to 35mm size.

6.11.0 All equipment shall have number and identification according to the schemes only. The numbering in the Substation and in the control panels shall be same to avoid possibility of any misunderstanding. The single line diagram in the control room shall have same numbering arrangement.

6.12.0 First aid box shall be maintained. These shall be checked periodically and refilled or items replaced as necessary.

6.13.0 Chart for providing relief and treatment of person electrocuted shall be displayed prominently at suitable places in the substation. These shall be checked for condition periodically and replaced as and when necessary.

6.14.0 Fire fighting equipment such as fire buckets filled with sand and fire extinguishers for both electrical and oil fires shall be maintained and kept at easily accessible place in substation

6.15.0 The Bidder shall supply and install all danger plates as per IS 2551. The danger plates shall be written in Hindi, local language and English and shall be provided as required for all electrical equipment.

6.16.0 All safety appliances and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Bidder for his personnel.

6.17.0 The following minimum safety working clearances shall be maintained for the bare conductors or live parts of any apparatus in outdoor substations excluding overhead lines of installations of voltage exceeding 650 volts.

Highest System Voltage (kV)	Safety Working Clearance (Meters)
12	2.6
36	3.0
72.5	3.1
145	3.8
245	5.0
420	6.5

6.18.0 The above safety working clearances are based on an insulation height of 2.44m which is the height of lowest point on the insulator (where it meets the earthed metal) from the ground. "Safety Working Clearance" is the minimum clearance to be maintained in air between the live part of the equipment on one hand and earth or another piece of equipment or conductor (on which it is necessary to carry out the work) on the other.

6.19.0 Suitable interlocks shall be provided in the following cases:

a) Isolators and the controlling circuit breakers shall be interlocked so that the isolators cannot be operated unless the corresponding breaker is in open position.
b) Isolators and the corresponding earthing switches shall be interlocked so that no earthing switch can be closed unless and until the corresponding isolator is in open position.
c) All gates or doors which give access to live parts of an installation shall be inter-locked in such a way that these cannot be opened unless the live parts are made dead. Proper discharging and earthing of these parts shall be ensured before any person comes in close proximity of such parts.

6.20.0 All non-current carrying metal parts associated with an installation shall be effectively earthed to a earthing system or mat which will:

a) limit the touch and step potential to tolerable values;
b) limit the earth potential rise to tolerable values so as to prevent danger due to transfer of potential through earth, earth wires, cable sheath, fences, pipe lines, etc.
c) maintain the resistance of the earth connection to such a value as to make operation of the protective device effective.