SECTION-IVC

TOWER: MATERIALS, FABRICATION, ERECTION & STRINGING

TECHNICAL SPECIFICATIONS

SECTION-IV C

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TECHNICAL SPECIFICATIONS

SECTION-IV C

TOWER: MATERIALS, FABRICATION, ERECTION & STRINGING

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TECHNICAL SPECIFICATIONS

SECTION- IV C

TOWER: MATERIALS, FABRICATION, ERECTION & STRINGING

1.1 Transmission Tower Materials

1.1.1 Tower Steel Sections

For Non-Snow Regions, IS Steel Sections of any tested quality A, B0 or BR in conformity with IS 2062:2011 corresponding to grade E250 (Designated Yield Strength 250 MPa) and/ or grade E350 (Designated Yield Strength 350 MPa) may be used in towers, extensions, stubs and stub setting templates. For Snow Regions, IS Steel Sections of tested quality C in conformity with IS 2062:2011 corresponding to grade E250 and/or E350 shall be used. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards viz BSEN 10025. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

Steel plates below 6mm size exclusively used for packing plates/ packing washers produced as per IS 1079 (Grade-0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates, joint splices etc. the same shall conform to IS 2062 or equivalent standard meeting mechanical strength/ metallurgical properties corresponding to grade E250 or above grade (designated yield strength not more than 355MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength/ metallurgical properties may also be used in place of plates for packing plates/ packing washers. The chequered plates shall conform to IS 3502. SAILMA 350HI grade plate can also be accepted in place of HT plates (EN 10025 grade S355 JR/ JO/ IS 2062:2011– grade E350, as applicable) provided SAILMA 350HI grade plate meet all the mechanical properties of plate as per EN 10025 grade S355 JR/JO (designated yield strength 355 MPa)/ IS 2062:2011–grade E350. While selecting equivalent grade, requirement of IS 2062 for particular grade has to be fully complied. Further, material shall be imported from the manufacturers having valid BIS license.

During execution of the project, if any particular section is not available, the same shall be substituted by higher section/ Grade. Any cost on account of the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Employer before any substitution and records of such substitutions shall be maintained by the Contractor.

1.1.2 Fasteners: Bolts, Nuts and Washers

1.1.2.1 All tower members shall be joined together with Hexagonal Bolts and nuts. All hexagonal bolts and nuts shall conform to IS 12427. They shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.

All bolts and nuts shall be galvanized as per IS 1367 (Part 13)/IS 2629.

1.1.2.2 The bolt shall be of 16/ 24 mm diameter and of property class 5.6 as specified in IS 1367 (Part III) and matching nut of property class 5.0 as specified in IS 1367 (Part VI). Alternatively, contractor may use 12mm diameter of property class 6.8 in place of 16 mm diameter bolts. However use of both 12 mm and 16 mm diameter bolts simultaneously in the same package is not permitted. Matching Nut for 12 mm diameter bolts shall be property class 6 as specified in IS 1367 (Part VI).

1.1.2.3 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MPa minimum as per IS 12427. The shear strength of bolts for 6.8 grade should be minimum 372 MPa. Bolts should be provided with washer face in accordance with IS 1363 (Part I) to ensure proper bearing.

1.1.2.4 Nuts for hexagonal bolts should be double chamfered as per the requirement of IS 1363 Part III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.

1.1.2.5 Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.

1.1.2.6 All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.

1.1.2.7 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electrogalvanised, positive lock type and 2.5 mm in thickness for 12mm dia bolt ,3.5mm in thickness for 16mm dia bolt and 4.5mm for 24 mm bolt.

1.1.2.8 To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.

1.1.2.9 The bolt positions in assembled towers shall be as per structural drawing.

1.1.2.10 Bolts at the joints shall be so staggered that nuts shall be tightened with spanners without fouling.

1.1.2.11 To ensure effective in-process Quality control it is desirable that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this specification and IS 9001 series Quality System Standard.

1.2 Design and Drawings

1.2.1 In case design of tower is covered in the scope of Contractor: -

1.2.1.1 The following design calculation and drawings are required to be furnished to the Employer

A) Alongwith the bid:

i) Detailed design calculations and drawings for A/DA/QA (as applicable) type tower of any one wind zone applicable for each of the package quoted by the Bidder

ii) Line diagram of all the tower types indicating live metal clearances, ground clearance, mid span clearance, shielding angle etc. as applicable in the package.

iii) Typical foundation sketches adopted for various types of soil. Bidder has to furnish along with the bid one sample calculation for one type of foundation for Towers at A i) above.

The above is for assessing the present design capability of the Bidder and should not be construed as review/ approval of correctness of drawings/ designs by the Employer. Subsequent to the award, successful Bidder shall have to comply with the technical specifications irrespective of the designs/drawings submitted at the bidding stage without any financial implication to the Employer.

B) After award of contract:

The Contractor shall submit detailed design of tower & extension alongwith stress diagram/ computer output together with sample calculations for few critical members etc., stub templates and loading/ rigging arrangement of tower testing to enable the Employer to make a preliminary check regarding structural stability of tower (before) tests.

In case, contractor proposes to use tested design of tower/ towers meeting all technical specification stipulations, the approved copy of design/ drawing of tower from utility along with proto type test report shall be submitted to purchaser for approval.

1.2.1.2 After successful testing of the tower and subsequent approval of design, drawings and bill of materials, the Contractor shall submit the documents to the Employer for necessary distribution with in fifteen (15) days after approval of drawings:

a) Detailed design calculation and drawing for towers and foundations.

b) Detailed structural drawings indicating section size, length of members, sizes of plates along with hole to hole distance & joint details etc.

c) Bill of materials,

d) Shop drawings showing all details relevant to fabrication including cutting and bending details against each member.

e) All the drawings for the tower accessories.

1.2.2 In case of Employer design tower: -

1.2.2.1 The relevant drawings for all the towers and their extensions shall be furnished to the Contractor by the Employer which shall include structural drawings/ erection drawings and/ or shop fabrication drawings, Bill of Materials for all the towers and their extensions as well as construction drawings for foundations.

1.2.2.2 The tower members can be directly fabricated from the structural/ erection drawings wherever the required fabrication details are provided on the same or shop fabrication drawings. However, if the contractor is required to prepare shop fabrication drawings, of their own, in addition to the structural/ erection drawings with required fabrication details, they may prepare the same without any additional financial implication to Employer.

1.2.3 Proto Assembly:

i) Contractors, who have not done the proto assembly of the towers/ tower extensions or have not supplied the same towers/ tower extensions against any earlier POWERGRID's project, shall before taking up mass fabrication, the Contractor shall arrange for one number proto assembly for each type of towers and extensions. POWERGRID reserves the right to get the same witnessed by their representative. After proto assembly, the contractors, shall incorporate revisions in the drawings/ documents if any on account of proto corrections, and make necessary endorsement with reference to the respective packages/ Letter of Awards. The revised drawing/ documents shall be submitted for final approval by the Employer.

ii) The contractors who have already done the proto assembly of the towers/ tower extensions or have supplied the same towers/ tower extensions against any earlier POWERGRID's project need not do the proto assembly. They shall submit documentary evidence viz. proto inspection reports, supply records etc. in its support. However, they may do the proto assembly for their verification and satisfaction. Further, they shall submit the structural drawings and BOM of tower/ tower extensions after endorsing the projects name for further distribution by Employer.

~~Alternatively, in place of physical proto assembly (as specified in (i) and (ii) above), contractor may also carry out proto assembly using any suitable software/3D modelling software.~~

~~No payment shall be made to the Contractor on the account of proto assembly in either of the cases mentioned at (i) or (ii).~~

~~In any case, the onus of correct fabrication / fitment of tower parts shall lie with contractor. Any defect, if found during erection at site, the same has to be rectified by the contractor without any additional financial implication to POWERGRID.~~

~~1.2.4~~ ~~All the drawings shall have a proper name plate clearly displaying the name of Employer on right hand bottom corner. The approval for exact format of the nameplate shall be provided to the successful bidder for incorporation of the same on all the drawings.~~

~~1.2.5~~ ~~The Contractor is required to submit the drawings as mentioned in clause 1.5.1 for Employer's approval. While submitting the designs, structural drawings, bill of materials and any other drawing pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing POWERGRID Specification No., Name of the transmission line and project, letter reference No. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies.~~

~~1.2.6~~ ~~The tower accessories drawings like Number plate, Danger plate, phase plate, Circuit Plate, Anti climbing device, Pole plate, Step Bolt and Earthing Arrangement have been standardized (except Bird Guard) and are enclosed in drawing section of this specification. The contractor is required to submit distribution copies of the above drawings after endorsing the name of the projects. However, drawing of Bird Guard, D shackle etc. shall be prepared by the Contractor and shall be submitted to the Employer for approval.~~

~~1.2.7~~ ~~The drawings submitted by the Contractor shall be approved/ commented by the Employer as the case may be within fifteen (15) days of receipt of drawings in Employer office. If the designs/ drawings are commented by the Employer, the Contractor shall submit revised design/ drawings duly incorporating all comments within fifteen (15) days of date of issue of comments.~~

~~The mass fabrication shall be taken up from the shop drawings. The overall responsibility of fabricating tower members correctly lies with the Contractor only and the Contractor shall ensure that all the tower members can be assembled/ fitted while erecting without any undue strain on them.~~

~~1.2.8~~ ~~The Contractor is required to furnish the progress of submissions and approvals of designs and drawings on twenty fifth day of every month till the completion of all the design activities.~~

~~The details shall include description of design/ drawing, schedule date of submission, actual date of submission, schedule date of approval, actual date of approval, schedule date of submission of distribution copies, actual date of submission of distribution copies, schedule date of tower test, actual date of tower test and 'Remarks' column. Provision of six additional columns shall also be made in the above progress report to indicate date of comments issued by the Employer and details of submission of revised designs/ drawings.~~

~~1.2.9~~ ~~Other than the items indicated above, some other drawings and documents such as BOM, Shop drawings, structural drawings for towers/ extensions which are required for the project, shall also be developed by the Contractor based on single line diagram provided by the Employer. However, no extra cost on this account shall be payable to the Contractor.~~

~~1.3 Tower Accessories~~

~~Arrangement shall be provided for fixing of all tower accessories to the tower at a height between 2.5 meters and 3.5 meters above the ground level.~~

~~1.3.1 Step Bolts & Ladders~~

~~Each tower shall be provided with step bolts as per drawing enclosed in the section of drawing. The step bolts conforming to IS 10238 of not less than 16mm diameter and 175 mm long, spaced not more than 450 mm apart and extending from 2.5 meters above the ground level to the top of the tower. However, the head diameter shall be 35mm as indicated in the enclosed drawing. The step bolt shall be fixed on two diagonally opposite legs up to top of the towers for single, double and multi circuit towers. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special river crossing towers, ladders alongwith protection rings as per the Employer approved design shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 2.5m to 30m height of super structure step bolts shall be fixed on two diagonally opposite legs. Suitable platform using 6mm thick perforated chequered plates alongwith suitable railing for access from step bolts to the ladder and from the ladder to each cross arm tip and the ground wire support shall also to be provided. The platform shall be fixed on tower by using counter sunk bolts.~~

1.3.2 Insulator Strings and Earth wire Clamps Attachments

a) For the attachment of suspension Insulator string, if required a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The hanger, extensions links, D-shackles etc. as required shall be of same rating/ strength as that of corresponding rating/ Ultimate tensile Strength of Insulator string. The design and supply of hanger, D-shackles, strain plate, extension link etc. are also in the scope of Contractor.

b) At tension towers, strain plates of suitable dimensions under each cross arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. Full details of the attachments shall be provided to the contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor. These items shall be same rating/strength as that of as that of corresponding rating/ Ultimate tensile Strength of Insulator string.

c) D shackles, if required for attachment of Insulator strings, shall be supplied by the contractor from the identified and approved sub-vendor/ supplier of Hardware fittings.

1.3.3 Earth wire Clamps Attachments

For Suspension and tension clamp for attachment of earthwire, wherever required, the Contractor shall supply U-Bolts, D-Shackles etc. for attachment of clamp to the tower. Full details of the attachments shall be provided to the contractor. These items shall be same rating/ strength as that of corresponding rating/ Ultimate tensile Strength of earthwire suspension/tension clamp.

1.3.4 Anti climbing Device

Barbed wire type anti climbing device, as per enclosed drawing shall be provided and installed by the Contractor for all towers. The barbed wire shall conform to IS 278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS 1340

1.3.5 Danger, Number, Circuit and Phase plate

Danger Plates, Circuit plates, Phase Plates and Number plates shall be provided and installed by the Contractor. These Danger/ Number/Phase/ Circuit Plate shall be as per the drawings enclosed in the section of drawing. The contractor shall submit distribution copies of the same endorsing the package details (i.e. line name, LOA No. etc.) and installed by the Contractor.

a) Each tower shall be fitted with a danger plate, number plate, circuit plate and a set of phase plates for single circuit tower and two sets of phase plates for double circuit tower. The transposition towers should have provision of fixing phase plates on both the transverse faces.

b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS 2551 and shall be in a signal red on the front of the plate.

c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.

d) The letters of number and circuit plates shall be red enameled with white enameled background.

1.3.5.1 Bird Guard

To prevent birds perching immediately above the suspension insulator strings (I type/ V type) and fouling the same with dropping, suitable bird guards shall be provided on all suspension towers. In case of I string Bird Guard as per IS 5613 shall be provided at cross arm tips. In case of V string, saw type Bird Guard shall be provided on all the members/ redundant members provided on Top and Bottom plan of cross arm/ Girder/ BOOM/ Beam of Suspension. The typical drawing of Bird guard is attached at the drawing section of this specification. Suitable provision of cleat/ plate to be provided on all Suspension towers facilitating installation of bird guard after stringing.

1.3.6 Aviation Requirements

1.3.6.1 Aviation requirements viz Span marker, night marker (obstruction light) and painting of towers conforming to IS 5613 shall be in the scope of Contractor, wherever indicated in BPS.

1.3.6.2 Night Markers (Obstruction lights)

1.3.6.2.1 The scope of night markers covers the design, manufacture, testing at manufacturers works, if any, supply, delivery, erection, testing and commissioning of medium intensity, low intensity, lights along with storage battery & solar panel, control panel, cables, clamps other accessories etc. as per the provision of IS 5613 (Part II/Section I) regarding night & day visual aids for denoting transmission line structures as per the requirement of directorate of flight safety.

1.3.6.2.2 The detail of each component of medium intensity, low intensity lights & associated accessories to be provided on the towers shall be as per the technical specifications given in the preceding clauses and IS/ICAO, International Standards recommended practices.

1.3.6.2.3 One set of Aviation Lights shall consist of one medium intensity light & two/four (as applicable) low intensity lights along with all accessories such as solar panel, control panel, batteries, cables etc.

1.3.6.2.4 Medium Intensity Light

~~Medium Intensity light shall be provided on the top of each tower. The medium light should have night time intensity as per ICAO requirements in international Standards Recommended Practices. The light on top of the structure should flash at the rate of 20 sequences per minute. The effective intensity during night time for the medium flashing light shall be 1600 CD. The light shall conform to ICAO requirements/ BS 3224a and shall have weather protection conforming to IP 55.~~

~~The above lights conforming to ICAO specifications flashing red lights shall be DC operated through a suitably sized battery bank at the operating voltage 12V/24V DC. The burning life of the lamps shall be maximum possible in view of the maintenance hazard of H.T. live but in no case, it should be less than 15,000 burning hours. In case of failure of the lamp before 15,000 burning hours, the same shall have to be replaced by the Contractor free of cost even if the pendency of contract expires. The light shall be equipped with radio suppression facility conforming to BS800 in order to avoid any interference with signals of PLCC etc.~~

~~1.3.6.2.5 Low Intensity Lights~~

~~Two/ four (as applicable) nos. of low intensity lights are required to be put on each of the towers. Placement drawing for the same shall be submitted by the bidder Contractor.~~

~~The light shall be stationary lamp with minimum effective intensity of 32 CD. of red light. The lamps shall conform to the ICAO requirement/relevant BS and shall have weather protection of minimum IP 55 class.~~

~~Two/four nos. of L.I. lamp required for each tower shall be operated through a suitable size common battery bank solar panel as per the requirement of operating voltage and load current of the type of lamps being offered.~~

~~The burning life of the lamps shall be maximum possible in view of the maintenance hazard of H.T live line, but in no case, it should be less than 15,000 burning hours. In case of failure of the lamp before 15,000 hours, the same shall have to be replaced by the Contractor free of cost even if the pendency of contract expires.~~

~~The low intensity lamp shall not generate any R.F. which can interfere with the PLCC signals.~~

~~1.3.6.2.6 Storage Battery~~

~~Storage Battery required for the above purpose shall be sealed maintenance free, valve regulate lead acid and suitable for mounting on the top of the transmission line towers. Contractors shall offer the most optimum capacity of the Battery Bank at 120hour discharge rate (considering 80 % percentage usage) matching with the load requirement of the type of lamps being offered including any power loss in the associated cables. The battery sizing shall conform to JISC 8707/ relevant Indian Standard or any other internationally recognized standard. The~~

battery shall be hermetically sealed explosion proof and self resealing type and free from orientation constraints. The working temperature ranges shall be minimum 0^0 C and maximum 50^0 C. Performance certificate of the offered batteries shall be submitted by the Contractor.

1.3.6.2.7 Battery Box

The battery box suitable for mounting on power transmission tower shall be robust construction suitable to accommodate desired number of storage batteries with proper clearance between the batteries. The sides and the top of the battery box shall be made from MS sheets not less than 14 SWG thickness duly mounted on MS angle frame. The bottom of the battery box shall have suitably designed MS structure to freely hold the total weight of the batteries. The batteries should be placed on insulated base with proper drainage holes. Lifting lugs shall be provided. Dust and vermin proof lockable doors shall be provided for safety and easy access to the batteries for the maintenance. The battery box should incorporate the design for proper ventilation system in order to prevent a gas concentration inside the box. The ventilation opening shall be protected against rain/ splash water and dust. The inside of the battery box shall be lined with insulating polyurethane plating and the exterior painted with weather proof polyurethane paint. The cable entry into the battery box shall be through suitable cable glands.

1.3.6.2.8 Solar Modules

Solar module required for the system shall be suitable for mounting on the transmission line towers and shall be designed for high performance, maximum reliability and minimum maintenance and shall be installed below bottom cross arms levels. The solar modules shall be IP 55 grade protection class. These should be highly resistant to water, abrasion, nail, impact and other environmental factors.

These should be placed on the tower at a most optimum angle so as to harness the maximum solar energy and facilitate self cleaning and shall conform to relevant Indian/ International Standards.

Module mounting frames shall be weather proof suitable for mounting on tall towers. Details of mounting frames shall be furnished by the Contractor.

Junction box shall be provided with weather proof hinged lid with provision for cable glands entry and protections grade of class IP 55.

The Contractor shall submit the basis of selecting the numbers of solar modules.

The provision for design, supply & erection of mounting arrangements for photovoltaic modules on the transmission towers in a suitable manner to harness maximum solar energy shall be in the scope of the Contractor.

Provision for design, supply & erection of resting platform for the erection of battery bank in a closed enclosure with safety arrangement on the transmission towers shall also be in the scope of the Contractor. The design and load consideration for safety of towers due to additional plate form shall be kept in view while designing, selecting the above.

1.3.6.2.9 Control Panels

Control panels shall consist of solar charge controller, flasher unit, sensor, isolator, MCB, Voltmeter, Ammeter and other control gears. Panel enclosure shall be fabricated out of 14 SWG CRCA sheet and thoroughly treated and painted. Suitable neoprene rubber gasket and pad locking device shall be provided and the protection class shall be of IP 55 class.

The Solar charge controller shall be most efficient and preferably fully solid state. It shall be provided with protection to load against increase in temperature, Surge, automatic low voltage and automatic disconnection and reconnection during high inrush current and normalcy respectively.

The flash regulator shall be provided for regulating light flashing. The same shall be completely solid state and provided with flash rate set points. The protection against overload current shall also be provided.

Necessary sensor/ timer shall be provided in the system to "switch on" the light automatically in the evening and poor visibility period and switch off the same during day time and normal visibility period.

1.3.6.2.10 Cables, Cable Glands, Conduits and Accessories

The cable to be supplied and erected shall be of multi strands copper conductor, weather proof, PVC insulated PVC sheathed, armoured 1.1 KV grade. The same shall conform to IS 1554.

All the cable accessories such as thimble, glands etc. shall be in the scope of supply and erection of the Contractor.

Supply and erection of all the PVC conduits and accessories shall be in the scope of the contract. All the conduit and accessories shall be as per the relevant ISS or ISI brand.

The inter-connection cable/ conduit will be clamped in a secured manner with the tower members and any interconnection should be made only inside the environmentally protected junction box.

1.3.6.2.11 Earthing

All the installations on the tower shall be securely and properly earthed with the tower body by using flexible copper braided wire. Cost of earthing material shall deem to be included in the total cost.

1.3.7 Bird Flight Diverter

Bird diverters shall be placed in identified stretches as per the conditions stipulated by forest authority or other appropriate authority to avoid the chances of collision of birds with transmissions lines. These Bird Diverters shall be placed on earth wire/OPGW only (in case of transmission line(s) having two or more bundle conductors in each phase) and on all phase conductors also(only in case of transmission lines having single conductor in each phase) in staggered manner at a distance of 10 m, unless otherwise specified by forest/ wildlife authority, in the central 80% of identified spans. An indicative sketch of the placement of the bird diverter is attached in the drawing section of this specification.

The dynamic solar powered LED type Bird Flight Diverter, consist of warning disc (2-D or 3-D in design) and associated clamps & connectors, shall be preferred in areas where foggy/dusty weather persists or intensity of light is low or the sections of the lines lying in the route of migratory birds. BFD may be mixture of LED and Non-LED BFD, where on a line LED type BFD should be at least 20%. For solar powered LED type diverter, following additional requirement shall be fulfilled:

(a) LED shall be of Orange colour with adequate light intensity so that it is clearly visible from a distance (>300 m) even during foggy/dusty weather/ under low intensity of light.

(b) Battery shall be guaranteed for service life of 5 years and shall be suitable for at least 100 hours of flashing operation by single charge.

(c) An automatic power cut-off electronics circuit shall be provided to improve battery life so that during day time (due to high intensity of light from sun), the circuit gets cut off & stops flashing and the circuit switches on automatically under low intensity light condition.

(d) Position of solar cell shall be such that it gets sunlight irrespective of direction of the diverter face and the dust & snow does not decrease its efficiency.

Bird Flight Diverter (BFD) shall be designed for expected service life of at least 15 years. The Bird Flight Diverter shall be lightweight (total weight for each Non-

~~LED & LED type BFD shall not more than 500 gm and 800 gm respectively), and should be easily installed by hand or by hot stick (under live line condition) or by any other suitable method. Length of bird diverter, from connection point to end, should not be more than 430 mm. The bird diverters should retain good physical characteristics under all weather conditions, within a range of extreme temperatures i.e. from -15^0 C to 85^0 C for conventional conductor and maximum operating temperature under emergency loading conditions may be considered to withstand temperature in case of HTLS conductor. Contractor/ subcontractor shall submit valid test report/test certificate for mechanical test, ageing test i.e. solar radiation test & sand and dust test as per MIL- STD 810 F etc. from accredited third party laboratory for the design which they intend to supply. The grip on the earthwire/OPGW should ensure that the Bird Flight Diverter remains in the applied position and does not move along the span under Aeolian vibration or other conditions.~~

~~Generally Suspended devices i.e. Dynamic Bird Flight Diverters shall be used in the transmission line as bird diverters.~~

~~1.3.7.1 Suspended devices: Dynamic Bird Flight Diverters~~

~~Bird flight Diverters shall have one warning disc(2-D or 3-D in design) which shall be attached to the wire through spring loaded clamp & connectors. Warning disc shall be made through injection moulding of UV stabilized plastic while the attachment clamp shall be made of UV stabilized engineered composite plastic. All fasteners and spring shall be of stainless steel.~~

~~1.3.7.1.1 Warning Disc~~

~~Warning disk of Bird Flight Diverter must swing, sway, must not flip on the powerline in high wind velocity, rotate and should have contrasting coloured (combination of any two colours from Red,black, Yellow, Orange, White) retro-reflective surface with Sun and Moon light reflectors on both faces. The colour change, while revolving, shall provide significant forewarning. Warning disk must glow in dark & glow in the dark shall remain activated for at least 12 hours after exposure to sunlight and the warning disk in the BFD should have strong luminescence properties that emit immense light to provide enhanced visibility to the birds at night. If Glow in dark stickers are used, the same shall be laminated and suitable for all weather conditions. The Warning disc should be aerodynamically stable so that diverter faces minimum amount of drag force which provide swing and rotation effect under medium/strong wind speed.~~

~~Diameter of circular warning disk shall not be less than 150 mm. If warning disk is quadrilateral or trapezoid, then shortest arm length should not be less than 90 mm and total surface area of warning disc should not be less that 15,000 mm^2 (including air vents). Thickness of the warning disc shall not be less than 3 mm. Minimum reflective area on each face of warning disk shall not be less than 3500 mm2 . Glow in Dark area also should not be less than 3500 mm2 for LED type~~

BFD and not less than 7500 mm2 for the non LED type BFD. All suspension hardware which are directly exposed (moving or static) must be corrosion free. Bearing swivel shall be made of stainless steel and should allow free spinning in minimum wind speed of 1 km/hour & be made of sealed bearing to avoid deposition of sand and/or soil particles and helps in smooth rotation.

1.3.7.1.2 Clamp

The clamp of the Bird flight diverter shall be made of UV stabilized engineered composite plastic (polymer) or metal or carbon fibre. Spring type clamp, suitable for holding earth wire/ OPGW/conductor shall be used.

It shall be capable of supporting the Bird flight diverter during installation and prevent damage or chaffing of the earth wire/ OPGW/conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the Bird flight diverter in position on the earth wire/ OPGW/conductor without damaging the strands or causing premature fatigue failure of the earth wire/OPGW/conductor under the clamp. More than 50% of clamp gripping area shall be in contact with earth wire/OPGW/conductor. The groove of the clamp body and clamp cap shall be smooth, free from projections, sharp end/edges, abrasions, grit or materials which could cause damage to the earth wire/OPGW/conductor when the clamp is installed. In case of metallic bird diverters, the parts of clamp, touching earth wire/OPGW/conductor must be made of material, which is bad conductor of electricity.

The Clamp shall have strong grip on earth wire/ OPGW***/conductor***. The clamp should not slip when pulled by a force of 250 N in the direction parallel to earthwire/ OPGW***/conductor***. The details/ properties of Earthwire /OPGW***/conductor*** are mentioned in relevant section of Earth wire/OPGW of Technical specification. All exposed metal parts of clamp shall be corrosion free. The Clamp must be able to bear pulling load of minimum 500 N.

1.3.7.2 The supplier shall guarantee that there shall not be any failure/ breaking of bird flight diverters under normal operating condition. In the event of any failure/ breaking of bird flight diverters during the first five (05) years of service, supplier shall supply to the purchaser free of cost spare bird flight diverters equal to the failed bird flight diverters quantity.

1.3.7.3 Tests & Certifications

1.3.7.3.1 Type Tests

Report/ Certificate for following type tests conducted in any NABL or equivalent accredited laboratory shall be submitted to the Purchaser. All of the following tests shall be conducted on the same sample. However, No. of Samples for type tests shall be as per relevant standard or procedure specified in *Annexure I to*

~~*this Section*. Type test report shall be valid for 10 years from the date of successful completion of test.~~

~~1~~	~~Mechanical Strength test~~	~~As per Annexure I~~
~~a)~~	~~Direct Pull Test~~	
~~b)~~	~~Clamp Slip Test/Grip Retaining Strength Test~~	
~~2~~	~~Vibration test~~	~~As per Annexure I~~
~~3~~	~~Temperature cycle test~~	~~As per Annexure I~~
~~4~~	~~Corrosion Resistance Test~~	~~As per Annexure I~~
~~5~~	~~Ageing test~~	~~As per Annexure I~~
~~6~~	~~Heating cycle test~~	~~As per Annexure I~~
~~7~~	~~Radio Interference test Voltage , (applicable for bird diverters for use on transmission line at 220 kV and above)~~	~~As per Annexure I~~
~~8~~	~~Visual Corona Test (applicable for bird diverters for use on transmission line at 220 kV and above)~~	~~As per Annexure I~~

~~**1.7.7.3.2 Acceptance tests**~~

~~Following acceptance tests shall be carried out on at least 20 (twenty) samples in presence of the representative of the purchaser:~~

~~1~~	~~Visual Examination Test~~	~~As per Annexure I~~
~~2~~	~~Verification of Dimensions~~	~~As per Annexure I~~
~~3~~	~~Mechanical Strength test (Only one of the 20 samples shall be subjected to ultimate failing load)~~	~~As per Annexure I~~
~~a)~~	~~Direct Pull Test~~	
~~b)~~	~~Clamp Slip Test/Grip Retaining Strength Test~~	

1.4 Tower Fabrication

The fabrication of towers shall be in conformity with the following:

1.4.1 Except where hereinafter modified, details of fabrication shall conform to IS 802 (Part-II) or the relevant international standards.

~~1.4.2 The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.~~

~~1.4.3 No angle member shall have the two leg flanges brought together by closing the angle.~~

1.4.4 The diameter of the hole shall be equal to the diameter of bolt plus 1.5 mm.

1.4.5 The structure shall be such that all parts are accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water.

1.4.6 All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.

1.4.7 Drilling and Punching

1.4.7.1 Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

1.4.7.2 Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The punching may be adopted for thickness up to 12 mm. Tolerances regarding punch holes are as follows:

a) Holes must be perfectly circular and no tolerances in this respect are permissible.

b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter.

c) Holes must be square with the plates or angles and have their walls parallel.

1.4.7.3 All burns left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly concentric/ matching to each other. Drilling or reaming to enlarge holes shall not be permitted.

1.4.8 Erection mark

1.4.8.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark numbers shall be marked with marking dies of 16mm size before galvanising and shall be legible after galvanizing.

1.4.8.2 Erection Mark shall be A-BB-CC-DDD

A = Employer's code assigned to the Contractors - Alphabet

BB = Contractor's Mark-Numerical

CC = Tower Type Alphabet.

DDD = Number mark to be assigned by Contractor - Numerical.

Erection mark for high tensile steel members shall be prefixed by the letter "H"

1.5 Quantities and weights

1.5.1 The quantities of the following items have been envisaged in Metric Tonne (MT) in case of Employer design towers and in 'Nos.' in case of Contractor design towers, in the relevant price Schedules for various types of towers: -

i) Basic Body

ii) Body Extensions, wherever required

iii) Leg Extension

iv) Stubs & Cleats

v) Bolts & Nuts including spring washers and step bolts etc. for above items

During detailed engineering, proto corrected shop drawings shall be released by POWERGRID for fabrication and manufacturing as per the Technical Specification to the Contractor. The contractor shall carry out proto assembly after fabrication from the Employer's shop drawing for his verification/ satisfaction prior to mass production of the tower.

The manufacturing of the above items shall be taken up in such a manner that the Equipment/ Material offered for inspection to POWERGRID are on completed tower basis for each type of tower, completed Stubs & Cleats set basis so as to facilitate availability of erectable tower of each type and erectable stubs & cleats set for casting of foundation. After inspection of the offered Equipment/ Material by POWERGRID representative(s), CIP shall be issued by POWERGRID for the material meeting the Technical Specification. However, MICC shall be issued only on Completed Tower Basis for each type of tower (comprising the required Basic Body, body extensions wherever required, four (4) equal or defined unequal Leg Extension, Bolts & Nuts along with D shackles, Hangers, Packing and Spring Washers) and on completed Stubs & Cleats set basis for each type of tower foundations (comprising a set of stubs & Cleats, required Bolts and Nuts along with Spring Washers).

Towers to be supplied by the Contractors/ Tower Manufacturers shall be dispatched Panel wise as per mutually agreed procedure with Employer Quality Assurance & Inspection Department.

Accordingly, the payment shall be released on completed Tower Basis for each type of tower (comprising the Basic Body, body extensions, wherever applicable, bolts & nuts along with spring washer and step bolts, four (4) equal or defined unequal leg extensions wherever applicable for a completed tower) and on completed Stubs and Cleats set basis for each type of foundation (comprising a set of stubs & cleats, required Bolts and nuts along with Spring Washers) based

~~on the weight of the tower parts as calculated as per Clause 1.5.3 and fasteners based on the unit rates incorporated in the contract.~~

~~1.5.2~~ ~~The provisional quantities required (including provisional spare tower quantity) are mentioned in the respective Schedules of BPS. Final quantities shall be determined after completion and approval of the detailed route survey. The final quantities of tower including spare towers shall be confirmed by the Employer/ Site in charge based on the requirement of quantities of various towers furnished by the Contractor after completion of detailed survey. Hence it will be responsibility of the Contractor to intimate the exact requirement of all towers and various line materials required for line immediately after the survey.~~

~~The Employer reserves the right to order the final quantities including required quantities of spares for which the rates quoted in the Bid shall be valid. Regarding quantity variation the provisions of relevant clauses of SCC shall apply.~~

~~1.5.3~~ ~~The estimated total weight of tower/ tower parts as well as bolts & nuts along with spring washers and step bolts to be supplied by the Contractor under various packages have been envisaged in the relevant Price Schedule. Though fully galvanised tower parts are to be supplied, the weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. ungalvanised) weight of steel members of the size indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weights due to holes, notches and bevel cuts etc. but taking into consideration the weight of the D shackles, hangers, strain plates, pack plates, gusset plates, extension link/plates and pack washers etc. The weight of stub and cleats also shall be calculated in similar manner. The weight of strain plates, pack plates, extension link and gusset plates shall mean the weight of its circumscribing rectangle, without taking into considerations the reductions in weight due to holes, notches etc. The weight of D shackles, hangers and pack washers shall be net actual weight taking into consideration reduction due to holes. For bolts and nuts along with spring washers and step bolts, the weight per tower shall be calculated from the bolt schedule applicable to each type of towers and body extensions as approved by the Employer. The rate quoted by the bidder for tower/tower parts supply, is deemed to be inclusive of galvanising charges including the cost of zinc.~~

~~1.5.4~~ ~~The contractor is permitted to get inspected and supply upto 2.5% extra fasteners to take care of losses during erection. No payment shall be admissible for these extra supplies.~~

1.6 Galvanising

1.6.1 Fabricated Tower Parts & Stubs

The tower parts, stubs and pack washers shall be hot dip galvanized. The galvanization shall be done as per requirements of IS 4759 after all fabrication

work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

The fabricated tower parts and stubs shall have a minimum overall Zinc coating of 610 gm per sq. m of surface area except for plates & sections below 5mm which shall have Zinc coating of 460 gm per sq. m of surface area. The average zinc coating for all sections and plates 5mm & above shall be maintained as 87 microns and that for plates & sections below 5mm shall be maintained as 65 microns.

However, for coastal areas or creek regions or aggressive soil areas or under marine environment, as specifically mentioned in BPS the fabricated tower parts and stubs shall have a minimum overall zinc coating of 900 gm/ sqm of surface area except for plates and sections below 5mm which shall have a minimum overall zinc coating of 610 gm/sqm of surface area. The average zinc coating for all sections and plates 5mm and above shall be maintained as 127 microns and that for plates and sections below 5mm shall be maintained as 87 microns.

The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/ bare spots, ash rust strains, bulky white deposits/ wet storage strains and blisters.

The surface preparation for fabricated tower parts and stubs for hot dip galvanizing shall be carried out as indicated herein below:

(i) Degreasing & Cleaning of Surface: Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS 2629. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.

(ii) Pickling: Pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program.

(iii) Rinsing: After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank

is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residue from the tank.

(iv) Fluxing: The rinsed article shall be dipped in a solution of Zinc ammonium chloride. The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to Employer along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5.0 to 5.5.

(v) Drying: When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc. shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program.

(vi) Quality of Zinc: Any one or combination of the grades of zinc specified in IS 209 or IS 13229/ Prime Western (PW grade) (Zn 98.65%) or other comparable international standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminum alloy shall be added as per IS 2629.

(vii) Dipping Process: The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450+/-10^0 C. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its

uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.

(viii) Post Treatment: The article shall be quenched in water. The quench water is to be changed/ drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling arrangements should be made. The galvanized articles shall be dipped in chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard white rust attack. The temperature of the chromate solution shall not exceed 65^0 C. The articles shall not be stacked immediately after quenching and dichromating. It shall be ensured that the articles are dry before any further handling operation.

(ix) Storing, Packing and Handling: In order to prevent white rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to POWERGRID for approval as part of Quality Assurance Plan.

~~**1.6.2 Fasteners**~~

~~For fasteners, the galvanizing shall conform to IS 1367 (Part 13). The galvanizing shall be done with centrifuging arrangement after all mechanical operations are completed. The nuts, may however be tapped (threaded) or rerun after galvanizing and the threads oiled. The threads of bolts & nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts. Spring washers shall be electro galvanized as per Grade-IV of IS 1573.~~

~~**1.7 Earthing**~~

~~Each tower shall be earthed. The tower footing resistance shall not exceed 10 ohms. The Contractor shall measure the tower footing resistance (TFR) of each tower during dry weather after it has been erected and before the stringing of the~~

earth wire. Pipe type earthing and counter poise type earthing shall be done as required in accordance with the following standards:

IS 3043 Code of practice for Earthing

IS 5613 Code of practice for Design, Installation and maintenance (Part II/Section 2) of overhead power lines

1.7.1 The drawings for pipe & counterpoise type earthing are enclosed with these specifications.

1.7.2 For pipe type earthing, length of flat indicated in the *Section Drawing* is indicative only and actual length shall vary depending on site requirement (to avoid fouling of pipe type earthing with foundation base slab). The payment for the pipe type earthing shall be as per the unit rates in the BPS irrespective of the length of flat

1.7.3 For counterpoise type earthing, the earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohms-meter, earthing shall be established by providing 4 lengths of 30m counterpoise wire. Otherwise, for soil resistivity greater than 1500 ohms meter earthing shall be established by providing 4 length of 70m counterpoise wire. The contractor shall also measure tower footing impedance using high frequency Tower footing impedance measurement kit, in addition to Tower footing resistance (TFR). The value of Tower footing resistance as well as tower footing impedance shall not exceed 10 Ohms.

1.7.4 The provisional quantities for pipe type earthing and counterpoise earthing are indicated in the BPS. The bidders are required to quote unit rates for the same in appropriate schedule of BPS. The quoted price shall include fabrication, supply and installation of earthing material including supply of coke, salt etc. In case of counterpoise type earthing, the unit rates shall correspond to 120/280 meters of counterpoise wire per tower.

1.7.5 Chemical pipe/ counter poise type earthing shall be provided in some locations as decided by Site In charge, where due to high resistivity tower footing resistance/ impedance below 10 ohms is not achieved with normal pipe/ counter poise type earthing. The provisional quantities for chemical pipe type earthing and counterpoise earthing are indicated in the BPS. For chemical pipe/ counter poise type earthing, ground enhancement material/ back fill/ grounding compound shall be used. The material should generally conform to IEC 62561 (Part 7). The material should be permanent and maintenance free. It should not dissolve or decompose or otherwise pollute the soil or local water table & environment and should not depend on the continuous presence of water or moisture in the surrounding to maintain its conductivity. The material of the earthing enhancing compound in its set form should have a resistivity of less than 0.12 ohm-m (as per IEEE 80-2000, Clause No. 14.5(d)). It should have hygroscopic properties and should not cause burns, irritation to eyes, skin etc. Test report for the following test on earthing enhancement compound (conducted at accredited

~~laboratory as per IEC 62561 (Part-7) shall be submitted by the contractor to the site in charge.~~

- ~~Resistivity test using soil box~~
- ~~Leaching test~~
- ~~Sulfur determination~~
- ~~Corrosion test~~

~~1.7.6~~ ~~Earthing for River Crossing Towers /Pile foundation~~

~~Galvanised earthing strip of flat 50x6 mm is to be provided in two legs of tower for each location with proper arrangement of connecting these strips by 16 mm bolts shall be provided in the stubs. The Earthing strip from the tower leg may be connected to the MS liner through the pile cap (an indicative drawing is enclosed at drawing section). In case the length of the liner embedded in the ground/ river bed is less than 3m or pile without liner the earthing strip shall be extended along the pile & embedded in the soil upto min. 3m depth from the present minimum RL. After execution of the earthing tower footing resistance/impedance is to be measured and should be maintained below 10 Ohms by suitable measures. In case due to specific soil conditions required tower footing resistance/ impedance below 10 Ohms is not achieved, then additional separate earthing (pipe/ counterpoise type) may be provided. Only bolted connections are allowed for connecting this strip to achieve desired length. Contractor shall submit the detailed drawing for approval of Employer before installations.~~

~~Note: During O&M stage, in case it is observed that MS liner/ strip embedded in the ground/ river bed is exposed due to scouring etc. and length of embedment of liner/strip is less than 3m. Earthing strip may be extended in the ground/ river bed upto 3m from the other end of the liner/ strip by POWERGRID.~~

~~1.7.7~~ ~~In case of location where foundation is classified as hard rock and laying of counter poise earthing at required depth of 1 m below the ground level is not feasible, the earthing shall be provided at reduced depth as per enclosed drawing of "counter poise earthing in hard rock strata. For the payment of hard rock earthing, the unit rate under the contract for chemical counter poise earthing shall be applicable.~~

~~1.7.8~~ ~~Additional earthing shall be provided on every 7 to 8 km distance at tension tower (exact quantity & location to be decided by Site In-charge) for direct earthing of both shield wires (earthwire/ OPGW). Indicative drawing of shield wire earthing arrangement is enclosed at relevant section (Drawing) of technical specification. The scope of work shall inter-alia include supply & installation of PG clamp & down lead clamps and supply & installation of additional earthing (pipe type or counter poise type) depending upon soil resistivity. Additional earthwire bits required for down leads connecting shield wires with the earthing shall be either supplied by~~

~~Owner separately (as Owner supplied material) or shall be supplied by contractor (payable as per unit rate of GS Earthwire under the contract), as may be decided by Site In-Charge.~~

~~1.7.9~~ ~~Additional Rod type earthing shall be provided in one of the foundation pit (diagonally opposite to pipe type earthing) of all the transmission line towers in normal soil (i.e. Dry, Wet cultivated, Wet, PS, FS & Black Cotton soil) in addition to pipe type earthing. This additional earthing MS Rod of 40 mm dia & 3.0 M length shall be driven after excavation of foundation pit and connected to stub cleat. The indicative drawing of Rod type earthing is enclosed in the section of drawing.~~

1.8 Standards

1.8.1 The design, manufacturing, fabrication, galvanising, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following Indian Standards (IS)/ International Standards which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

1.8.2 The material and services covered under the:se specifications shall be performed as per requirements of the relevant latest standard code referred hereinafter against each set of equipment and services

Sl. No.	Indian Standard	Title
1	IS 209	Zinc INGOT - Specification
2	IS 278	Galvanized steel barbed wire for fencing-Specification
3	IS 800	General construction in steel - Code of practice
4(a)	IS 802(Part 1) Sec 1-2015 Sec 2-2016	Use of structural steel in overhead transmission line towers - code of practice part 1 materials, loads and design strengths Section-1: Materials and loads Section-2: Design Strengths.

Sl. No.	Indian Standard	Title
4(b)	IS 802(Part 2)	Code of Practice for use of structural steel in Overhead Transmission Line Towers: Part-2 Fabrication, Galvanising, inspection & Packing
4(c)	IS:802(Part 3)	Code of Practice for use of structural steel in Overload Transmission Line: Part-3 Tower testing
5	IS 808	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.
6(a)	IS 875 Part-1, 2, 4, 5	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.
6(b)	IS 875 Part-3	Design Loads (other than Earthquakes) for Buildings and Structures- Code of Practice
7	IS 1363 Part-1, 2, 3	Hexagon head bolts, Screws and Nuts of product Grade `C'
8	IS 1367, Part 1 to 20	Technical Supply Conditions for Threaded Steel Fasteners
9	IS 1477	Code of practice for Painting of Ferrous Metals in Buildings: Part-I: Pre-treatment Part-II: Painting.
10	IS 1573	Electro-Plated Coatings of Zinc on iron and Steel
11	IS 1852	Rolling and Cutting Tolerances of Hot Rolled Steel Products
12	IS1893 Part 1 Part 2 Part 3 Part 4	Criteria for Earthquake Resistant Design of Structures
13	IS 2016	Specification for Plain Washers
14	IS 2062	Hot Rolled medium and High tensile Structural steel
15	IS 2074 & IS 2074 (Part-1)	Ready Mixed Paint. Air Drying, Red Oxide Zinc Chrome, Priming Specification.
16	IS 2551	Danger Notice Plates

Sl. No.	Indian Standard	Title
17	IS 2629	Recommended Practice for Hot Dip Galvanizing of iron and steel.
18	IS 2633	Method of Testing Uniformity of Coating of Zinc Coated Articles
19	IS 3043	Code of Practice for Earthing
20	IS:3063	Fasteners-Single coil Rectangular Section Spring Lock Washers
21	IS 3757	Specification for High Strength Structural Bolts
22	IS 4759	Specification for Hot-dip zinc coatings on structural steel and other Allied products
23	IS 5369	General Requirements for Plain Washers and Lock Washers
24 a)	IS 5613 (Part 1)	Code of Practice for Design installation and Maintenance of Overhead Power Lines: Lines up to and including 11 KV Section-1: Design, Section-2: Installation and Maintenance
24 b)	IS 5613 (Part 2)	Code of Practice for Design installation and Maintenance of Overhead Power Lines: Lines above 11 KV and upto and including 220 KV Section-1: Design, Section-2: Installation and Maintenance
24 c)	IS 5613 (Part 2)	Code of Practice for Design installation and Maintenance of Overhead Power Lines: 400kV Lines Section-1: Design, Section-2: Installation and Maintenance
25	IS 6610	Specification for Heavy Washers for Steel structures
26	IS 6623	High Strength Structural Nuts
27	IS 6639	Hexagon Bolts for Steel Structure.
28	IS 6745	Method for Determination of Mass of Zinc coating on zinc coated iron and Steel Articles.
29	IS 10238	Fasteners - Threaded Steel Fasteners - Step Bolts for Steel Structures
30	IS 12427	Fasteners - Threaded Steel Fasteners - Hexagon Head Transmission Tower Bolts
31	Publication No. 19(N)/700	Regulation for Electrical Crossing of Railway Tracks

The standards mentioned above are available from

Reference Abbreviation	Name and Address
BIS/IS	Bureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001 INDIA
ISO	International Organisation for Standardization. ISO Central Secretariat BIBC II Chemin de Blandonnet 8 CP 401 1214 Vernier, Geneva Switzerland

2.0 Inspection and Tests

2.1 General

All standard tests, including quality control tests, in accordance with appropriate Indian/ International Standard, shall be carried out unless otherwise specified herein.

2.1.1 Inspection

In addition to the provision of GCC and ~~Cl. 1.7.3 of Section II~~ of this Specification, the following shall also apply:

a) The Contractor shall keep the Employer informed in advance about the time of starting and of the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.

b) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.

2.1.2 The Employer or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the Employer's material for satisfying himself that the fabrication is being done in accordance with the provisions of the Specification.

2.1.3 Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be concluded so as not to interfere unnecessarily with the operation of the work.

2.1.4 Should any member of the structure be found not to comply with the supplied design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Purchaser or his authorized representative considers that the defects can be rectified.

2.1.5 Defect which may appear during fabrication shall be made good with the consent of the Employer according to the procedure proposed by the Contractor and its approval.

2.1.6 All gauges and templates necessary to satisfy the Employer shall be supplied by the Contractor.

2.1.7 The specified grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used, the inspector may at his discretion get the material tested at an approved laboratory.

~~**3.0 Tower Erection, Stringing and Installation of Line Materials**~~

~~**3.1 General**~~

~~3.1.1 The scope of erection work shall include the cost of all labour, tools and plant such as sagging bridges/ working platform, power operated winch machines, cranes of suitable capacity and height (wherever feasible), tension stringing equipment, mechanized rope way wherever required for hilly areas for transportation of materials 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. Use of Tractor for tower erection & final sagging shall not be permitted.~~

~~Use of helicopter for faster erection of transmission line, particularly in difficult and inaccessible terrain, may be considered subject to the required clearance from Director General of Civil Aviation (DGCA) / any other competent authority.~~

~~3.1.2 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 Employer. Similarly, the Contractor shall be responsible for transportation, proper storage, safe custody, and loss or damage of all Employer'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 over and above specified and permitted in Clause 3.13.2 of this section.~~

3.1.3 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 Employer. Employer during the kick off meeting at site supplied items shall be dispatched to the stores set up by the Contractor.

3.1.4 Payment for stringing shall be done on the basis of per kilometer and irrespective of number of tension/ suspension towers. However, stringing for river crossing spans with special towers (Anchor to Anchor) have been given separately in the BPS. The units of measurement for tower erection and other line materials, like, earth wire, Hardware fittings and Accessories for conductor & earth wire are indicated in the BPS.

3.1.5 While handing over the Employer supplied OPGW drums, the testing (fibre loss and length measurement using OTDR) of OPGW in each drum shall be carried out by Contractor in presence of OPGW supplier and/or Employer representatives.

3.1.6 After installation of OPGW, the testing of each section shall be carried out by Contractor in presence of Employer representatives. In case of any damage / high loss in the fiber, the total length of that particular section/ portion of OPGW shall be replaced by the contractor and in such case, the de-stringing & re-stringing shall be carried out by the contractor without any extra cost to Employer and cost of additional OPGW cable, hardware fittings and joint box, if any, for replacement of damaged OPGW etc. shall be recovered from the contractor. However, introduction of additional joints in the links due to replacement of OPGW in damaged portion shall be allowed subject to meeting the optical link budget.

3.1.7 In case FO Cabling (OPGW, Approach cable etc.) installation is covered under the scope of package, Site Acceptance Testing (SAT) for FO Cabling shall be carried out by contractor as per ***Annexure-II***.

3.2 Treatment of Minor Galvanization Damage

Minor defects in hot dip galvanized members shall be repaired by applying zinc rich paint to the satisfaction of the Employer before erection.

3.3 Assembly

The Contractor shall give complete details of the erection procedures he proposes to follow. For erection of towers using crane (wherever feasible) Cranes of suitable capacity along with other necessary T&P, power operated hydraulic/ motorized winches, Gin pole/ Derrick etc. shall be deployed by the Contractor accordingly.

In case erection of tower is carried out by conventional method, Gin Pole/ center mast shall be used for erection of 400 kV towers with +18 m & higher extensions and 765 kV towers with +9 m & higher extensions. For these extension towers, in cases of difficult site conditions/constraints, derricks for tower erection, if proposed by the contractor, to be permitted only with approval of CGM/ ED (Region).

3.3.1 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 450 mm 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, Bird guard, circuit plate, pole plate and phase plates as well as anti-climbing device, as described;
f) After complete erection of the tower, all blank holes, except for additional holes, if any in universal plates and/or in redundant members at different levels for fixing tower accessories (viz. Tower Number plate, Danger plate, Phase plate etc.) are to be filled by bolts and nuts of correct size.
g) The towers shall not be out of vertical by more than 1 in 360 before stringing is carried out.

3.3.2 Tools & plants and PPEs

In addition to the provisions stipulated in the sections of bidding document under conditions of contract, Safety Plan etc., the following shall also apply:

Broad list & basic parameters of major T&P to be used for tower erection & stringing is enclosed at ***Appendix I*** to this specification.

The above-mentioned list is not exhaustive and all T&Ps/ PPEs required for execution of works covered under the contractor scope of work within the schedule in a safe manner, to be deployed by the Contractor.

The contractor shall provide details of all Tools & Plants including lifting machines, lifting tools/ lifting tackles/ lifting gears and all types of ropes and slings and PPEs to be deployed at site for approval of site-in-charge/ project manager as part of safety plan.

All the tools and plants required for safe and efficient tower erection should be available at site. Detailed list of T&P being deployed by the contractor and used by different erection gangs shall be maintained.

Tools and plants should be tested as per applicable standards and safety norms. Relevant test certificates should be available at respective sites.

Derricks/ Gin pole and other load bearing tools i.e. Wire rope, PP rope, D-Shackles, pulleys etc. must be inspected for their healthiness before putting them in use. Only tested tools with valid test certificates should be used. Periodic testing should be carried out to check safe working capacity as per safety plan.

Homemade tools shall not be allowed to use at site.

All necessary PPEs like hand gloves, Safety Belts (Full body harness), safety helmet, safety shoes, etc. as per relevant IS should be used and their healthiness should be ensured.

All the persons working on tower should wear safety helmet, gloves, safety harnesses, fall arrester, high visible vest and safety shoes as the per job requirements. Similarly, all the persons working on ground should wear safety helmet, high visible vest and safety shoes. Detailed list of safety equipment & PPEs being used by the gangs shall be maintained at site.

Condition of safety equipment should be visually checked before every use. These should be tested as per applicable standards; safety norms and necessary test certificate should be available. Also, periodic check should be carried out to ensure their requisite strength.

3.3.3 Use of safety nets

Suitable safety nets shall be used during tower erection activity to provide protection to workers in case of fall from heights.

3.4 Tightening of Bolts and Nuts

3.4.1 All nuts shall be tightened properly using torque wrench, applying the torque recommended by manufacturer of bolts & nuts and proper tightening of bolts & nuts shall be checked by Site Engineer randomly. 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.

3.4.2 The threads of all the 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 up to waist level for single circuit towers and up to bottom cross arm level for double circuit towers and single circuit vertical configuration towers subject to maximum 30 m height from ground level. After welding the surface of welding shall be cleaned, dried and made free of oil, grease and corrosion product and on this surface Zinc Rich Paint shall be applied by means of a brush according to the paint manufacturer's recommendations. Zinc Rich Paint, Pre-mixed type paint, based on organic/ inorganic binders specially formulated for steel surfaces may be used. The dried film of Zinc Rich Paint should contain a minimum of 90 percent Zinc Dust by mass. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.

3.5 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. Also, for checking the soundness of Porcelain Disc insulators, IR measurement using 10 kV (DC) Megger shall be carried out on 100% insulators (*Not applicable for porcelain longrod insulators/ Composite longrod insulators/Glass disc 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.

3.6 Handling of Conductor and Earth wire

3.6.1 Running Out of the Conductors

3.6.1.1 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.

3.6.1.2 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.

3.6.1.3 The sequence of running out shall be from the top down i.e. the earth wire 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.

3.6.1.4 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.

3.6.1.5 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 Employer 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.

3.6.1.6 When the transmission line 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.

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

3.6.2 Running Blocks

3.6.2.1 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.

3.6.2.2 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.

3.6.3 Repairs to Conductors

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

3.6.3.2 Repairs to conductor if accidentally damaged, shall be carried out with repair sleeve.

3.6.3.3 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.

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

3.6.4 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.

Joint measurement of electrical clearances shall be done by the Engineers of Employer and contractor after completion of final sagging in major crossing spans i.e. Railway crossing, River crossing, National/ State Highway crossing, expressway crossing, transmission line crossing (132kV and above voltage level) by using hand held clearance measurement device/ total station. Deviation, if any, is to be attended immediately. Value of measured electrical clearances is to be recorded for future reference.

3.7 Stringing of Conductor and Earth wire

3.7.1 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.

3.7.2 The contractor 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 alongwith equivalent spans in the lines for the approval of the Employer.

3.7.3 A controlled stringing method suitable for simultaneous stringing of the sub conductors shall be used. The conductors making up one phase bundle shall be pulled in and paid out simultaneously. The synchronous stringing of one phase with six bundle conductors may be carried out by using one TSE of adequate capacity. However, two pullers of adequate capacity, towing (4+2) or (3+3) conductors combined with two sets of tensioners may also be used. 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 30^0C for ACSR or AACSR BERSIMIS, SNOWBIRD & LAPWING /26^0C for AAAC/ AL59 conductors and ACSR or AACSR MOOSE, ZEBRA, PANTHER lower than the ambient temperature or by using the initial sag and tensions indicated in the sag and tension chart.

3.8 Jointing

3.8.1 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.

3.8.2 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.

3.8.3 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.

Dimensions of compression type joints (Dead end clamps, MS compression joints, jumper cones, repair sleeves etc.) shall be measured before and after compression to check compliance as per approved drawings. Record of dimension measurement shall be maintained by the Contractor. POWERGRID site engineer shall check the records and verify the dimensions on sample basis.

3.8.4 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 state/ National highway, railways, power lines and major river crossing. 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.

3.8.5 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 alongwith protection can be passed over it smoothly.

3.9 Tensioning and Sagging Operations

3.9.1 The tensioning and 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.

3.9.2 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.

3.9.3 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.

3.9.4 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.

3.9.5 Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperature are not likely to occur.

3.10 Clipping In

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

3.10.2 Jumpers at section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, as per design requirement, to restrict jumper swing to design values. Balancing weights shall be provided with pilot insulator strings in case of triple/ quad/ hexa bundle line and for all lines with composite insulators.

3.10.3 The Jumper drop shall be maintained as per design requirement. Jumper length calculations for different line deviation angles shall be submitted by the Contractor to Employer/ Site In Charge. The jumpers shall be prepared to the required length & compressed with jumper pads at site stores. These shall be assembled with due care taking into consideration conductor bundle configuration and installed correctly.

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

3.11 Fixing of Conductors and Earth wire/OPGW Accessories and Bird Guard

Conductor and earth wire/ OPGW 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. Bird guard shall be installed on all suspension towers. Stringing shall not be considered completed without installation of Bird guard and all Conductors and Earth wire/ OPGW Accessories.

3.11.1 Insulated Conductor sleeve

Insulating sleeve shall be used on bare conductor of Jumper of transposition tower as per site requirement with approval of Employer site in-charge. However, Insulation sleeves shall not be used for HTLS conductors. Insulating sleeve shall provide minimum 66kV class insulation. The protective conductor cover shall be made of silicone rubber. The conductor cover shall be secured with the application of self-adhesive silicone rubber tape.

Insulating tape and insulating sleeve shall be suitable for conductor operating temperature of 0 to 180 degree centigrade. The insulating sleeve and insulation tape shall be Flame, Arc, UV & Ozone Resistant.

Supply & installation charges for insulated conductor sleeve shall be payable pro-rata basis as per unit rate of respective BPS items under the contract.

Type tests on Insulated Conductor sleeve

The required type tests on insulation sleeve are stipulated hereunder. The specified type tests under the following clause shall not be required to be carried out if a valid test certificate is available for a similar design. The tests certificate shall be considered valid if:

i) Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC vide 25/17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or utility and

ii) Tests have been conducted not prior to 5 (five) years from the date of NOA.

iii) In case the test have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test not applicable due to any design/manufacturing change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the Supplier at no extra cost to the Purchaser.

Sl. No.	Type test Description	Applicable Test Standard/ Procedure
1	Ozone Resistance Test on Insulation Sleeve and Tape	ASTM D1149*
2	Power Frequency Voltage Withstand Test on Insulation Sleeve and Tape	The test sample consisting of Insulation sleeve along with Insulating tape (as per the installation condition) shall withstand 66 kV for 1 minute
3	Arc Resistance on Insulation Sleeve and Tape	ASTM D495*
4	UV Resistance on Insulation Sleeve and Tape	1000 hrs as per IEC 62217*
5	Hardness test on Insulation Sleeve	ASTM D2240*
6	Tensile Strength test on Insulation Sleeve & tape	ASTM D 412*
7	Elongation test on Insulation sleeve and Tape	ASTM D 412*
8	Dielectric Strength test on Insulation sleeve and Tape	ASTM D 149*
9	Silicone Content test on Insulation sleeve and Tape	Minimum content of silicone as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Purchaser& Supplier in Quality Assurance Programme
10	Tracking and Erosion Resistance on Insulation sleeve and Tape	ASTM D2303*
11	Flammability test on Insulation sleeve and Tape	IEC 62217*

12	Temperature test for 180^0 for Insulation sleeve and Tape	Sample shall not develop any cracks/ fissures after subjecting to $180^0$for 4 hours.

* Equivalent Indian Standards shall also be acceptable.

Acceptance Tests on Insulated Conductor sleeve:

1. Verification of dimensions of Insulation sleeve and Insulating Tape
2. Tensile Strength test of Insulation sleeve and Insulating Tape
3. Elongation test of Insulation sleeve and Insulating Tape
4. Hardness test of Insulation sleeve
5. Silicone Content Test on Insulation sleeve and Insulating Tape

3.12 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.

3.13 Permitted Extra Consumption of Line materials

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

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

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

Quantity of Earthwire = Line length* as per detailed survey x nos. of earthwire

Quantity of OPGW = Line length* as per detailed survey x no. of OPGW

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

3.13.2 The Contractor shall make every effort to minimise 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 the table below and shall be permitted to dispose of the scrap, if any at the end.

Table: Permitted extra consumption of line materials

~~Item~~	~~% of permitted extra consumption~~
~~Conductor & earth wire~~	~~1~~
~~Insulators~~	~~1*~~
~~OPGW (in Plain area)~~	~~5~~
~~OPGW (in Hilly area)~~	~~7~~

~~* will be applicable whenever insulators are supplied by owner.~~

~~In case of Composite Long Rod Insulators, permitted extra consumption will be subject to physical evidence of damaged insulators otherwise excess insulators are required to be returned to POWERGRID.~~

~~3.13.3~~ ~~In case of conductor and earth wire, the maximum permitted extra consumption limit of one percent is inclusive of sag, jumpering, damage, loss and wastage etc.~~

~~3.13.4~~ ~~The Conductor can be supplied in Wooden drums/ steel drums and hybrid drums and the following methodology/ procedure to be followed: –~~

~~In case of wooden drums for conductor and earthwire, the Contractor shall not be required to return empty wooden drums to the Employer. The empty drums shall dispose off by the contractor at his cost.~~

~~In case of steel drums and hybrid drums for conductor, the Ownership of the empty conductor drums shall lie with the conductor supplier who shall ultimately take back the empty conductor drum from the Project site(s). Accordingly, erection Contractor is required to return the drums to the Conductor Supplier at erection contractor's designated stores after the running out of conductor from the drum.~~

~~The erection contractor shall intimate the Conductor supplier and Employer regarding empty steel drums at their designated stores. Necessary coordination for taking back the empty steel/ hybrid drums in this regard shall be carried out by the Conductor Supplier with the erection Contractor. The erection Contractor shall handle the Steel/ Hybrid Drums in a manner so that these drums can be reused. All efforts shall be made by the erection Contractor to use the Conductor at the earliest.~~

~~Erection Contractor is required to return all the empty steel/ hybrid drums. However, 2% wastage due to transportation & handling etc. of steel/ hybrid drums is allowed. The wastage beyond 2% has to be reimbursed by Erection Contractor.~~

~~3.13.5~~ ~~Any conductor and earth wire drum which has been opened by the Contractor shall not be taken back by Employer and the unused conductor or earth wire in~~

such drums may be treated as waste permissible within the overall limits specified in the Table above under ***clause 3.1.3.2***.

3.13.6 The Contractor shall return to the Employer all Employer supplied material not incorporated in the works, except those permitted by Employer as scrap in terms of Table above under ***clause 3.1.3.2***. Otherwise, the Contractor shall either replenish the excess material from approved source or pay in respect of such excess materials which he is unable to return at rates corresponding to the actual cost of procurement plus (i) 15% for OSM procured under domestically funded packages; and (ii) 26.5% for OSM procured against packages funded by multilateral funding agencies. 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. In case of contract in Foreign currency, Bills clearing (BC) Selling, Market Rate of Exchange (MRE) established by State Bank of India (SBI) as prevalent on date of TOC shall be applicable for converting into Indian Rupees.

3.13.7 The quantities of line materials to be supplied by the contractor (i.e. earth wire and/or OPGW, 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 on the basis of actual requirements. The Employer shall have right, not to take any surplus contractor supplied line materials.

3.13.8 OPGW shall be supplied as per standard length of 5 km in plain area and 3 km in hilly area.

3.14 Final checking, Testing and Commissioning

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 Employer. All the works shall be thoroughly inspected in order to ensure that:

a) Sufficient backfilled 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 zinc rich 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 and 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 Employer 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 *Employer.*

k) All towers are properly grounded.

l) The line is tested satisfactorily for commissioning purpose.

3.14.1 The contractor shall submit minimum 4 nos. of high resolution (min. 20MP) geo tagged photographs of each tower after completion of stringing. Stringing shall not be considered completed without submission of soft copy of following photographs of each tower.

i) Complete tower
ii) Close up on Cross arms covering insulators, Hardware etc.
iii) Forward span focusing on Conductor & corridor
iv) Foundation

3.14.2 The Contractor should also fulfill the requirements of pre-commissioning procedure as given in ***Appendix–II*** to this Specification

3.14.3 After commissioning of the line, thermos vision scanning of jumper connections, dead end joints and mid span compression joints of the complete line shall be completed by the Contractor by deploying third party agency within three months of commissioning of the line using minimum 640x480 pixel resolution day time thermos vision Camera alongwith suitable lenses. Details of the proposed third party agency (including past experience) shall be submitted by the Contractor to POWERGRID site in charge/ RHQ. The thermos vision scanning shall be carried out under supervision of Contractor & POWERGRID site engineers. Location and span wise report of thermos vision scanning shall be submitted by the Contractor to POWERGRID site in charge. Identified defects, if any, shall be rectified by the Contractor within contractual defect liability period.

~~4.0~~ **~~Field Quality Plan~~**

~~The Contractor shall execute the work in accordance with the Field Quality Plan which is available on the POWERGRID Website 7 (seven) days prior to the actual date of bid opening~~

~~5.0~~ **~~Manufacturing Quality Plan~~**

~~Tower manufacturing shall be carried out in accordance with Standardized Manufacturing Quality plan as given in ***Appendix-III*** to this section of the Specification.~~

Annexure-I

~~Test Procedures for Bird Flight Diverters~~

~~1 Visual Examination Test~~

~~Bird diverter assemblies shall be visually examined for general finish and good workmanship.~~

~~2 Verification of Dimensions~~

~~The dimensions of the bird diverter assembly, including area of warning disc, reflective area and glow in dark area, shall be checked against approved drawings and requirements given in the technical specification.~~

~~3 Mechanical Strength Test~~

~~Following Mechanical Strength Tests shall be carried out: -~~

~~a) Direct Pull test~~

~~The clamp of the completely assembled Bird diverters shall be subjected to a load equal to 50% of the specified load of 500 N (using Universal Testing machine) which shall then be increased at a steady rate to 67% of the specified load. The load shall be held for five minutes and then removed. After removal of the load, the assembly and its components shall not show any visual deformation and it shall be possible to disassemble them. The clamp shall then be re-assembled and loaded to 50% of specified load. The load shall be further increased at a steady rate to the maximum load of 500 N and shall be held for one minute. No damage /deformation should occur during this period. The applied load shall then be gradually increased until the failing load is reached and the value shall be recorded.~~

~~b) Clamp Slip Test/Grip Retaining Strength test~~

~~The test shall be carried out as per IEC 61854 (Fig. 1a). The tests shall be performed separately using earthwire, and OPGW. The earthwire/ OPGW, free of any defects or damage, shall be tensioned to 20% of its rated tensile strength. By means of a suitable device (see fig. 1a of IEC 61854), load shall be applied to the clamp along the axis of the earthwire/OPGW and shall be gradually increased (not faster than 100 N/s) until it reaches the specified minimum slip load of 250 N. The load shall be kept constant for one minute. The movement of the clamp relative to its original position on the earthwire/ OPGW shall be observed. The clamp should not slip more than 10 mm and there should not be any damage / deformation of the bird diverter and the earth wire/OPGW. Thereafter, the load shall be increased gradually in steps of 25 N and shall be kept constant for one minute at each step. The slippage at each step shall be~~

recorded. The process shall be continued till the slippage is observed to be more than ~~10 mm from its previous position and the corresponding load shall be recorded.~~

4 ~~Vibration Test~~

~~The tests shall be conducted in a laboratory set up with a minimum effective span length of 30 m for earthwire and OPGW separately. The earthwire/ OPGW shall be tensioned at 25% of its Ultimate Tensile Strength (UTS). Constant tension shall be maintained within the span by means of lever arm arrangement. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be able to measure the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.~~

~~Four number of Bird Diverters shall be clamped to the earthwire/ OPGW in and around the middle of the test span. These bird diverters shall be free to vibrate and shall not be re-torqued or adjusted between the tests. The frequency of vibration is so chosen as to get an odd number of loops. The shaker shall be positioned at least two loops away from the test specimens to allow free movement of the earthwire/ OPGW close to the test specimens. The earthwire/ OPGW shall be connected to the shaker and vibrated to an amplitude such that~~

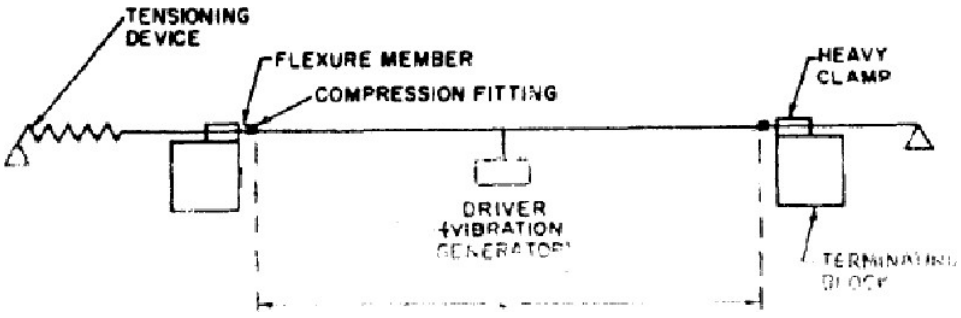
~~$f^{1.8} Y_{max} > 1000$ mm/sec.~~

~~Where Y_{max} being the antinode displacement (mm) and f is the test frequency (Hz).~~

~~The test frequency shall be greater than 24 Hz and the total number of cycles shall be more than 10 million. The bird diverter shall withstand the vibration test without slipping on the earthwre/ OPGW, loosening, damage or failure of components parts.~~

~~After the completion of test, the same bird diverter shall be subjected to mechanical strength test (direct pull test & clamp slip test) as per the procedure given above and the sample shall be able to withstand the tests without damage/ deformation.~~

~~A representative diagram of test assembly is given below.~~



5 Temperature Cycle Test

The complete bird diverter assembly shall be quickly and completely immersed, without being placed in an intermediate container, in a water bath maintained at a temperature of 85°C and left submerged at this temperature for 15 minutes. The sample then shall be withdrawn and quickly & completely immersed, without being placed in an intermediate container, in the cold water bath maintained at a temperature of 15°C where it shall remain for 15 minutes. The sample shall be subjected to 10 such cycles.

The time taken to transfer from either bath to the other shall be as short as possible and never exceed 30 seconds. The quantity of water in the test tanks shall be sufficiently large for the immersion of the samples so as not to cause a temperature variation of more than ±5°C in the water.

After completion of 10 cycles, the sample shall be examined to verify that the samples have not deformed/ damage.

After the completion of test, the same bird diverter shall be subjected to mechanical strength test (direct pull test & clamp slip test) as per the procedure given above and the sample shall be able to withstand the tests without damage/ deformation.

6 Corrosion Resistance Test

Salt fog (at 5% salt solution) and Humidity test (at 90% Rh) as per procedure in accordance with MIL-STD-810F (method 509.4 and Method 507.4).

After the completion of test, the same bird diverter shall be subjected to mechanical strength test (direct pull test & clamp slip test) as per the procedure given above and the sample shall be able to withstand the tests without damage/ deformation.

7 Ageing Test

Solar radiation test & sand and dust test as per procedure in accordance with MIL-STD-810F (Method 505.4 proc II and 510.4 proc I).

After the completion of test, the same bird diverter shall be subjected to mechanical strength test (direct pull test & clamp slip test) as per the procedure given above and the sample shall be able to withstand the tests without damage/ deformation.

8 **Heating Cycle Test**

The heating cycle test shall be carried out on an assembly of conductor & bird diverters and heated by passing a current through the assembly. The conductor shall be tensioned at 20 percent of its Ultimate Tensile strength (UTS) and shall be erected

indoors so that the conductor is roughly horizontal. Air shall be able to circulate freely around the assembly which shall not however be exposed to draughts.

The sample shall be connected on the conductor in accordance with the manufacturer's recommendations. The minimum length of conductor used for determining this current shall be 2 m. The test current shall be that power frequency current which raises the surface temperature of the conductor to the specified maximum operating temperature of the conductor and maintains the temperature at a steady value. The test current shall be passed continuously through the assembly for a period of 30 min or such longer period as may be necessary to bring the reference conductor to the specified maximum operating temperature of conductor ±2.5 °C. The current shall then be interrupted and the conductor shall be allowed to cool to within 5 °C above the ambient temperature. The conductor temperature shall be measured near the centre of the test length.

This sequence of operation shall be repeated so that 250 cycles of heating and cooling are applied. The sample shall not be tightened or adjusted during the test. The sample shall afterwards be opened and there shall be no sign of local heating, burning or fusing of any part of the sample or of the conductor, as a result of the test

9 Corona Extinction Voltage Test (Dry)

The sample, when subjected to power frequency voltage, shall have a corona extinction voltage of not less than that stipulated in the Table below. The test shall be carried out as per IEC: 61284. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60060-1.

10 Radio Interference Voltage Test (Dry)

Under the conditions as specified above, Radio Interference Voltage (RIV) level of the sample shall be less than the values stipulated in the Table given below. The test procedure shall be in accordance with IEC 61284.

Sl	Voltage Level	Minimum Corona extinction voltage	Maximum radio Interference Voltage(at 1 MHz under dry condition(micro volts)
1	765 kV	508	1000((at 508 kV rms))
2	400 kV	320	1000 (at 320kV rms)
3	220 kV /230 kV	156	1000 (at 156 kV rms)

Annexure-II

~~Site Acceptance Testing (SAT) for FO Cabling~~

~~1.0 Site Acceptance Test~~

~~Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.~~

~~SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links.~~

~~Sag and tension of OPGW shall generally be as per approved sag tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Table 1(a) through 1 (c) below:~~

~~Table 1(a)~~

~~Fibre Optic Cable Pre-Installation Testing~~

~~Sl. No.~~	~~Description~~
~~1~~	~~Physical Inspection of the cable assembly for damage~~
~~2~~	~~Optical fibre continuity and fibre attenuation with OTDR at 1550 nm~~
~~3~~	~~Fibre Optic Cable length measurement using OTDR~~

~~Table 1(b)~~

~~Fibre Optic Cable Splicing Testing~~

~~Sl. No.~~	~~Description~~
~~1~~	~~Per splice bi-directional average attenuation with OTDR~~
~~2~~	~~Physical inspection of splice box/enclosure for proper fibre / cable routing techniques~~
~~3~~	~~Physical inspection of sealing techniques, weather proofing, etc~~

~~**Table 1(c)**~~

~~**Fibre Optic Cable Commissioning Testing**~~

~~**Sl. No.**~~	~~**Description**~~
~~1~~	~~End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR~~
~~2~~	~~End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter~~
~~3~~	~~Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also)~~
~~4~~	~~Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan~~