



VOLUME-II

SECTION – 2.7

TOWER FOUNDATION, ERECTION, STRINGING AND INSTALLATION OF LINE MATERIALS



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SECTION – 2.7

TOWER FOUNDATION, ERECTION, STRINGING AND INSTALLATION OF LINEMATERIALS

1.0.0 INTENT OF SPECIFICATION

This section covers the scope of the work to be executed for various items of works coming under foundations of self-supporting galvanized lattice towers for 400kV transmission lines of Solar / Wind Hybrid RE Park of 2375 MW Capacity at Great Rann of Kutch Area, Gujarat.

The execution of works for foundation shall be as per relevant IS and in accordance with the CBI&P Publication No. 323 (Transmission Line Manual). Reference to any code/publication shall always mean reference to the latest revised edition of the code/publication including all its amendments upto date, unless otherwise specified. In the event of any conflict between the requirements of this specification and those of the referred codes, the former shall govern.

1.1.0 TECHNICAL SPECIFICATION FOR FOUNDATION OF TOWERS

1.2.0 GEOTECHNICAL INVESTIGATION

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the structures safely and rationally wherever required by the Engineer-in-charge. The procedures and result submissions as in compliance to the IS 1892 and CPWD manuals. A report by a qualified Geotechnical engineer to the effect shall be submitted by the Contractor for OWNER's specific approval giving details regarding data proposed to be utilized for the design. The Contractor shall submit the detailed report as specified in IS: 1892 wherein information regarding the geological detail of the site, summarized observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the Contractor shall submit draft report and after the draft report is approved, the final report in five (5) copies shall be submitted. The site test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of OWNER.

1.2.1 Applicable Design load & load combination shall be added.

1.2.2 DRAWINGS & DOCUMENTS

The Contractor shall submit his detailed schedule for submission of all information, documentation, calculations, drawings, schedules etc within such periods or dates, which are required to guarantee a smooth handling of the project without delays.

After award of contract, the Contractor shall submit the designs, layout and construction drawings and detailed working drawings including fabrication drawings and bar bending schedule for all structures and items covered under the scope of this contract. The quality of the submitted documents must be in accordance with acceptable national practice and allow a speedy checking procedure.

The design drawings shall consist of general arrangement drawings showing location of tower foundation all other related items / services required for the project. Subsequently detailed drawings along with design calculation shall be submitted by the Contractor for approval. Subsequent to approval of GA drawings, fabrication drawings for steel structures and Bar Bending Schedule for RCC structures shall be submitted before commencement of construction.



Detailed dimension drawings and design calculation for all civil and structural works shall be submitted to the Owner for scrutiny and approval. No construction shall commence prior to obtaining of written approval from the Owner. Any approval given by the Owner to the designs & drawings shall not relieve the Contractor of his responsibilities for the correctness of the same and for execution of the work in accordance with the terms of the specifications. Detailed drawings approved by the Owner shall supersede the general drawings when they differ from them.

The drawings bearing the Owner's approval or drawings corrected in accordance with the comments of the Owner shall be deemed to be contract drawings and no variation there from shall be taken without the Owners written consent.

1.3.0 EARTH WORK EXCAVATION

This item of work to be executed as per CPWD specifications and includes dewatering from all sources wherever necessary. Dewatering shall be executed as per CPWD specifications without any additional claims.

1.4.0 EARTH WORK EXCAVATION IN BLASTING PROHIBITED LOCATIONS

Excavation in hard rock or rock boulders of size more than 0.5m^3 in volume to be carried out by wedging, barring, picking using rock drills, hammer, rock breaking tools attached to excavator etc. without resorting to the use of conventional explosive methods at locations where such excavation is specifically ordered by the Engineer in charge in lifts as specified and conveying and depositing the excavated rock etc. at places within a distance of 50m as directed by the Engineer in Charge.

1.5.0 ROCK EXCAVATION USING NON-EXPLOSIVE AGENTS (CHEMICAL)

Excavation in hard rock or rock boulders of size more than 0.5m^3 in volume by use of non-explosives methods using specified chemical without resorting to the use of conventional explosive methods at locations where such excavation is specifically ordered by the Engineer-in-charge in all lifts and conveying and depositing the excavated rock etc. at places within a distance of 50m as directed by the Engineer in Charge. Necessity of usage of chemical will be decided by Engineer-in-charge. The location where the rock excavation is to be carried out by non-explosives methods (Chemical) will be decided by the Engineer in charge depending upon site conditions.

1.6.0 CONCRETING

This item of work to be executed as per CPWD specifications and includes dewatering from all sources wherever necessary.

Unless required otherwise, cement used shall be Sulphate Resistant Cement conforming to IS 12330. Special cement, as appropriate, shall be used for structures, or portions of structures, exposed to chemicals. The type of cement shall be as per the soil investigation report. All structural concrete shall be design mixes only. Ready mix concrete may be used where feasible, minimum cement content shall be 370 kg / m^3 of concrete unless otherwise specified in the detailed soil investigation report.

The following grades of concrete as per IS : 456 shall be adopted for the type of structures noted against each.

M 35 - RCC structures below ground (min).



M 35 - RCC structures above ground (min). M 35 –

M15 - PCC 1 : 4 : 8

Reinforcement fixing shall be as per IS 2502. Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening therein reinforcement. Spacers shall be cast from concrete of the same quality as that in which they will be embedded. Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size. Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the contractor shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.

Formwork shall be designed and constructed so as to remain sufficiently rigid during placing and compaction of concrete and shall be such as to prevent loss of cement slurry. The face of formwork in contact with concrete shall be cleaned and treated with form release agent. Striping out formwork shall be as per IS:456 standards. Formwork shall be in good condition to have good surface of concrete. Approved quality make and same grade of Concrete spacer block shall be provided as a cover in concrete structure

1.7.0 PILING

Since the diameter of pile can be ascertained only after detailed geo-technical investigation contractor has to submit the calculations and approval of pile diameter to OWNER. Contractor has to execute the pile in the specified diameter and to the specified depth in this item. The rate quoted by the contractor is inclusive of structural design of piles, all costs towards shifting, making ring bunds, access bunds, dewatering etc. complete for all diameters of piles. The work has to be carried out as per latest IS specifications.

Construction and installation of RCC bored/ driven cast-in- situ / pre-cast piles

Following list of Bureau of Indian Standard Codes is to be followed for the Design, construction and installation of RCC bored cast in situ piles.

1. IS-2911 (Part 1/Sec. 1) Code of practice for Design and Construction of pile foundation. Driven cast-in-situ piles.
2. IS-2911 (Part 1/Sec. 2) Code of practice of Design and Construction of pile foundation. Bored Cast-in-situ piles.
3. IS-2911 (Part 1/Sec. 3) Code of practice for Design and Construction of pile foundation. Driven pre-cast concrete piles.
4. IS-2911 (Part 1/Sec. 4) Code of practice for Design and Construction of pile foundation. Bored pre-cast concrete piles.
5. IS-2911 (Part 3) Code of practice for Design and Construction of pile foundation. Under reamed piles.
6. IS-2911 (Part 4) Code of practice for design and Construction of pile foundation. Load test on piles.
7. IS-5112 Safety Code for piling and other deep foundations.
8. IS-6426 Specification for pile driving hammer.
9. IS-6427 Glossary of terms relating to pile driving.
10. IS-6428 Specification for pile frame.



11. IS-9716 Guide for lateral dynamic load test on piles.
12. IS-14362 Pile boring equipment. General requirements.

The design of pile foundations and pile cap shall be as per the relevant IS codes.

Load Testing of Piles-Vertical, Pull out & lateral

The bearing capacity of a single or group of piles shall be determined from test loading. It is most direct method for determining safe load on pile and it is more reliable on account of its being in-situ test. The load test on a concrete pile shall not be carried out earlier than 28 days of its casting. Initial test shall be carried out on test pile which is not used as working pile and Routine tests shall be carried out as a check on working pile. Routine test shall be done as per IS 2911. Load tests shall generally conform to provision made in IS 2911 (Part IV).

1.8.0 CONSTRUCTION OF TOWER FOUNDATION

SETTING OF STUBS

The stubs shall be set correctly and precisely in accordance with approved method at the exact location, alignment and levels with the help of stub setting templates and levelling instruments. Stubs setting shall be done in the presence of OWNER's representative available at site where required and for which adequate advance intimation shall be given to OWNER by Contractor. Tolerances as per provisions of IS: 5613 shall be allowed for stub setting.

Setting of stubs at each location shall be approved by OWNER.

However, towers with unequal leg extensions for Multi circuit tower, Extensions for raised chimney foundations, for river crossing towers, Anchor tower and for foundations in highly collapsible soils, props may be used with complete accuracy and high skilled supervision, subject to prior approval from OWNER. No recovery shall be made on account of using Props for stub setting.

STUB SETTING TEMPLATES

Stub setting templates shall be arranged by the Contractor at his own cost for all heights of towers as per OWNER's supplied drawings. Stub templates shall be of adjustable type. Stub templates should be painted.

The Contractor shall deploy sufficient number of templates for timely completion of the line without any extra cost to OWNER.

However, the number of template to be deployed shall depend upon type of terrain condition, number & type of towers etc. Hence the quantity of template to be deployed for timely completion of the line shall be finalized in consultation with site in-charge without any extra cost to the OWNER. One set of stubs setting template (if used) shall be supplied to the OWNER, on completion of the project, at no extra cost to OWNER.

BENCHING

When the line passes through hilly / undulated terrain, levelling the ground may be required for casting of tower footings. All such activities shall be termed benching and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by OWNER. Benching shall be resorted to only after approval from OWNER. Further, to minimize benching, unequal leg extensions shall be considered and provided if found economical. If the levels of



the pit centres be in sharp contrast with the level of tower center, suitable leg extensions may be deployed as required. The proposal shall be submitted by the Contractor with detailed justification to the OWNER.

1.9.0 PROTECTION OF TOWER AND TOWER FOOTING

Tower shall be spotted such that the quantity of revetment is optimum. For tower locations in undulated terrain such as hill / mountain slopes, options like use of unequal leg extensions for towers, unequal chimney extensions etc. shall be explored by the contractor for optimizing the need for revetment & benching.

The work shall include all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in small water streams (Nallas), river bank / bed, undulated terrain, protection of uphill / downhill slopes required for protection of tower etc., including suitable revetment or galvanized wire netting and meshing packed with boulders. Contractor shall recommend protection at such locations wherever required.

In protection of tower footings works, the back filling shall generally be done using soil excavated at site unless deemed unsuitable for back filling. In the latter case, backfilling shall be done with contractor's earth.

All substructure or concrete surfaces which are in direct contact of soil and ground water shall be treated as critical and suitable surface protection shall be done to make the concrete durable against effects of acid / alkali soil substances

2.0.0 GENERAL

- 2.1.0 The scope of erection work shall include the cost of all labour, tools and plant such as tension stringing equipment and all other incidental expenses in connection with erection and stringing work. The stringing equipment shall be of sufficient capacity to string the bundle conductors of specified size.
- 2.2.0 The Contractor shall be responsible for transportation to site of all the materials to be supplied by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the Owner. Similarly, the Contractor shall be responsible for transportation, proper storage, safe custody, and loss or damage of any Owner's supplied items for incorporation in the lines and shall maintain and render proper account of all such materials at all times. The Contractor shall reimburse the cost of any of the materials lost or damaged during storage and erection.
- 2.3.0 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the Owner.
- 2.4.0 Owner supplied items shall be dispatched to the railway stations situated nearest to the stores set up by the Contractor. From the railway stations, receipt, unloading and transportation to the stores shall be the entire responsibility of the Contractor.

3.0.0 TREATMENT OF MINOR GALVANISATION DAMAGE

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



4.0.0 TOWER ERECTION

- 4.1.0 The towers shall be erected on the foundations not less than 14 days after concreting or till such time the concrete has acquired sufficient strength.
- 4.2.0 For the convenience of assembling the tower parts during erection operations, each member shall be marked in the factory to correspond with a number shown in the erection drawing. Any damage to the steel and injuring of galvanizing shall be avoided. No member shall be subjected to any undue over stress, during erection.
- 4.3.0 The contractor shall give complete details of the erection procedures. The method for the erection of towers shall ensure the following:
- a) Straining of the members shall not be permitted for positioning. It may, however, be necessary to match hole positions at joints using tommy bars not more than 450mm in length.
 - b) Prior to erection of an upper section, the lower sections shall be completely braced, and all bolts provided tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.
 - c) All plan diagonals, oblique bracings etc. for relevant section of tower shall be in place prior to assembly of an upper Section.
 - d) The bolt positions in assembled towers shall be as per IS-5613 (Part II/Section 2);
 - e) Tower shall be fitted with number, danger and phase plates as well as anti- climbing device, as described.
 - f) After complete erection of the tower, all blank holes, if any, are to be filled by bolts and nuts of correct size.
 - g) Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.
- 4.4.0 The contractor shall be entirely responsible for correct erection for all towers and their correct setting on the alignment finally approved by the purchaser. The towers must be truly vertical after erection, the permitted tolerance in verticality being 1 in 360 of the tower height. No straining will be permitted to make the towers vertical.
- 4.5.0 A reasonable amount of drifting as permissible in IS:5613 (Part 3, section-2)-1989 shall be allowed in assembling but reaming for correction of mismatched holes due to shop errors will not be permitted. If any shop errors are discovered, the contractor shall notify the purchaser, who will decide whether the errors may be corrected in the field or members returned to tower fabricator for correction or replacement.

All galvanized surfaces damaged as a result of correction shall be made good to the satisfaction of the department.

- 4.6.0 Tower shall be fitted with number plate, danger plate, phase plates, circuit plates and anti-climbing device as described. After complete erection of tower, all blank holes, if any, are to be filled by Bolts and nuts of correct size. Suspension towers shall be fitted with Bird guards.

5.0.0 TIGHTENING OF BOLTS AND NUTS

- 5.1.0 All nuts shall be tightened properly using correct size spanner and torque wrench. Before tightening, it will be verified that filler washers and plates are placed in relevant gap between



members, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nuts. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If, during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

- 5.2.0 The threads of all the bolts except for Anti-theft bolts projected outside the nuts shall be welded at two diametrically opposite places; the circular length of each welding shall be at least 10mm. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm for double circuit towers. However, for towers, with +18-meter, +25 meter extensions and river crossing towers, the welding shall be provided from ground level to 30m height from stub level. After welding, zinc-rich primer having approximately 90% zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The surface coated with zinc rich primer shall be further applied with two finish coats of high build enamel of the grade recommended by the manufacturer of the zinc rich primer.

6.0.0 INSULATOR HOISTING AND RUNNING OUT OF THE CONDUCTOR

6.1.0 INSULATOR HOISTING

Suspension insulator strings shall be used on Suspension towers and tension insulator strings on angle and dead-end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and strings, if any, shall not be employed in the assemblies. Prior to hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for that purpose. For checking the soundness of insulators, IR measurement using 10kV (DC) Meager shall be carried out on 100% insulators. Corona control rings/arcing horn shall be fitted in an approved manner. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor and earth wire, etc., whenever recommended by the manufacturer of the same.

6.2.0 RUNNING OUT OF THE CONDUCTORS

- 6.2.1 The conductors shall be run out of the drums from the top in order to avoid damage. The Contractor shall be entirely responsible for any damage to tower or conductors during stringing.
- 6.2.2 A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken that the conductors do not touch and rub against the ground or objects which could scratch or damage the strands.
- 6.2.3 The sequence of running out shall be from the top down i.e. the earth wire/OPGW shall be run out first followed in succession by the conductors. Unbalanced loads on towers shall be avoided as far as possible. Inner phase of line conductors shall be strung before the stringing of the outer phases is taken up.
- 6.2.4 The Contractor shall take adequate steps to prevent clashing of sub conductors until installation of the spacers/spacer dampers. Care shall be taken that sub conductors of a bundle are from the same Contractor and preferably from the same batch so that creep behavior of sub conductors remains identical. During sagging, care shall be taken to eliminate differential sag in sub-conductors as far as possible. However, in no case shall sag mismatch be more than 25mm.



6.2.5 Towers not designed for one sided stringing shall be well guyed and steps taken by the Contractor to avoid damage. Guying proposal along with necessary calculations shall be submitted by the Contractor to Owner for approval. All expenditure related to this work is deemed to be included in the bid price and no extra payment shall be made for the same.

6.2.6 When the transmission lines runs parallel to existing energised power lines, the Contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage built up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earth wires during stringing operations.

6.2.7 The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms.

6.2.8 RUNNING BLOCKS

The groove of the running blocks shall be of such a design, that the seat is semicircular and larger than the diameter of the conductor/earth wire and it does not slip over or rub against the slides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end will be fitted on the cross-arms with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

7.0.0 REPAIRS TO CONDUCTORS

The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations.

Repairs to conductor if accidentally damaged, shall be carried out with repair sleeve with the permission of the Engineer in charge.

Repairing of the conductor surface shall be carried out only in case of minor damage, scuff marks, etc. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc.

The Contractor shall be entirely responsible for any damage to the towers during stringing.

8.0.0 CROSSINGS

Derricks or other equivalent methods ensuring that normal services need not be interrupted, nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication lines, power lines and railway lines have to be crossed. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth wire and accessories in the field. The shutdown schedule and number of days will be intimated at the time of execution after consulting with Load Dispatch Center. The shutdown will be arranged by the OWNER as per requirement.

9.0.0 STRINGING OF CONDUCTOR AND EARTH WIRE

9.1.0 The stringing of the conductor shall be done by the control tension method. The equipment shall be capable of maintaining a continuous tension per bundle such that the sag for each



conductor is about twenty percent greater than the sags specified in the stringing sag table.

- 9.2.0 The bidder shall give complete details of the stringing methods he proposes to follow. Prior to stringing, the Contractor shall submit the stringing charts for the conductor and earth wire showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the lines for the approval of the Owner.
- 9.3.0 A controlled stringing method suitable for simultaneous stringing of the sub conductors shall be used. The two conductors making up one phase bundle shall be pulled in and paid out simultaneously. These conductors shall be of matched length. Conductors or earth wires shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

Conductor creep are to be compensated by over tensioning the conductor at a temperature of 26°C lower than the ambient temperature or by using the initial sag and tensions indicated in the tables.

- 9.4.0 The proposed 400kV transmission line may run parallel for certain distance with the existing transmission line which may remain energized during the stringing period. As a result there is a possibility of voltage build up due to electromagnetic and electrostatic coupling in the pooling wire, conductors and earth wires which although comparatively small during normal operation can be severe during switching. It shall be the contractor responsibility to take adequate safety precautions to protect his employees and others from this potential danger.

10.0.0 JOINTING

- 10.1.0 When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the specifications.
- 10.2.0 Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.
- 10.3.0 All the joints on the conductor and earth wire shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc. and be properly greased with anti-corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors.
- 10.4.0 All the joints of splices shall be made at least 30 meters away from the tower structures. No joints or splices shall be made in spans crossing over main roads, railways, power lines and small river spans up to 650m. Not more than one joint per sub conductor per span shall be allowed. The compression type fittings shall be of the self-centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint, the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.
- 10.5.0 During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector for mid span compression joints in case they are to be passed over pulley blocks/aerial rollers. The pulley groove size shall be such that the joint along with protection



can be passed over it smoothly.

11.0.0 TENSIONING AND SAGGING OPERATIONS

- 11.1.0 The tensioning the sagging shall be done in accordance with the approved stringing charts or sag tables. The “initial” stringing chart shall be used for the conductor and final stringing chart for the earth wire. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductor shall be clamped within 96 hours of sagging in.
- 11.2.0 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.
- 11.3.0 The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.
- 11.4.0 At sharp vertical angles, conductor and earth wire sags and tensions shall be checked for equality on both sides of the angle and running block. The suspension insulator assemblies will normally assume verticality when the conductor is clamped.
- 11.5.0 Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperature are not likely to occur.

12.0.0 CLIPPING IN

Clipping of the conductors into position shall be done in accordance with the manufacturer's recommendations.

Jumpers at section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, if found necessary, to restrict jumper swing to design values.

Fasteners in all fittings and accessories shall be secured in position. The securityclip shall be properly opened and sprung into position.

13.0.0 FIXING OF CONDUCTORS AND EARTH WIRE ACCESSORIES

Conductor and earth wire accessories including spacers, spacer dampers (for bundle conductor) and vibration dampers shall be installed by the Contractor as per the design requirements and manufacturer's instruction within 24 hours of the conductor/earth wire clamping. While installing the conductor and earth wire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no damage occurs to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the Dampers/Spacer Dampers, Suspension Clamps etc. and torque recommended by the manufacturer of the same shall be applied.

14.0.0 AERIAL MARKER BALLS & AVIATION SIGNAL

Aviation obstruction fixtures / lights / painting have been provided, if required.

Aircraft warning sphere/ aerial marker ball shall be provided where ever required, is designed to provide daytime visual warning or nighttime visual warning if comes with reflective tape, for



electricity transmission line and overhead wire for aircraft pilots, especially cross river high voltage transmission lines. An aircraft warning marker should be of one color such as aviation orange, white and red. Generally, the marking spheres are placed on the highest line. Where there is more than one line at the highest level, white and red, or white and orange spheres should be displayed alternately. This alternating color scheme provides the most conspicuity against all back ground.

15.0.0 REPLACEMENT

If any replacement is to be affected after stringing and tensioning or during maintenance, leg member and bracing shall not be removed without first reducing the tension on the tower by proper guying techniques or releasing of the conductor. For replacement of cross arms, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

16.0.0 PERMITTED EXTRA CONSUMPTION OF LINE MATERIALS

- 16.1.0 The quantity of conductor and earth wire to be incorporated in the line shall be worked as per the following norms.

Quantity of Conductor = Line length as per detailed survey x 3 phases x Nos. of conductor per bundle (for Single Circuit Line)

= Line Length as per detailed survey x 3 phases x Nos. of conductor per bundle x 2 (for Double Circuit Line)

Quantity of Earth wire = Line length as per detailed survey x nos. of groundwires

- For calculation of conductor & Earth wire requirement in hilly stretches, inclined distance between the towers may be considered instead of horizontal distance (considered for line length).

- 16.2.0 The Contractor shall make every effort to minimize breakage, losses and wastage of the line materials during erection. However, the Contractor shall be permitted and extra consumption of line materials up to the limits specified in Table 2.10.2.1 and shall be permitted to dispose of the scrap, if any at the end.

Permitted extra consumption of line materials

Item	% of permitted extra consumption
Conductor & earth wire	1
Insulators	1

- 16.3.0 In case of conductor and earth wire, the permitted extra consumption limit of one percent is inclusive of sag, jumpering, damage, loss and wastage etc.

- 16.4.0 The Contractor shall not be required to return to the Owner empty conductor and earth wire drums and shall dispose of the same at his cost.

- 16.5.0 Any conductor and earth wire drum which has been opened by the Contractor shall not be taken back by Board and the unused conductor or earth wire in such drums may be treated as waste permissible within the overall limits specified in Table 2.10.2.1.



- 16.6.0 The Contractor shall return to the Board all Board supplied material not incorporated in the works, except those permitted by Board as scrap in terms of Table 2.10.2.1. Otherwise, the Contractor shall pay in respect of such excess materials which he is unable to return at rates corresponding to the actual cost of procurement plus 15% for OSM procured under domestically funded packages. The “cost of procurement” for the above purpose shall be F O R destination site cost of OSM as per LOA of the respective packages plus taxes & duties plus price variation (if positive) applicable as on the date of issuance of TOC for Tower Package.
- 16.7.0 For calculation of conductor & earth wire consumption in hilly (mountainous) stretches inclined distance between towers may be considered, instead of horizontal distance between them.
- 16.8.0 The quantities of line materials to be supplied by the contractor (i.e. earth wire, Hardware fittings & accessories) as indicated in the bill of quantities are provisional and the actual quantity shall depend upon detailed survey.

Contractor shall be responsible for regulating the supplies of contractor supplied materials in the basis of actual requirements. The Owner shall have right, not to take any surplus contractor supplied line materials.

17.0.0 FINAL CHECKING, TESTING AND COMMISSIONING

- 17.1.0 After completion of the works, final checking of the line shall be carried out by the Contractor to ensure that all foundation works, tower erection and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected in order to ensure that:
- a) Sufficient back filled earth covers each foundation pit and is adequately compacted;
 - b) Concrete chimneys and their copings are in good condition and finely shaped.
 - c) All tower members are used strictly according to final approved drawing and are free of any defect or damage whatsoever.
 - d) All bolts are properly tightened, punched, tack welded and painted with zincrich paint;
 - e) The stringing of the conductors and earth wire has been done as per the approved sag and tension charts and desired clearances are clearly available.
 - f) All conductor and earth wire accessories are properly installed;
 - g) All other requirements for completion of works such as fixing of danger plate, phase plate, number plate, anti-climbing device, Aerial marker balls, aviation signal have been fulfilled.
 - h) Wherever required, that proper revetment (erosion protection) is provided;
 - i) The original tracings of profile and route alignment as well as tower design, structural drawings, bill of material and shop drawings of all towers are submitted to the Owner for reference and record.
 - j) The insulation of the line as a whole is tested by the Supplier through provision of his own equipment, labour etc., to the satisfaction of the Owner.
 - k) All towers are properly grounded.
 - l) The line is tested satisfactorily for commissioning purpose.