

SECTION-I B

GENERAL INFORMATION

TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

SECTION-I B

GENERAL INFORMATION

1.0 General Information

- 1.1 (a) For towers, pole structures & foundations (including pile foundations) to be designed by the Contractor, Contractor shall develop structural drawings, shop drawings & Bill of Materials of all transmission line towers/ pole structures and their extensions in the present project. The copyright in all drawings, documents and other materials containing data and information for such design(s) to be developed by the Contractor or through any third party under this Contract shall remain vested in the Employer for a period of 5 years from the date of Completion of the Contract. In case the Contractor intends to use these design(s) for any purpose other than for project(s) to be executed by POWERGRID prior to the period of 5 years as above, the Contractor shall obtain a written permission from POWERGRID to this effect. The permission shall be granted or otherwise by POWERGRID keeping in view the specifics of the case and POWERGRID shall be sole judge in this regard.

In case any breach of the aforesaid provisions of copyright during the copyright retention period comes to the notice, POWERGRID shall take the action as deemed fit keeping inter-alia under the provisions of the Integrity Pact.

- (b) The Contractor may also use previously tested tower/ pole structure designs and associated foundation designs (including pile foundation designs) meeting specification requirements, which have been designed by them for any other project of POWERGRID, having copyright retained thereof with POWERGRID, without any financial implication and without any written permission from POWERGRID as per para (a) above.
- (c) In case the Contractor uses previously tested tower/ pole structure and associated foundation designs (including pile foundation designs) meeting specification requirements, developed by the Contractor for any other utility/ developer, POWERGRID shall be free to use designs and reproduce all drawings, documents and other material for the purpose of the Contract including, if required, in its any other project and for operation and maintenance, without any financial implication.

No recovery/ additional payment on account of design/ testing shall be made in case of use of tested designs meeting specification requirements.

Also, all the drawings indicated at above (a) & (b) shall carry the following statement and shall be displayed conspicuously on the drawing:

WARNING: THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH POWERGRID UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM POWERGRID IN WRITING.

- 1.2 For towers/ pole structures* & foundations to be designed by the Contractor, during execution of the project, if any specific designs viz. Transposition tower, body extensions other than that specified in the BPS, other equal/ unequal leg extensions, cross-arm strengthening, auxiliary cross-arms, raised chimney foundations etc. are required as per site conditions, the contractor shall be required to develop the corresponding structural drawings, BOM & Shop drawings, Foundation drawings etc. without any financial implication to Employer. The drawings/ BOMs developed by the Contractor shall be submitted to the Employer for approval.
- 1.3 For Employer design towers/ pole structures, Employer shall provide structural drawings, shop drawings & Bill of Materials of all type of standard transmission line towers/ pole structures and their extensions, river crossing towers/ special towers as required to the Contractor after placement of award, in sequence, suiting the project requirement. The drawings for all type of foundations for these towers/ pole structures shall also be provided by Employer to the Contractor.

However, if the contractor has already executed/is executing any other POWERGRID project involving same type & design of towers as required under the present package, POWERGRID shall not provide the drawings, BOM and Shop sketches again and confirmation regarding the applicability of the same for present package shall be given.

- (a) **For towers, pole structures & foundations to be designed by the Contractor**, the provisional quantities of fabricated & galvanized steel towers as per specifications requirement, foundation type and their numbers, quantity of various line materials and other items are given in appropriate Schedule of Bid Proposal Sheet (BPS) for respective packages.

For Employer design towers/ pole structures, the provisional quantities of fabricated & galvanized steel parts required for towers, concrete, excavation volume & reinforcement steel for foundation and other items are given in appropriate Schedule of Bid Proposal Sheet (BPS) for respective packages.

However, the work shall be executed as per approved construction drawings and project requirement.

- (b) The various items of work are described very briefly in the appropriate Schedule of BPS. The various items of the BPS shall be read in conjunction with the corresponding sections in the Technical Specifications including amendments and, additions, if any. The Bidder's quoted rates shall be based on the description of activities in the BPS as well as other necessary

operations required to complete the works detailed in these Technical Specifications.

- (c) The Unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.
- (d) The unit rate quoted shall be inclusive of all plant equipment, men, material skilled and unskilled labour etc. essential for satisfactory completion of various works.
- (e) All measurements for payment shall be in S.I. units, lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters, rounded off to two decimals.

- 1.4 Bidder shall quote the unit rates for various items of towers/ pole structures and foundations as per units mentioned in appropriate schedule of (BPS). However, payment of these items identified in the schedule of prices shall be made as follows:

TOWER

Supply items : On supply of respective complete tower/ pole structure

Erection items : On erection of respective complete tower/ pole structure

Foundation items : On completion of respective foundation in all respect

For towers, pole structures & foundations specified in BPS to be designed by the Contractor, the payment shall be based on unit prices quoted by the bidder, irrespective of the weights/ volumes arrived in design finally approved by the Employer. For any tower or supplemental/ additional works related to tower/ pole structure/ foundation not specified in the Contract Agreement, but authorised by the Employer, the payment shall be made to the Contractor as detailed in **Section-IV** of this volume. However, Price variation applicable as per SCC shall apply for towers & foundations.

For towers/ pole structure/ foundation designed by the Employer & covered under BPS, payment to be made for towers/ pole structures/ foundations shall be worked out based on the unit rates and approved Bill of Materials (BOM) for towers/ pole structures and quantities/ volumes as per approved foundation drawings.

For other Line materials supply items, payment & price variation shall be as per payment terms indicated in SCC.

The Contractor shall not keep supply items inventory of more than 3 months at any time at their stores.

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.

1.5 Contractor shall clearly indicate in their offer, the sources from where they propose to procure various bought-out items in appropriate Schedule of BPS. The technical descriptions of these items are given in relevant sections of this Volume.

1.6

- i) All equipment/ materials/ items, as per **Annexure-A**, as applicable under present scope of works, shall be purchased only from class-I local Supplier meeting the specified minimum Local content (MLC).
- ii) Any imported equipment/ material/ item/ parts/ component to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/ trojans/ cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/ Govt. of India from time to time. In case of such import from specified “prior reference” countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/ Govt. of India shall also be complied with by the Contractor.
- iii) The equipment offered by the Contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for an equipment/ material, then other applicable International standard (IEC/ Equivalent), as per the specification, shall be accepted.
- iv) The bidder/ Contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract.

1.7 The Contractor shall take delivery of the Employer’s supplied materials at the stores established by the Contractor in consultation with the Employer and ensure their safe custody and shall install the same in the transmission lines as stipulated in this specification.

1.8 In case, part quantity of Tower/ Tower Parts/ Pole structures is supplied by the Employer or other Supplier, the contractor shall take delivery, carry out (unloading & stacking), ensure safe custody of materials at their stores including

insurance cover as required & install the same in the transmission lines as stipulated in this specification.

- 1.9 All the raw materials such as steel, zinc for galvanizing, reinforcement steel and cement for foundation, coke and salt for earthing etc. bolts, nuts, washers, step bolts, D-shackles, hangers, links, Danger Plates, Phase Plates, Pole Plates, number plates, Circuit Plates, aviation signals etc., required for transmission line tower/pole structure manufacture and erection shall be included in the Contractor's scope of supply. Bidder shall indicate in the offer, the sources from where they propose to procure the raw materials and the components.

1.10 Stringing

a) For Earthwire:

The entire stringing work of earth wire shall be carried out by standard stringing practice

b) For OPGW:

The entire stringing work of OPGW shall be carried out by power operated winch machines. No tractor shall be allowed for stringing of OPGW.

c) For transmission line with Single Conductor per phase:

The entire stringing work of conductor shall be carried out by standard stringing practice. No tractor shall be allowed for final sagging. The Contractor shall use power operated winch machines only

d) For transmission line with Bundle Conductor per phase:

The entire stringing work of conductor shall be carried out by tension stringing technique. The bidder shall deploy requisite number of TSEs as per following so as to meet the completion schedule

-Minimum 8Tonne capacity for 220kV Twin Bundle,

-Minimum 8Tonne capacity for 400kV Twin Bundle,

-Minimum 8Tonne capacity for 400kV Triple Bundle,

-Minimum 15Tonne capacity for Quad Bundle,

-Minimum 18Tonne capacity for Hexa Zebra Bundle and,

-Minimum 24Tonne capacity or double no. of TSEs of 15Tonne capacity for Hexa Lapwing Bundle Conductor.

The details regarding numbers and capacity of TSEs to be deployed shall be as mutually agreed between the Employer and Contractor. The period of

deployment of tension stringing equipment shall be as per actual site requirement. No tractor shall be allowed for final sagging.

To promote mechanization, for better safe working condition at site the Contractor shall mandatorily provide at site for each package (i) requisite numbers (minimum 2 nos. per TSE) of sagging bridges/ working platform with pull lifts for facilitating sagging & dead end jointing (ii) requisite numbers (minimum six nos. for each package) of power operated hydraulic/ motorized winch machines for tower erection & carrying out final sagging (iii) requisite numbers (minimum four) ladders with suitable hooks and attachment arrangement to facilitate worker movement on insulators strings and (iv) adequate number of walkie- talkies. In case more number of sagging bridges/ working platform, power operated winch machines etc. are required for stringing of transmission line in accordance with time schedule, the same shall be provided by the Contractor. Further, use of tractor for final sagging shall not be permitted. The Contractor shall use power operated hydraulic/ motorized winch machines only.

Power line crossing, river crossings, railway crossings, other single span sections where deployment of tension stringing machine is not warranted and in hilly terrain, thick forest or areas with site constraints, where deployment of tension stringing machine is not feasible, manual stringing may be adopted after getting approval of Employer's site Engineer. The contractor shall deploy appropriate tools/ equipments/ machinery to ensure that the stringing operation is carried out without causing damage to conductor/ earth wire/ OPGW which are installed at the prescribed sag-tension as per the approved stringing charts.

However, the Bidder having requisite experience may use helicopter for stringing. The Bidder intending to use helicopter shall furnish detailed description of the procedure, type & number of helicopter & accessories etc., to be deployed for stringing operation. Helicopters may be used in stringing processes, particularly in difficult and inaccessible terrain, subject to the required clearance from Director General of Civil Aviation (DGCA) / any other competent authority. The payment for stringing shall be done as per the unit rates of stringing under the contract irrespective of use of Helicopters for stringing.

However, in the Forest areas the stringing of pilot wires/ropes shall be carried out through drones only.

The Contractor may also deploy drones for stringing of pilot wires/ ropes for stringing, keeping in view site constraints as per the direction of Engineer-In-charge.

The quoted rate of stringing through drones shall be inclusive of all necessary T&P's required for successful completion of stringing work including deployment of drone of suitable capacity etc.

For use of Drones in stringing, clearance from Director General of Civil Aviation (DGCA) / any other competent authority may be obtained if required.

1.11 Access to the Line and Right of Way

Right of way and way leave clearance shall be arranged by the Employer in accordance with work schedules. Employer will secure way leave and Right of way in the Forest area.

1.12 Contractor Execution Plan

After award of the Contract, the Contractor shall submit a detailed plan for resources mobilization & execution of various activities under the project scope along with the L2 network (L2 network to be approved by CMG) to Site, CMG & Corporate Engineering The detail should also cover the locations and size of stores to be established by the contractor.

2.0 Qualification Requirement for Contractor's Supplied Tower Parts and Line Materials

The Bidder should have assured access to supply the Conductor, Insulator, Earth wire, Hardware fittings, Accessories for Conductor & Earth wire and OPGW from Qualified Manufacturers meeting the following minimum requirements and must demonstrate that based on known commitments they will be available for use in the proposed contract.

All materials shall be procured from the POWERGRID approved firms which meet the respective qualifying requirements stipulated below. The Contractor shall finalize their sub-vendors/ manufacturers for supply of various line materials from amongst qualified firms within one month from date of NOA and submit the details in support of their meeting the stipulated qualification requirements.

In case Contractor proposes to supply the line material(s) from a sub-vendor/

manufacturer which is not already approved by POWERGRID, the same may be considered subject to following: -

- i) The proposal shall be given by Contractor along with complete details in support of suppliers' meeting the stipulated qualification requirements including details of past supplies, test certificates, performance certificates etc.
- ii) POWERGRID may carryout assessment of the works of the proposed suppliers, if required.
- iii) The final approval of the supplier shall be subject to verification of QR data and assessment of the supplier to the satisfaction of POWERGRID.

The review/ verification of QR data by POWERGRID/ assessment of supplier's works/ approval of the proposed supplier shall not in any way limit Contractor's responsibility or dilute their obligation of timely completion of supplies/ works. Any delays, what-so-ever, shall be entirely to Contractor's account.

- iv) Wherever the qualification requirement mentioned below stipulate requirement of providing additional warranty, the requisite CPG shall be submitted to POWERGRID regional HQ with intimation to Corporate Engineering department for subsequent review & approval of sub vendor drawings/ documents.

2.1 Tower Parts

The bidder/ Contractor should be a POWERGRID approved vendor of Tower and Tower Parts as on originally scheduled last date of bid submission or should have assured access from tower manufacturers approved by POWERGRID as on date of NOA-

In case of assured access from tower manufacturers, the Contractor shall furnish a Joint Deed of Undertaking (Format enclosed at **Annexure-B**) along with the manufacturer(s) to guarantee quality & timely supply of tower parts from each of the manufacturer(s) at the time of finalizing the manufacturer(s), during execution of the Contract.

2.2 Earthwire

The qualified manufacturer should have manufactured, tested and supplied at least three hundred (300) km of galvanized steel ground wire/ ACSR core wire of size 7/3.15mm or above.

2.3 OPGW

TECHNICAL EXPERIENCE

- (a) OPGW manufacturer should be a “Local Supplier” as per latest DPIIT and DoT notification.
- (b) (i) OPGW manufacturer must have manufactured, type tested (as per IEC or equivalent standard) and supplied at least 100 km of OPGW during last seven (7) years and the same must be in satisfactory operation⁵ for at least one (01) year on 66kV or above transmission line(s), as on the date of NOA.

OR

- (ii) OPGW manufacturer must have manufactured, type tested (as per IEC or equivalent standard) and supplied at least 100 km of OPGW as on the date of NOA. Further, extended warranty of one (1) year over and above the warranty period specified for OPGW shall be submitted.
- (c) OPGW manufacturer established as Subsidiary/ JVC/ Group company who has manufactured, type tested (as per IEC or equivalent standard) and supplied OPGW and meets the requirement at (a) but not (b)(i) above, shall also be considered, provided its Parent/ Principal company meets the requirement at (b)(i) above. Further the following shall also be submitted by OPGW manufacturer:
 - (i) Performance guarantee for an amount of 10% (Ten) of the cost of OPGW cable.
 - (ii) Valid collaboration agreement (between Parent/ Principal and OPGW manufacturer) for technology transfer/ license to design, manufacture, test and supply OPGW in India.

For Live Line Installation (if applicable)

Agency must have installed at least 100 km of OPGW cable in live-line condition on 66 kV or higher voltage transmission line(s), as on the date of NOA.

*Note: All relevant OPGW Forms are enclose at **Annexure-C**.*

2.4 Composite Insulators for 765kV voltage level transmission lines

2.4.1 For all insulator ratings except 320kN

2.4.1.1 The Qualified Manufacturer’s experience should include the following:

- i) **(A) QR Criteria for suppliers for 85% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos.**

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 160kN or above rating Composite long rod insulators for 345kV or above voltage transmission lines/ sub-stations and the same should have been in satisfactory operation⁵ for a minimum period of two years as on date of NOA.

(B) QR Criteria for suppliers for 15% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos. and for packages where cumulative quantity requirement indicated in BOQ is less than 4000 nos.

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 150 nos. of 160kN or above rating Composite long rod insulators for 345KV or above voltage transmission lines/ substations and the same should have been in satisfactory operation⁵ for a minimum period of two years as on date of NOA.

ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA.

- a. Tests on individual units of 210 KN or above rating as per IEC 61109:1995 or IEC 61109:2008.
- b. Following Type tests on insulator strings assembly for 765kV or above Voltage transmission lines with 210kN or above electromechanical strength insulators:
 - Power Frequency Voltage withstand test (Wet)
 - Switching Surge Voltage Withstand test (Wet)
 - Lightning Impulse Voltage Withstand test (Dry)
 - Radio Interference Voltage Test (Dry)
- c. Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.

2.4.1.2 For a manufacturer, not meeting the requirements specified at 2.4.1.1(i) (A) & 2.4.1.1(ii) of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.

2.4.1.3 In case the cumulative requirement of insulators indicated in the BOQ is less than 4000nos, the bidder/Contractor may supply the entire requirement from supplier(s) (with a maximum of 2000 nos. from each) meeting the Technical

requirement indicated at 2.4.1.1 (i) (B) and other mandatory requirement specified at 2.4.1.1.

2.4.1.4 In case the cumulative requirement of insulators indicated in the BOQ is more than 4000 nos., the bidder/ Contractor may supply cumulatively not more than 15% with a maximum of 2000 nos. of the requirement from a supplier meeting the Technical requirement indicated at 2.4.1.1 (i) (B) and other mandatory requirement specified at 2.4.1.1. For balance 85% quantity, the supplier shall meet the Technical requirement indicated at 2.4.1.1 (i) (A) and other mandatory requirement specified at 2.4.1.1 or Technical requirement indicated at 2.4.1.2.

2.4.2 For 320kN insulator ratings

2.4.2.1 The Qualified Manufacturer's experience should include the following:

- i) The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 160kN or above rating Composite long rod insulators for 345kV or above voltage transmission lines/ sub-stations and the same should have been in satisfactory operation⁵ for a minimum period of two years as on date of NOA.
- ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA.
 - a. Tests on individual units of 210 KN or above rating as per IEC 61109:1995 or IEC 61109:2008.
 - b. Following Type tests on insulator strings assembly for 765kV or above Voltage transmission lines with 210kN or above electromechanical strength insulators:
 - Power Frequency Voltage withstand test (Wet)
 - Switching Surge Voltage Withstand test (Wet)
 - Lightning Impulse Voltage Withstand test (Dry)
 - Radio Interference Voltage Test (Dry)
 - c. Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.

2.4.2.2 For a manufacturer, not meeting the requirements specified at 2.4.2.1 of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.

2.5 Composite Insulators for 400kV voltage level transmission lines with Twin Moose or Quad Moose or Twin HTLS configuration and having upto 160kN rating Insulator

2.5.1 The Qualified Manufacturer's experience should include the following:

i) (A) QR Criteria for suppliers for 85% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos.

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 160kN or above rating Composite long rod insulators for 345kV or above voltage transmission lines/ sub-stations and the same should have been in satisfactory operation[§] for a minimum period of two years as on date of NOA.

(B) QR Criteria for suppliers for 15% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos. and for packages where cumulative quantity requirement indicated in BOQ is less than 4000 nos.

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 150 nos. of 160kN or above rating Composite long rod insulators for 345KV or above voltage transmission lines/substations and the same should have been in satisfactory operation[§] for a minimum period of two years[@] as on date of NOA.

@ If the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.5.1i)(B), he shall furnish a legally enforceable undertaking for extended warranty of additional two years over and above the warranty period specified under the package.

ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA.

a) Tests on individual units of 160 KN or above rating as per IEC 61109:1995 or IEC 61109:2008.

b) Following Type tests on insulator strings assembly for 345kV or above Voltage transmission lines with 160kN or above electromechanical strength insulators:

- Power Frequency Voltage withstand test (Wet)
- Switching Surge Voltage Withstand test (Wet)
- Lightning Impulse Voltage Withstand test (Dry)
- Radio Interference Voltage Test (Dry)

c) Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.

2.5.2 For a manufacturer, not meeting the requirements specified at 2.5.1(i) (A) & 2.5.1(ii) of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.

2.5.3 In case the cumulative requirement of insulators indicated in the BOQ is less than 4000nos, the bidder/ Contractor may supply the entire requirement from supplier(s) (with a maximum of 2000 nos. from each) meeting the Technical requirement indicated at 2.5.1 (i) (B) and other mandatory requirement specified at 2.5.1.

2.5.4 In case the cumulative requirement of insulators indicated in the BOQ is more than 4000nos, the bidder/ Contractor may supply cumulatively not more than 15% with a maximum of 2000nos of the requirement from a supplier meeting the Technical requirement indicated at 2.5.1 (i) (B) and other mandatory requirement specified at 2.5.1. For balance 85% quantity, the supplier shall meet the Technical requirement indicated at 2.5.1 (i) (A) and other mandatory requirement specified at 2.5.1 or Technical requirement indicated at 2.5.2.

2.6 Composite Insulators for 400kV voltage level transmission lines with Triple Snowbird or Twin Lapwing or Twin HTLS configuration and having upto 210kN rating Insulator

2.6.1 The Qualified Manufacturer's experience should include the following:

i) (A) QR Criteria for suppliers for 85% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos.

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 160kN or above rating Composite long rod insulators for 345kV or above voltage transmission lines/ sub-stations and the

same should have been in satisfactory operation⁵ for a minimum period of two years as on date of NOA.

(B) QR Criteria for suppliers for 15% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos. and for packages where cumulative quantity requirement indicated in BOQ is less than 4000 nos.

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 150 nos. of 160kN or above rating Composite long rod insulators for 345KV or above voltage transmission lines/substations and the same should have been in satisfactory operation⁵ for a minimum period of two years[@] as on date of NOA.

@ If the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.6.1i) (B), he shall furnish a legally enforceable undertaking for extended warranty of additional two years over and above the warranty period specified under the package.

- ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA.
- a. Tests on individual units of 210 KN or above rating as per IEC 61109-1995 or IEC 61109-2008.
 - b. Following Type tests on insulator strings assembly for 345kV or above Voltage transmission lines with 210kN or above electromechanical strength insulators:
 - Power Frequency Voltage withstand test (Wet)
 - Switching Surge Voltage Withstand test (Wet)
 - Lightning Impulse Voltage Withstand test (Dry)
 - Radio Interference Voltage Test (Dry)
 - c. Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.

2.6.2 For a manufacturer, not meeting the requirements specified at 2.6.1(i) (A) & 2.6.1(ii) of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.

2.6.3 In case the cumulative requirement of insulators indicated in the BOQ is less than 4000nos, the bidder/ Contractor may supply the entire requirement from supplier(s) (with a maximum of 2000 nos. from each) meeting the Technical requirement indicated at 2.6.1 (i) (B) and other mandatory requirement specified at 2.6.1.

2.6.4 In case the cumulative requirement of insulators indicated in the BOQ is more than 4000nos, the bidder/Contractor may supply cumulatively not more than 15% with a maximum of 2000nos of the requirement from a supplier meeting the Technical requirement indicated at 2.6.1 (i) (B) and other mandatory requirement specified at 2.6.1. For balance 85% quantity, the supplier shall meet the Technical requirement indicated at 2.6.1 (i) (A) and other mandatory requirement specified at 2.6.1 or Technical requirement indicated at 2.6.2.

2.7 Composite Insulators for 220kV voltage level transmission lines

2.7.1 Composite Insulators for 220kV voltage level transmission lines with Single Zebra configuration

2.7.1.1 The Qualified Manufacturer's experience should include the following:

- i) **(A) QR Criteria for suppliers for 85% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos.**

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 120kN or above rating Composite long rod insulators for 220 kV or above voltage transmission lines/ sub-stations and the same should have been in satisfactory operation^S for a minimum period of two years as on date of NOA.

- (B) QR Criteria for suppliers for 15% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos. and for packages where cumulative quantity requirement indicated in BOQ is less than 4000 nos.**

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 150 nos. of 120kN or above rating Composite long rod insulators for 220 kV or above voltage transmission lines/substations and the

same should have been in satisfactory operation[§] for a minimum period of two years[@] as on date of NOA.

@ If the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.7.1.1(i) (B), he shall furnish a legally enforceable undertaking for extended warranty of additional two years over and above the warranty period specified under the package.

ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA.

- a. Tests on individual units of 120 KN or above rating as per IEC 61109-1995 or IEC 61109-2008.
- b. Following Type tests on insulator strings assembly for 220kV or above Voltage transmission lines with 120kN or above electromechanical strength insulators:
 - Power Frequency Voltage withstand test (Wet)
 - Lightning Impulse Voltage Withstand test (Dry)
 - Radio Interference Voltage Test (Dry)
- c. Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.

2.7.1.2 For a manufacture, not meeting the requirements specified at 2.7.1.1(i) (A) & 2.7.1.1(ii) of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.

2.7.1.3 In case the cumulative requirement of insulators indicated in the BOQ is less than 4000nos, the bidder/Contractor may supply the entire requirement from supplier(s) (with a maximum of 2000 nos. from each) meeting the Technical requirement indicated at 2.7.1.1 (i) (B) and other mandatory requirement specified at 2.7.1.1.

2.7.1.4 In case the cumulative requirement of insulators indicated in the BOQ is more than 4000nos, the bidder/ Contractor may supply cumulatively not more than 15% with a maximum of 2000nos of the requirement from a supplier meeting the Technical requirement indicated at 2.7.1.1 (i) (B) and other mandatory requirement specified at 2.7.1.1. For balance 85% quantity, the supplier shall

meet the Technical requirement indicated at 2.7.1.1 (i) (A) and other mandatory requirement specified at 2.7.1.1 or Technical requirement indicated at 2.7.1.2.

2.7.2 Composite Insulators for 220kV voltage level transmission lines with Twin Moose configuration

2.7.2.1 The Qualified Manufacturer's experience should include the following:

- i) **(A) QR Criteria for suppliers for 85% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos.**

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 160kN or above rating Composite long rod insulators for 220 kV or above voltage transmission lines/ sub-stations and the same should have been in satisfactory operation[§] for a minimum period of two years as on date of NOA.

- (B) QR Criteria for suppliers for 15% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos. and for packages where cumulative quantity requirement indicated in BOQ is less than 4000 nos.**

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 150 nos. of 160kN or above rating Composite long rod insulators for 220 kV or above voltage transmission lines/substations and the same should have been in satisfactory operation[§] for a minimum period of two years[@] as on date of NOA.

@ If the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.7.2.1(i) (B), he shall furnish a legally enforceable undertaking for extended warranty of additional two years over and above the warranty period specified under the package.

- ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA.
- Tests on individual units of 160 KN or above rating as per IEC 61109-1995 or IEC 61109-2008.
 - Following Type tests on insulator strings assembly for 220kV or above Voltage transmission lines with 160kN or above electromechanical strength insulators:

- Power Frequency Voltage withstand test (Wet)
- Lightning Impulse Voltage Withstand test (Dry)
- Radio Interference Voltage Test (Dry)

c. Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.

2.7.2.2 For a manufacture, not meeting the requirements specified at 2.7.2.1(i) (A) & 2.7.2.1(ii) of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.

2.7.2.3 In case the cumulative requirement of insulators indicated in the BOQ is less than 4000nos, the bidder/Contractor may supply the entire requirement from supplier(s) (with a maximum of 2000 nos. from each) meeting the Technical requirement indicated at 2.7.2.1 (i) (B) and other mandatory requirement specified at 2.7.2.1

2.7.2.4 In case the cumulative requirement of insulators indicated in the BOQ is more than 4000nos, the bidder/ Contractor may supply cumulatively not more than 15% with a maximum of 2000nos of the requirement from a supplier meeting the Technical requirement indicated at 2.7.2.1 (i) (B) and other mandatory requirement specified at 2.7.2.1. For balance 85% quantity, the supplier shall meet the Technical requirement indicated at 2.7.2.1 (i) (A) and other mandatory requirement specified at 2.7.2.1 or Technical requirement indicated at 2.7.2.2.

2.8 Composite Insulators for 132kV voltage level transmission lines with Single Panther configuration

2.8.1 The Qualified Manufacturer's experience should include the following:

- i) (A) QR Criteria for suppliers for 85% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos.**

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 2000 nos. of 90kN or above rating Composite long rod insulators for 110kV or above voltage transmission lines/ sub-stations and the same should have been in satisfactory operation⁵ for a minimum period of two years as on date of NOA.

(B) QR Criteria for suppliers for 15% of cumulative quantity under packages where cumulative quantity requirement indicated in BOQ is more than 4000 nos. and for packages where cumulative quantity requirement indicated in BOQ is less than 4000 nos.

The Qualified Manufacturer should have designed, manufactured, tested and supplied minimum 150 nos. of 90kN or above rating Composite long rod insulators for 110 kV or above voltage transmission lines/substations and the same should have been in satisfactory operation\$ for a minimum period of two years@ as on date of NOA.

@ If the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.8.1 i) (B), he shall furnish a legally enforceable undertaking for extended warranty of additional two years over and above the warranty period specified under the package.

- ii) The Qualified manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of Composite long rod insulators) as on date of NOA: -
- a. Tests on individual units of 90 KN or above rating as per IEC 61109-1995 or IEC 61109-2008.
 - b. Following Type tests on insulator strings assembly for 110kV or above Voltage transmission lines with 90kN or above electromechanical strength insulators: -
 - Power Frequency Voltage withstand test (Wet)
 - Lightning Impulse Voltage Withstand test (Dry)
 - c. Accelerated ageing test of 5000hrs as described in Appendix-C of IEC 61109 or Test at Multiple stresses of 5000 hrs as described in IEC 62730 or Annex-B of IEC 62217.
- 2.8.2** For a manufacturer, not meeting the requirements specified at 2.8.1 (i) (A) & 2.8.1 (ii) of its own, he should be a qualified Licensee of a qualified manufacturer meeting the above specified requirements and also meeting the conditions stipulated at 2.43.
- 2.8.3** In case the cumulative requirement of insulators indicated in the BOQ is less than 4000nos, the bidder/Contractor may supply the entire requirement from supplier(s) (with a maximum of 2000 nos. from each) meeting the Technical requirement indicated at 2.8.1 (i) (B) and other mandatory requirement specified at 2.8.1

2.8.4 In case the cumulative requirement of insulators indicated in the BOQ is more than 4000nos, the bidder/ Contractor may supply cumulatively not more than 15% with a maximum of 2000nos of the requirement from a supplier meeting the Technical requirement indicated at 2.8.1 (i) (B) and other mandatory requirement specified at 2.8.1. For balance 85% quantity, the supplier shall meet the Technical requirement indicated at 2.8.1 (i) (A) and other mandatory requirement specified at 2.8.1 or Technical requirement indicated at 2.8.2.

2.9 Disc/ Porcelain Longrod Insulators for 400 kV voltage level transmission lines with Twin/ Quad Moose configuration

2.9.1 The Qualified manufacturer shall be a manufacturer of Insulators of similar nature for the last five years. The manufacturer's experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied 120 KN & 160 KN or above electro-mechanical strength of disc insulators/ long rod insulators for 110/132 KV or above voltage transmission line of quantities not less than 50,000 nos. disc insulators /6520 nos. long rod insulators of each rating and the same should have been in satisfactory operation for a minimum period of two years as on date of NOA.

Further, the manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of # Standard &/Anti-fog disc insulators/ long rod insulators as the case may be) as on date of NOA: -

a) Tests on individual units.

b) Following type tests on insulator strings assembly for 345/ 400 KV or above voltage transmission lines with 120 KN & 160 KN or above electro-mechanical strength insulators: -

- Power frequency Voltage withstand test (Wet)
- Switching Surge Voltage Withstand test (Wet)
- Lightning Impulse Voltage withstand test (Dry)
- Radio interference voltage test (dry)

Either Standard or Anti-fog or both depending on scope

2.9.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.9.1 and also meeting the conditions stipulated at 2.43.

2.10 Disc/ Porcelain Longrod Insulators for 400 kV voltage level transmission lines with Triple Snowbird configuration

2.10.1 The Qualified manufacturer shall be a manufacturer of Insulators of similar nature for the last five years. The manufacturer's experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied 120 KN & 160 KN or above electro-mechanical strength of disc insulators/ long rod insulators for 110/132 KV or above voltage transmission line of quantities not less than 50,000 nos. disc insulators /6520 nos. long rod insulators of each rating and the same should have been in satisfactory operation for a minimum period of two years as on date of NOA.

Further, the manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of # Standard &/Anti-fog disc insulators/ long rod insulators as the case may be) as on date of NOA: -

a) Tests on individual units.

b) Following type tests on insulator strings assembly for 345/ 400 KV or above voltage transmission lines with 120 KN & 210 KN or above electro-mechanical strength insulators: -

- Power frequency Voltage withstand test (Wet)
- Switching Surge Voltage Withstand test (Wet)
- Lightning Impulse Voltage withstand test (Dry)
- Radio interference voltage test (dry)

Either Standard or Anti-fog or both depending on scope

2.10.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.10.1 and also meeting the conditions stipulated at 2.43.

2.11 Disc/ Porcelain Longrod Insulators for 400 kV voltage level transmission lines with Twin Lapwing configuration

2.11.1 The Qualified manufacturer shall be a manufacturer of Insulators of similar nature for the last five years. The manufacturer's experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied 160 KN or above electro-mechanical strength of disc insulators/ long rod insulators for 110/132 KV or above voltage transmission line of quantities not less than 50,000 nos. disc insulators /6520 nos. long rod insulators of each rating and the same should have been in satisfactory operation for a minimum period of two years as on date of NOA.

Further, the manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of # Standard &/Anti-fog disc insulators/ long rod insulators as the case may be) as on date of NOA: -

a) Tests on individual units.

b) Following type tests on insulator strings assembly for 345/ 400 KV or above voltage transmission lines with 160 KN & 210 KN or above electro-mechanical strength insulators: -

- Power frequency Voltage withstand test (Wet)
- Switching Surge Voltage Withstand test (Wet)
- Lightning Impulse Voltage withstand test (Dry)
- Radio interference voltage test (dry)

Either Standard or Anti-fog or both depending on scope

2.11.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.11.1 and also meeting the conditions stipulated at 2.43.

2.12 Disc/ Porcelain Longrod Insulators for 220 kV voltage level transmission lines with Single Zebra configuration

2.12.1 The Qualified manufacturer shall be a manufacturer of Insulators of similar nature for the last five years. The manufacturer's experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied 70kN & 120kN or above electro-mechanical strength of disc insulators/ long rod insulators for 110/132 KV or above voltage transmission line of quantities not less than 50,000 nos. disc insulators /6520 nos. long rod insulators of each rating and the same should have been in satisfactory operation for a minimum period of two years as on date of NOA.

Further, the manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of # Standard &/Anti-fog disc insulators/ long rod insulators as the case may be) as on date of NOA: -

- a) Tests on individual units.
- b) Following type tests on insulator strings assembly for 220 KV or above voltage transmission lines with 70 KN & 120 KN or above electro-mechanical strength insulators: -
 - Power frequency Voltage withstand test (Wet)
 - Lightning Impulse Voltage withstand test (Dry)
 - Radio interference voltage test (dry)

Either Standard or Anti-fog or both depending on scope

2.12.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.12.1 and also meeting the conditions stipulated at 2.43.

2.13 Disc/ Porcelain Longrod Insulators for 132kV voltage level transmission lines with Single Panther configuration

2.13.1 The Qualified manufacturer shall be a manufacturer of Insulators of similar nature for the last five years. The manufacturer's experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied 70kN & 90kN or above electro-mechanical strength of disc insulators/ long rod insulators for 110/132 KV or above voltage transmission line of quantities not less than 50,000 nos. disc insulators /6520 nos. long rod insulators of each rating and the same should have been in satisfactory operation for a minimum period of two years as on date of NOA.

Further, the manufacturer should also have successfully completed at least the following tests on insulator units and insulator strings (of # Standard &/Anti-fog disc insulators/ long rod insulators as the case may be) as on date of NOA: -

- a) Tests on individual units.
- b) Following type tests on insulator strings assembly for 110/132 KV or above voltage transmission lines with 70kN & 90kN or above electro-mechanical strength insulators: -

- Power frequency Voltage withstand test (Wet)
- Lightning Impulse Voltage withstand test (Dry)

Either Standard or Anti-fog or both depending on scope

2.13.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.13.1 and also meeting the conditions stipulated at 2.43.

2.14 ACSR MOOSE and ACSR ZEBRA Conductor

2.14.1 The qualified manufacturer's experience should include the following:

The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Sixty one (61) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.14.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.14.1 and also meeting the conditions stipulated at 2.43.

2.15 ACSR LAPWING Conductor

2.15.1 The qualified manufacturer's experience should include the following:

The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Fifty two (52) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.15.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.15.1 and also meeting the conditions stipulated at 2.43.

2.16 ACSR BERSIMIS Conductor

2.16.1 The qualified manufacturer's experience should include the following:

The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Forty Nine (49) or above strands ACSR/AAAC/AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.16.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.16.1 and also meeting the conditions stipulated at 2.43.

2.17 ACSR PANTHER Conductor

2.17.1 The qualified manufacturer's experience should include the following:

The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Thirty seven (37) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.17.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.17.1 and also meeting the conditions stipulated at 2.43.

2.18 AACSR MOOSE and AACSR ZEBRA Conductor

2.18.1 The qualified manufacturer's experience should include the following:

- i) The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Sixty one (61) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA and
- ii) The qualified manufacturer should have manufactured, tested and supplied at least cumulative two hundred (200) km of Sixty one (61) or above strands AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.18.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.18.1 and also meeting the conditions stipulated at 2.43.

2.19 AACSR LAPWING Conductor

2.19.1 The qualified manufacturer's experience should include the following:

- i) The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Fifty two (52) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA and

- ii) The qualified manufacturer should have manufactured, tested and supplied at least cumulative two hundred (200) km of Fifty two (52) or above strands AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.19.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.19.1 and also meeting the conditions stipulated at 2.43.

2.20 AACSR BERSIMIS Conductor

2.20.1 The qualified manufacturer's experience should include the following:

- i) The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Forty Nine (49) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA and
- ii) The qualified manufacturer should have manufactured, tested and supplied at least cumulative two hundred (200) km of Forty Nine (49) or above strands AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.20.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.20.1 and also meeting the conditions stipulated at 2.43.

2.21 AACSR PANTHER Conductor

2.21.1 The qualified manufacturer's experience should include the following:

- i) The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Thirty seven (37) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA and
- ii) The qualified manufacturer should have manufactured, tested and supplied at least cumulative two hundred (200) km of Thirty seven (37) or above strands AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.21.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.21.1 and also meeting the conditions stipulated at 2.43.

2.22 AAAC MOOSE, AAAC ZEBRA and AAAC BERSIMIS Conductor

2.22.1 The qualified manufacturer's experience should include the following:

- i) The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Sixty one (61) or above strands ACSR/ AAAC/ AL59/AACSR conductor during last seven (7) years as on date of NOA and
- ii) The qualified manufacturer should have manufactured, tested and supplied at least cumulative two hundred (200) km of Sixty one (61) or above strands AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.22.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.22.1 and also meeting the conditions stipulated at 2.43.

2.23 AAAC PANTHER Conductor

2.23.1 The qualified manufacturer's experience should include the following:

- (i) The qualified manufacturer should have manufactured, tested and supplied at least cumulative One Thousand (1000) km of Thirty Seven (37) or above strands ACSR/ AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA and
- (ii) The qualified manufacturer should have manufactured, tested and supplied at least cumulative two hundred (200) km of Thirty Seven (37) or above strands AAAC/ AL59/ AACSR conductor during last seven (7) years as on date of NOA.

2.23.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.23.1 and also meeting the conditions stipulated at 2.43.

2.24 AL59 MOOSE, AL59 ZEBRA and AL59 BERSIMIS Conductor

2.24.1 The qualified manufacturer's experience should include the following:

- (a) The qualified manufacturer should have manufactured, tested and supplied at least cumulative one thousand (1000) km of ACSR/ AAAC/AL59/ AACSR conductor with Sixty one (61) strands or above during last seven (7) years as on date of NOA and

(b)(i) The qualified manufacturer should have manufactured, tested and supplied at least two hundred (200) km of AL59 conductor of thirty seven (37) strands or above during last seven (7) years as on date of NOA.

OR

(b)(ii) A manufacturer not meeting the requirements stipulated in clause (b)(i) above can also participate provided he has manufactured, tested and supplied at least cumulative two hundred (200) km of AAAC/ AL59/AACSR conductor of thirty seven (37) strands or above during last seven (7) years and should have manufactured & successfully completed following tests on AL59 Conductor of thirty seven (37) strands or above, as on date of NOA: -

- i) UTS test
- ii) DC resistance test

2.24.2 The proposed manufacturer can also be a qualified Licensee of a qualified manufacturer meeting the above specified requirements at 2.24.1 (a) & 2.24.1(b) (i) above and also meeting the conditions stipulated at 2.43.

2.25 AL59 PANTHER Conductor

2.25.1 The qualified manufacturer's experience should include the following:

(a) The qualified manufacturer should have manufactured, tested and supplied at least cumulative one thousand (1000) km of ACSR/ AAAC/ AL59/ AACSR conductor with thirty seven (37) strands or above during last seven (7) years as on date of NOA and

(b)(i) The qualified manufacturer should have manufactured, tested and supplied at least two hundred (200) km of AL59 conductor of thirty seven (37) strands or above during last seven (7) years as on date of NOA.

OR

(b)(ii) A manufacturer not meeting the requirements stipulated in clause (b)(i) above can also participate provided he has manufactured, tested and supplied at least cumulative two hundred (200) km of AAAC/ AL59/ AACSR conductor of thirty seven (37) strands or above during last seven (7) years and should have manufactured & successfully completed following tests on AL59 Conductor of thirty seven (37) strands or above, as on date of NOA: -

- i) UTS test
- ii) DC resistance test

2.25.2 The proposed manufacturer can also be a qualified Licensee of a qualified manufacturer meeting the above specified requirements at 2.25.1 (a) & 2.25.1(b) (i) above and also meeting the conditions stipulated at 2.43.

2.26 HTLS Conductor for 400 kV voltage level transmission lines

2.26.1 (a) The Qualified Manufacturer should have manufactured, tested and supplied at least one hundred (100) km of High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in this package having minimum thirty seven (37) number of strands or 200 sq. mm. aluminum cross section area in last seven (7) years as on date of NOA and the same should have been in satisfactory operation^s for a period of at least one (1) year as on date of NOA.

OR

(b) The Qualified Manufacturer should have manufactured, tested and supplied at least one hundred (100) km of High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in this package having minimum thirty seven (37) number of strands or 200 sq. mm. aluminum cross section area in last seven (7) years as on date of NOA and the same should have been in satisfactory operation^s as on date of NOA.

Note: In case of Clause 2.26.1 b) above, the warranty obligations in terms of 10% of the ex-work cost of the HTLS conductor for additional period of two (2) years over and above the warranty period as specified in the bidding documents shall be applicable.

OR

(c) The manufacturer not meeting the qualification requirements stipulated in clause 2.26.1(a) or 2.26.1(b) above can also participate as a Licensee of a Licensor meeting the requirement stipulated at Clause 2.26.1(a) and also meeting the conditions stipulated at Clause 2.44 provided that: -

- i) The manufacturer/ Licensee has manufactured, tested and supplied at least cumulative one thousand (1000) km of ACSR/ AAAC/ ACAR/ AACSR/ AL59 conductor having at least same or more number of strands as that of the conductor being offered in the package during last seven (7) years as on the date of NOA and
- ii) The manufacturer/ Licensee should have established manufacturing facility & developed High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in the package having

minimum thirty seven (37) number of strands or 200 sq. mm aluminium cross section area and should have successfully carried out following tests as on date of NOA: -

A) **On complete Conductor**

- i) DC resistance test on stranded conductor
- ii) UTS test on stranded conductor at ambient & at designed elevated temperature (minimum 150 deg C design temperature)

B) **On Conductor strand/ core**

- i) Heat resistance test on Aluminium Alloy strands (not applicable for annealed aluminium)
- ii) Torsion & Elongation tests on core strands#/ composite core#
- iii) Breaking load test on core strands#/ composite core# and Aluminium#/ Aluminium Alloy# strands
- iv) Conductivity test on thermal resistant Aluminium#/ Aluminium Alloy# strands
- v) Glass transition temperature test (for composite core only)
- vi) Flexural strength test (for composite core only)

as the case may be

Note:

1. The tests indicated at B) above should have been carried out by the manufacturer/ Licensee on their own or by their supplier of aluminium alloy strands, core/ core strands.
2. In case of Clause 2.26.1 c) above, the manufacturer participating as a Licensee shall provide warranty obligations in terms of 10% of the ex-work cost of the HTLS conductor for additional period of two (2) years over and above the warranty period specified in the bidding documents.

2.27 HTLS Conductor for 220 kV voltage level transmission lines

- 2.27.1** (a) The Qualified Manufacturer should have manufactured, tested and supplied at least one hundred (100) km of High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in this package having minimum thirty three (33) number of strands or 150 sq. mm. aluminum cross section area in last seven (7) years as on date of NOA and the same should have

been in satisfactory operation\$ for a period of at least one (1) year as on date of NOA.

OR

(b) The Qualified Manufacturer should have manufactured, tested and supplied at least one hundred (100) km of High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in this package having minimum thirty three (33) number of strands or 150 sq. mm. aluminum cross section area in last seven (7) years as on date of NOA and the same should have been in satisfactory operation\$ as on date of NOA.

Note: In case of Clause 2.27.1 b) above, the warranty obligations in terms of 10% of the ex-work cost of the HTLS conductor for additional period of two (2) years over and above the warranty period as specified in the bidding documents shall be applicable.

OR

(c) The manufacturer not meeting the qualification requirements stipulated in clause 2.27.1(a) or 2.27.1(b) above can also participate as a Licensee of a Licensor meeting the requirement stipulated at Clause 2.27.1 (a) and also meeting the conditions stipulated at Clause 2.44 provided that: -

- i) The manufacturer/ Licensee has manufactured, tested and supplied at least cumulative one thousand (1000) km of ACSR/ AAAC/ ACAR/ AACSR/ AL59 conductor having at least same or more number of strands as that of the conductor being offered in the package during last seven (7) years as on the date of NOA and
- ii) The manufacturer/ Licensee should have established manufacturing facility & developed High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in the package having minimum thirty three (33) number of strands or 150 sq. mm aluminium cross section area and should have successfully carried out following tests as on date of NOA: -

A) **On complete Conductor**

- i) DC resistance test on stranded conductor
- ii) UTS test on stranded conductor at ambient & at designed elevated temperature (minimum 150 deg C design temperature)

B) On Conductor strand/ core

- i) Heat resistance test on Aluminium Alloy strands (not applicable for annealed aluminium)
- ii) Torsion & Elongation tests on core strands#/ composite core#
- iii) Breaking load test on core strands#/ composite core# and Aluminium#/ Aluminium Alloy# strands
- iv) Conductivity test on thermal resistant Aluminium#/ Aluminium Alloy# strands
- v) Glass transition temperature test (for composite core only)
- vi) Flexural strength test (for composite core only)

as the case may be

Note:

1. The tests indicated at B) above should have been carried out by the manufacturer/ Licensee on their own or by their supplier of aluminium alloy strands, core/ core strands.
2. In case of Clause 2.27.1 c) above, the manufacturer participating as a Licensee shall provide warranty obligations in terms of 10% of the ex-work cost of the HTLS conductor for additional period of two (2) years over and above the warranty period specified in the bidding documents.

2.28 HTLS Conductor for 132 kV voltage level transmission lines

- 2.28.1** (a) The Qualified Manufacturer should have manufactured, tested and supplied at least one hundred (100) km of High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in this package having minimum thirty (30) number of strands or 100 sq. mm. aluminum cross section area in last seven (7) years as on date of NOA and the same should have been in satisfactory operation⁵ for a period of at least one (1) year as on date of NOA.

OR

- (b) The Qualified Manufacturer should have manufactured, tested and supplied at least one hundred (100) km of High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in this package having minimum thirty (30) number of strands or 100 sq. mm. aluminum cross section area in last seven (7) years as on date of NOA and the same should have been in satisfactory operation⁵ as on date of NOA.

Note: In case of Clause 2.28.1 b) above, the warranty obligations in terms of 10% of the ex-work cost of the HTLS conductor for additional period of two (2) years over and above the warranty period as specified in the bidding documents shall be applicable.

OR

(c) The manufacturer not meeting the qualification requirements stipulated in clause 2.28.1(a) or 2.28.1(b) above can also participate as a Licensee of a Licensor meeting the requirement stipulated at Clause 2.28.1(a) and also meeting the conditions stipulated at Clause 2.44 provided that: -

i) The manufacturer/ Licensee has manufactured, tested and supplied at least cumulative one thousand (1000) km of ACSR/ AAAC/ ACAR/ AACSR/ AI59 conductor having at least same or more number of strands as that of the conductor being offered in the package during last seven (7) years as on the date of NOA and

ii) The manufacturer/ Licensee should have established manufacturing facility & developed High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in the package having minimum thirty (30) number of strands or 100 sq. mm aluminium cross section area and should have successfully carried out following tests as on date of NOA:-

A) **On complete Conductor**

- i) DC resistance test on stranded conductor
- ii) UTS test on stranded conductor at ambient & at designed elevated temperature (minimum 150 deg C design temperature)

B) **On Conductor strand/ core**

- i) Heat resistance test on Aluminium Alloy strands (not applicable for annealed aluminium)
- ii) Torsion & Elongation tests on core strands#/ composite core#
- iii) Breaking load test on core strands#/ composite core# and Aluminium#/ Aluminium Alloy# strands
- iv) Conductivity test on thermal resistant Aluminium#/ Aluminium Alloy# strands
- v) Glass transition temperature test (for composite core only)
- vi) Flexural strength test (for composite core only)

as the case may be

Note:

1. The tests indicated at B) above should have been carried out by the manufacturer/ Licensee on their own or by their supplier of aluminium alloy strands, core/ core strands.
2. In case of Clause 2.28.1 c) above, the manufacturer participating as a Licensee shall provide warranty obligations in terms of 10% of the ex-work cost of the HTLS conductor for additional period of two (2) years over and above the warranty period specified in the bidding documents.

2.29 Technical Qualification Requirement for supplier of core of any special material for High temperature low sag conductor (HTLS)

The Conductor manufacturer shall use core of any special material (if used) such as Invar steel or composite core supplied from the qualified manufacture(s) meeting the following requirements: -

The Qualified Manufacturer should have manufactured, tested and supplied at least two hundred (200) km of the same type of core material as used in the HTLS conductor being offered in the package. Further, conductor manufactured from the supplied core of such manufacturers should have been in satisfactory operation⁵ for a period of at least two years as on date of NOA.

An undertaking by the proposed supplier of core of HTLS conductor shall be submitted during execution of the contract (Performa enclosed as **Annexure–D** to this section).

2.30 Clamp fittings and accessories for high temperature low sag conductor (HTLS) for 400 kV voltage level transmission lines

- 2.30.1** (a) The qualified manufacturer(s) should have designed, manufactured, tested and supplied fittings for suspension & tension strings and accessories for any type of conductor, viz. ACSR, AACSR, AAAC etc. for 345/400 kV or above voltage transmission line.

Further, the qualified manufacturer(s) for any individual item(s) of clamp fittings and accessories covered under the package should have designed, manufactured, tested and supplied the item(s) of clamp fittings and accessories for High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in the package(s) for application on 66 kV or above voltage transmission line and the same should have been in satisfactory operation⁵ for a minimum period of two (2) years as on date of NOA.

The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

b) However, if the proposed manufacturer of Hardware fittings and Accessories for conductor is not meeting the above requirements on its own, he should be qualified licensee of a qualified manufacturer meeting the above specified requirements and meeting the conditions stipulated at 2.43.

2.30.2 For Indigenous Manufacturer

The Indigenous manufacturer[^] of hardware fittings and accessories not meeting the requirement of clause 2.30.1(a) above can also supply provided they meet the following requirements: -

The indigenous manufacturer[^] must have designed, manufactured, tested and supplied fittings for suspension & tension strings and accessories for any type of conductor, viz. ACSR, AACSR, AAAC etc. for 345/400 kV or above voltage transmission line as on date of NOA.

Further, the indigenous manufacturer[^] for any individual item(s) of clamp fittings and accessories covered under the package should have designed, manufactured and type tested, as per the Technical specification of POWERGRID, the item(s) of clamp fittings and accessories for same technology of HTLS conductor as being offered in the package for application of 345/400 kV or above voltage transmission line as on date of NOA.

The Contractor shall furnish a legally enforceable undertaking for extended warranty^{^^} of additional two (2) years over and above the warrantee period specified under the package.

^ Indigenous manufacturer means a manufacturer who proposes to offer the fittings and accessories for HTLS conductor from manufacturing facilities located in India.

^^ Additional extended warranty in terms of 10 % CPG corresponding to cost of the item(s).

2.31 Clamp fittings and accessories for high temperature low sag conductor (HTLS) for 220kV voltage level transmission line

- 2.31.1** a) The qualified manufacturer(s) should have designed, manufactured, tested and supplied fittings for suspension & tension strings and accessories for any type of conductor, viz. ACSR, AACSR, AAAC etc. for 220 kV or above voltage transmission line. Further, the qualified manufacturer(s) for any individual item(s) of clamp fittings and accessories covered under the package should have designed, manufactured, tested and supplied the item(s) of clamp fittings and accessories for High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in the package(s) for application on 66 kV or above voltage transmission line and the same should have been in satisfactory operation[§] for a minimum period of two (2) years as on date of NOA.

The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

b) However, if the proposed manufacturer of Hardware fittings and Accessories for conductor is not meeting the above requirements on its own, he should be qualified licensee of a qualified manufacturer meeting the above specified requirements and meeting the conditions stipulated at 2.43.

2.31.2 For Indigenous Manufacturer

a) The Indigenous manufacturer[^] of hardware fittings and accessories not meeting the requirement of clause 2.31.1(a) above can also supply provided they meet the following requirements: -

The indigenous manufacturer[^] must have designed, manufactured, tested and supplied fittings for suspension & tension strings and accessories for any type of conductor, viz. ACSR, AACSR, AAAC etc. for 220 kV or above voltage transmission line as on date of NOA.

Further, the indigenous manufacturer[^] for any individual item(s) of clamp fittings and accessories covered under the package should have designed, manufactured and type tested, as per the Technical specification of POWERGRID, the item(s) of clamp fittings and accessories for same technology of HTLS conductor as being offered in the package for application of 220 kV or above voltage transmission line as on date of NOA.

The Contractor shall furnish a legally enforceable undertaking for extended warranty^{^^} of additional two (2) years over and above the warranty period specified under the package.

[^] Indigenous manufacturer means a manufacturer who proposes to offer the fittings and accessories for HTLS conductor from manufacturing facilities located in India.

^{^^} Additional extended warranty in terms of 10% CPG corresponding to cost of the item(s).

2.32 Clamp fittings and accessories for high temperature low sag conductor (HTLS) for 132kV voltage level transmission lines

- 2.32.1** The qualified manufacturer(s) should have designed, manufactured, tested and supplied fittings for suspension & tension strings and accessories for any type of conductor, viz. ACSR, AACSR, AAAC etc. for 110/ 132 kV or above voltage transmission line.

Further, the qualified manufacturer(s) for any individual item(s) of clamp fittings and accessories covered under the package should have designed, manufactured, tested and supplied the item(s) of clamp fittings and accessories for High temperature low sag (HTLS) conductor of same technology as that of the conductor being offered in the package(s) for application on 66 kV or above voltage transmission line and the same should have been in satisfactory operation[§] for a minimum period of two (2) years as on date of NOA.

The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

- b) However, if the proposed manufacturer of Hardware fittings and Accessories for conductor is not meeting the above requirements on its own, he should be qualified licensee of a qualified manufacturer meeting the above specified requirements and meeting the conditions stipulated at 2.43.

2.32.2 For Indigenous Manufacturer

The Indigenous manufacturer[^] of hardware fittings and accessories not meeting the requirement of clause 2.32.1(a) above can also supply provided they meet the following requirements: -

The indigenous manufacturer[^] must have designed, manufactured, tested and supplied fittings for suspension & tension strings and accessories for any type of conductor, viz. ACSR, AACSR, AAAC etc. for 110/132 kV or above voltage transmission line as on date of NOA.

Further, the indigenous manufacturer[^] for any individual item(s) of clamp fittings and accessories covered under the package should have designed, manufactured and type tested, as per the Technical specification of POWERGRID, the item(s) of clamp fittings and accessories for same technology of HTLS conductor as being offer in the package for application of 110/ 132 kV or above voltage transmission line as on date of NOA.

The Contractor shall furnish a legally enforceable undertaking for extended warranty^{^^} of additional two (2) years over and above the warrantee period specified under the package.

[^] Indigenous manufacturer means a manufacturer who proposes to offer the fittings and accessories for HTLS conductor from manufacturing facilities located in India.

^{^^} Additional extended warranty in terms of 10% CPG corresponding to cost of the item(s).

2.33 Hardware Fittings for 765kV voltage level transmission lines

2.33.1 The qualified manufacturer shall be a manufacturer of hardware fittings of similar nature. The qualified manufacturer's experience should include the following:

- (i) The qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 765kV or above voltage transmission line and the same should have been in satisfactory operation⁵ for a minimum period of two (2) years as on date of NOA;

OR

(ii) (a) Alternatively, the qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 345kV or above voltage transmission line and the same should have been in satisfactory operation for a minimum period of two (2) years as on as on date of NOA; and

(b) The qualified manufacturer should also have successfully completed at least the following type tests on tension & suspension strings for 765kV or above application as on date of NOA: -

- Power Frequency Voltage withstand test (Wet)
- Switching Surge Voltage Withstand test (Wet)
- Lightning Impulse Voltage Withstand test (Dry)
- Corona & Radio Interference Voltage Test (Dry)

(iii) In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at (i) & (ii) (a) above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10% CPG corresponding to cost of the item(s).

2.33.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.33.1 (i) or (ii) and also meeting the conditions stipulated at 2.43.

2.34 Hardware Fittings for 400 kV voltage level transmission line

2.34.1 The qualified manufacturer shall be a manufacturer of hardware fittings of similar nature. The qualified manufacturer's experience should include the following:

(i) The qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 345kV or above voltage transmission line and the same should have been in satisfactory operation⁵ for a minimum period of two (2) years as on date of NOA: -

OR

(ii) (a) Alternatively, the qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 220kV or above voltage

transmission line and the same should have been in satisfactory operation for a minimum period of two (2) years as on as on date of NOA; and

(b) The qualified manufacturer should also have successfully completed at least the following type tests on tension & suspension strings for 345kV or above application as on date of NOA:

- Power Frequency Voltage withstand test (Wet)
- Switching Surge Voltage Withstand test (Wet)
- Lightning Impulse Voltage Withstand test (Dry)
- Corona & Radio Interference Voltage Test (Dry)

(iii) In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at (i) & (ii) (a) above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10% CPG corresponding to cost of the item(s).

2.34.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.34.1 (i) or (ii) and also meeting the conditions stipulated at 2.43.

2.35 Hardware Fittings for 220 kV voltage level transmission line

2.35.1 The qualified manufacturer shall be a manufacturer of hardware fittings of similar nature. The qualified manufacturer's experience should include the following:

(i) The qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 220kV or above voltage transmission line and the same should have been in satisfactory operation[§] for a minimum period of two (2) years as on date of NOA;

OR

(ii) (a) Alternatively, the qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 110kV or above voltage transmission line and the same should have been in satisfactory operation for a minimum period of two (2) years as on as on date of NOA; and

(b) The qualified manufacturer should also have successfully completed at least the following type tests on tension & suspension strings for 220kV or above application as on date of NOA:

- Power Frequency Voltage withstand test (Wet)
- Lightning Impulse Voltage Withstand test (Dry)

(iii) In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at (i) & (ii) (a) above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10% CPG corresponding to cost of the item(s).

2.35.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.35.1 (i) or (ii) and also meeting the conditions stipulated at 2.43.

2.36 Hardware Fittings for 132 kV voltage level transmission line

2.36.1 The qualified manufacturer shall be a manufacturer of hardware fittings of similar nature. The qualified manufacturer's experience should include the following:

(i) The qualified manufacturer should have designed, manufactured, tested and supplied hardware fittings for at least 600 sets of tension strings and 1200 sets of suspension strings for 110kV or above voltage transmission line and the same should have been in satisfactory operation[§] for a minimum period of two (2) years as on date of NOA;

(ii) In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at (i) above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10 % CPG corresponding to cost of the item(s).

2.36.2 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.36.1 (i) and also meeting the conditions stipulated at 2.43.

2.37 Accessories for Conductor and Earth wire for 765kV voltage level transmission line

2.37.1 The qualified manufacturer shall be a manufacturer of accessories for conductor & earthwire of similar nature. The qualified manufacturer experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied the item(s) of accessories for conductor & earth wire covered under the package or item(s) of similar/ comparable nature. For spacer dampers for Hexa/ Quad bundle conductor and vibration dampers for earth wire, the experience should include at least the supply of 6900 nos. of quad spacer dampers and 2300 nos. of vibration dampers for earth wire for 345kV or above transmission line and the same should have been in satisfactory operation⁵ for a minimum period of two (2) years as on date of NOA. (For accessories for galvanized steel Earthwire, the requirement of voltage level shall not be applicable).

2.37.2 In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.37.1 above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10 % CPG corresponding to cost of the item(s).

2.37.3 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.37.1 and also meeting the conditions stipulated at 2.43.

2.37.4 The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

2.38 Accessories for Conductor and Earth wire for 400 kV transmission line with Quad/ Triple bundle conductor

2.38.1 The qualified manufacturer shall be a manufacturer of accessories for conductor & earthwire of similar nature. The qualified manufacturer experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied the item(s) of accessories for conductor & earth wire covered under the package or item(s) of similar/ comparable nature. For spacer dampers for Quad/ Triple bundle conductor and vibration dampers for earth wire, the experience should include at least the supply of 6900 nos. of quad spacer dampers and 1950 nos. of vibration dampers for earth wire for 345kV or above transmission line and

the same should have been in satisfactory operation⁵ for a minimum period of two (2) years as on date of NOA. (For accessories for galvanized steel Earthwire, the requirement of voltage level shall not be applicable).

- 2.38.2** In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.38.1 above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10% CPG corresponding to cost of the item(s).

- 2.38.3** The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.38.1 and also meeting the conditions stipulated at 2.43.

- 2.38.4** The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

2.39 Accessories for Conductor and Earth wire for 400 kV transmission line with twin bundle conductor

- 2.39.1** The qualified manufacturer shall be a manufacturer of accessories for conductor & earthwire of similar nature. The qualified manufacturer experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied the item(s) of accessories for conductor & earth wire covered under the package or item(s) of similar/ comparable nature. For Bundle Spacer and Vibration dampers, the experience should include at least the supply of 7,875 nos. of twin bundle spacers and 5,850 nos. of vibration dampers for conductor and 1,950 nos. of vibration dampers for earthwire for 220kV or above voltage transmission line and the same should have been in satisfactory operation⁵ for a minimum period of two (2) years as on date of NOA. (For accessories for galvanized steel Earthwire, the requirement of voltage level shall not be applicable).

- 2.39.2** In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.39.1 above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10 % CPG corresponding to cost of the item(s).

- 2.39.3** The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.39.1 and also meeting the conditions stipulated at 2.43.

2.39.4 The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

2.40 Accessories for Conductor and Earth wire for 220kV transmission line

2.40.1 The qualified manufacturer shall be a manufacturer of accessories for conductor & earthwire of similar nature. The qualified manufacturer experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied the item(s) of accessories for conductor & earth wire covered under the package or item(s) of similar/comparable nature. For Bundle Spacer and Vibration dampers, the experience should include at least the supply of 7,875 nos. of twin bundle spacers and 5,850 nos. of vibration dampers for conductor and 1,950 nos. of vibration dampers for earthwire for 220kV or above voltage transmission line and the same should have been in satisfactory operation\$ for a minimum period of two (2) years as on date of NOA. (For accessories for galvanized steel Earthwire, the requirement of voltage level shall not be applicable).

2.40.2 In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.40.1 above, the contractor shall furnish extended warranty^^ of additional two years over and above the warranty period specified under the package.

^^ Additional extended warranty in terms of 10 % CPG corresponding to cost of the item(s).

2.40.3 The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.40.1 and also meeting the conditions stipulated at 2.43.

2.40.4 The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

2.41 Accessories for Conductor and Earth wire for 132 kV transmission line

2.41.1 The qualified manufacturer shall be a manufacturer of accessories for conductor & earthwire of similar nature. The qualified manufacturer experience should include the following:

The qualified manufacturer should have designed, manufactured, tested and supplied the item(s) of accessories for conductor & earth wire covered under the package or item(s) of similar/ comparable nature. For Vibration dampers, the experience should include at least the supply of 5,850 nos. of vibration dampers for conductor and 1,950 nos. of vibration dampers for earthwire for 132kV or

above voltage transmission line and the same should have been in satisfactory operation[§] for a minimum period of two (2) years as on date of NOA. (For accessories for galvanized steel Earthwire, the requirement of voltage level shall not be applicable).

- 2.41.2** In case of indigenous manufacturers, if the Qualified manufacturer is not meeting the stipulated two years operational experience requirements specified at 2.41.1 above, the contractor shall furnish extended warranty^{^^} of additional two years over and above the warranty period specified under the package.

^{^^} Additional extended warranty in terms of 10 % CPG corresponding to cost of the item(s).

- 2.41.3** The proposed manufacturer can also be a qualified licensee of a qualified manufacturer meeting the above specified requirements at 2.41.1 and also meeting the conditions stipulated at 2.43.

- 2.41.4** The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items only.

2.42 Mono Pole Structures

(Applicable in packages where QR provisions for Pole structure manufacturers is not covered under Main QR)

The bidder/ Contractor should have its own manufacturing facilities & experience as stipulated below or should have assured access to supply the pole structures from Qualified Manufacturer(s) meeting individually the following minimum requirements and must demonstrate that based on known commitments they will be available for use in the proposed contract: -

The qualified manufacturer should have its own manufacturing facilities for transmission line pole structures. Further, the qualified manufacturer should have designed, manufactured and either type tested or supplied transmission line pole structures for *345kV or above voltage / **220 kV or above voltage / ***110 kV or above voltage / ****66 kV or above voltage transmission line as on date of NOA.

(* Applicable for 765kV voltage level)

(** Applicable for 400kV voltage level)

(*** Applicable for 220kV voltage level)

(**** Applicable for 132kV or below voltage level)

In case the Contractor is proposing supply of pole structures from his sub-vendors(s), the Contractor will be required to furnish a Joint Deed of Undertaking

(Format enclosed at Annexure-E) along with the manufacturer(s) to guarantee quality & timely supply of pole structures and confirming to furnish a performance guarantee of 2% of the cost of such transmission line pole structures, at the time of finalizing the manufacturer(s), during execution of the Contract.

2.43 Licensor-Licensee conditions (Applicable for items other than HTLS Conductor)

- (i) Manufacturer/licensees shall have adequate design infrastructure and manufacturing facility and capacity and procedures including quality control.
- (ii) A qualified Licensee of a qualified manufacturer shall comply with all of the following requirements and furnish a joint undertaking by the licensor along with the bid.
 - a) Any design undertaken by the licensee shall be approved by the licensor.
 - b) Manufacture by the licensee shall be done with the approval of the licensor and Employer under a quality assurance programme approved and monitored by the licensor.
 - c) Licensee must furnish back-up guarantee from the licensor for individual and overall performance of all materials supplied under the contract.
 - d) Licensor must guarantee sequential and timely supply of materials and submission of technical information and data as desired by the Employer so as to meet the overall construction schedule and
 - e) The agreement between licensee and licensor (copy to be submitted along with the undertaking as per, Proforma enclosed as **Annexure-F** to this section) shall be valid for a period of at least five (5) years after the guarantee period of equipment and materials under supply is over.

2.44 Licensor-Licensee conditions (Applicable for HTLS Conductor)

- (i) Manufacturer/ Licensee shall furnish a legally enforceable joint undertaking by the Licensor along with the Licensee in the bid to guarantee following requirement:-
 - a) Any design undertaken by the Licensee shall be approved by the Licensor.
 - b) Manufacturing by the Licensee shall be done with the approval of the Licensor under a quality assurance programme approved and monitored by the licensor.
 - c) In addition to the Contract Performance Security to be furnished by the Contractor, the Licensor shall furnish back-up performance security in the form of bank guarantee for 5% of the Ex-works cost of the HTLS conductor as per the format provided for successful performance of HTLS

conductor to be manufactured and supplied by the Licensee under the contract.

- d) Licensor must guarantee sequential and timely supply of materials and submission of technical information and data as desired by the Employer so as to meet the overall construction schedule and
- e) The agreement between licensee and licensor (copy to be submitted along with the undertaking as per Proforma enclosed as **Annexure-G** to this section) shall be valid for a period of at least two (2) years after the guarantee period of equipment and materials under supply is over.

2.45 In case manufacturer is a holding company, the technical experience referred to in above clauses shall be of that holding company only (i.e. excluding its subsidiary/ group companies). In case manufacturer is a subsidiary of a holding company, the technical experience referred to in above clauses shall be of that subsidiary company only (i.e. excluding its holding companies)

Note: \$ Satisfactory operation under above clauses means certificate issued by the Employer certifying the operation without adverse remark.

2.46 Technical requirement of Sub-Contractors

2.46.1 The subcontractor must have either of the following experience of having successfully completed similar works during last 7 years as on the last day of month previous to the one in which the sub-contractor is proposed to be engaged:

- a) Three similar works costing not less than the amount equal to 40% of the cost of the work to be sub-contracted
OR
- b) Two similar works costing not less than the amount equal to 50% of the cost of the work to be sub-contracted
OR
- c) One similar work costing not less than the amount equal to 80% of the cost of the work to be sub-contracted

2.46.2 Minimum Average Annual Turnover* (MAAT) for best three years i.e. 36 months out of last five financial years of the sub-contractor should be

*Annual Gross Revenue from operations/ Gross operating income as incorporated in the profit & loss account excluding other operating income/Other Income.

Note:

1. Similar work shall mean the work which are of similar in nature to the work to be sub-contracted e.g. for the scope of civil work to be sub contracted, the experience should be of civil work.
2. The aforesaid qualifying requirement shall however, not be applicable for engaging labour as per extant policy.
3. The cost of the work to be sub-contracted shall be considered as available in the Contract Agreement. However, if the value is not available in the Contract Agreement, the same shall be the estimated value for such work.
4. The above criteria is in addition to extant policy on selection of sub-contractor as per WPPP, Vol-II.
5. The MAAT requirement shall be worked out basis the following formula:
Minimum Average Annual Turnover (MAAT)= Cost of the work to be sub-contracted x1.5/Completion period in years**

**The completion period shall be considered as 1 year even if the same is less than 1 year

3.0 General aspects of Employer design Towers

3.1 Tower Extensions

3.1.1 Provisions for tower extensions shall be as per clause 1.2 of Section IV A of technical specification

3.1.2 All above extension provisions to towers and foundations shall be treated as part of normal towers and foundations only.

3.2 Span and clearances

Span and clearances given in following clauses are indicative. Span & Clearances to be adopted for the specific package shall be as per Tower Spotting Data to be given to the contractor during execution stage.

3.2.1 Normal Span

The normal ruling span of the line of different voltage level is given in the table below:

Sl. No.	Voltage Level of Transmission Line	Design Span or Normal Ruling Span
A)	400 kV, 765 kV, ± 500 kV HVDC and ± 800 kV HVDC	400 meters

B)	220 kV	350 meters
C)	132 kV	320 meters

3.2.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

3.2.3 Weight span

The weight span is the horizontal distance between the null points of the conductors on the two spans adjacent to the tower.

3.2.4 In case at certain locations, actual spans are found to be exceeding the design spans and cross-arms/ other members of towers are required to be modified/ reinforced, the tower shall be modified/ reinforced by the contractor based on drawings supplied to the Contractor.

4.0 Details of Line Materials

4.1 AC Lines

4.1.1 765 kV Voltage level

A) 765 kV Single Circuit Transmission Line with Horizontal / DELTA/ Vertical Delta Configuration

1	Conductor	Four ACSR BERSIMIS conductor per phase with sub-conductor spacing of 457 mm in Horizontal/ Delta configuration.
2	Earthwire/ OPGW	Two Earthwires (7/3.66mm) or One Earthwire (7/3.66mm) and one OPGW or Two OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' suspension Pilot	120
b)	Double 'I' suspension	240

c)	Single 'V' suspension Pilot	120 (Along one arm)
d)	Single Tension	120
e)	Single 'V' suspension	210 (Along one arm)
f)	Double 'V' suspension	420 (Along one arm)
g)	Quadruple Tension	840

B) 765 kV Double Circuit Transmission Line

1	Conductor	Six ACSR ZEBRA conductor per phase with sub-conductor spacing of 457 mm in vertical configuration.
2	Earthwire / OPGW	Two Earthwires (7/3.66mm) or One Earthwire (7/3.66mm) and one OPGW or Two OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
Insulator String details		
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Double 'I' suspension	320
b)	Single 'I' suspension Pilot	160
c)	Single Tension	160
d)	Quadruple Tension	840

4.1.2 400 kV Voltage Level

A) 400kV Double Circuit (QUAD ACSR MOOSE) Transmission Line

1	Conductor	Four ACSR MOOSE conductor per phase with sub-conductor spacing of 457 mm in vertical configuration.
2	Earthwire / OPGW	Two Earthwires (7/3.66mm) or One Earthwire (7/3.66mm) and one OPGW or Two OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.

3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Double 'I' suspension	240
b)	Single 'I' suspension Pilot	120
c)	Single Tension	120
d)	Quadruple Tension	640

B) 400 kV Single/Double Circuit (TWIN ACSR MOOSE) Transmission Line

1	Conductor	Two ACSR MOOSE conductor per phase with sub-conductor spacing of 450 mm.
2	Earthwire / OPGW	Two Earthwires (7/3.66mm) or One Earthwire (7/3.66mm) and one OPGW or Two OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' Suspension	120
b)	Single 'I' suspension Pilot	120
c)	Single Tension	120
d)	Double Tension	320

C) 400 kV Double Circuit (triple ACSR SNOWBIRD) Transmission Line

1	Conductor	Triple ACSR Snowbird conductor per phase with sub-conductor spacing of 457 mm.
2	Earthwire / OPGW	Two Earthwires (7/3.66mm) or One Earthwire (7/3.66mm) and one OPGW or Two OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)

a)	Double 'I' Suspension	240
b)	Single 'I' suspension Pilot	120
c)	Single Tension	120
d)	Double Tension	420

D) 400 kV Double Circuit (twin ACSR LAPWING) Transmission Line

1	Conductor	Twin ACSR Lapwing conductor per phase with sub-conductor spacing of 450 mm.
2	Earthwire / OPGW	Two Earthwires (7/3.66mm) or One Earthwire (7/3.66mm) and one OPGW or Two OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' Suspension	160
b)	Single 'I' suspension Pilot	160
c)	Single Tension	160
d)	Double Tension	420

4.1.3 220 kV Voltage Level

A) 220kV Single/Double Circuit (Single ACSR Zebra) Transmission Line

1	Conductor	ACSR Zebra conductor
2	Earthwire / OPGW	One Earthwire (7/3.15mm) or OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' Suspension	70

b)	Single 'I' suspension Pilot	70
c)	Single Tension	120
d)	Double Tension	240

B) 220kV Single/Double Circuit (TWIN ACSR MOOSE) Transmission Line

1	Conductor	Two ACSR MOOSE conductor per phase with sub-conductor spacing of 450 mm.
2	Earthwire / OPGW	One Earthwires (7/3.66mm) or One OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' Suspension	120
b)	Single 'I' suspension Pilot	120
c)	Single Tension	120
d)	Double Tension	320

4.1.4 132 kV Voltage Level

A) 132kV Single/ Double Circuit Transmission Line with Single ACSR PANTHER Conductor

1	Conductor	ACSR Panther conductor
2	Earthwire / OPGW	One Earthwire (7/3.15mm) or OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' Suspension	90
b)	Single Tension	90
c)	Double Tension	180

B) **132kV Single/ Double Circuit Transmission Line with Single ACSR ZEBRA Conductor**

1	Conductor	ACSR ZEBRA conductor
2	Earthwire / OPGW	One Earthwire (7/3.15mm) or OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in Section-IA.
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'I' Suspension	90
b)	Single Tension	120
c)	Double Tension	240

4.2 HVDC Lines

4.2.1.1 **±800kV HVDC Transmission line**

1	Conductor	Four ACSR Lapwing conductor per phase with sub-conductor spacing of 457 mm in Horizontal configuration.
2	Earthwire/ OPGW	Two Earthwires (7/4.50mm) or One Earthwire and one OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in section-1 A
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'Y' suspension	420 along each arm of V portion & 840 along I portion
b)	Triple Tension String	1260
c)	Single I Pilot	160
Details of DMR		
1	Conductor	Twin ACSR Lapwing conductor per phase with sub-conductor spacing of 450 mm in Horizontal configuration.
2	Insulator String Details	

	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single "I" Suspension	160/ 210
b)	Double Tension	420

4.2.1.2 **±500kV HVDC Transmission line**

A) ±500kV HVDC with Quad ACSR LAPWING Conductor

1	Conductor	Four ACSR Lapwing conductor per phase with sub-conductor spacing of 457 mm in Horizontal configuration.
2	Earth Electrode line	Twin ACSR MOOSE conductor per phase with sub-conductor spacing of 450 mm in Horizontal configuration.
3	Earthwire/ OPGW	Two Earthwires (7/3.66mm) or One Earthwire and one OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in section-1 A
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'V' suspension	210 (Along one arm)
b)	Double 'V' suspension	420 (Along one arm)
c)	Quadruple Tension	840

B) ±500kV HVDC With Quad ACSR BERSIMIS Conductor

1	Conductor	Four ACSR BERSIMIS conductor per phase with sub-conductor spacing of 457 mm in Horizontal configuration.
2	Earthwire/ OPGW	Two Earthwires (7/3.66mm) or One Earthwire and one OPGW with mechanical & electrical properties equivalent to the used earthwire may be used as indicated in section-1A
3	Insulator String details	
	Type of String	Mechanical Strength of Insulator String (kN)
a)	Single 'V' suspension	210 (Along one arm)
b)	Quadruple Tension	640

5.0 Electrical System Data for Different Voltage of Line.

5.1 AC lines

Sl. No.	Parameters	Unit	Values				
			765	400	220	32	66
1	Nominal Voltage	kV	765	400	220	32	66
2	Maximum system voltage	kV	800	420	245	145	72
3	BIL (Impulse)	kV (Peak)	2400	1550	1050	650	325
4	Power frequency withstand voltage (Wet)	kV (rms)	830	680	460	275	175
5	Switching surge withstand voltage (Wet)	kV (peak)	1550	1050	NA	NA	NA
6	Minimum Corona extinction voltage at 50 Hz AC system under dry condition	kV (rms) phase to earth	510	320	154	NA	NA
7	Radio interference voltage at one MHz for phase to earth voltage as indicated under dry condition.	Micro Volts (Max)	1000 at 510 kV	1000 at 305 kV	1000 at 154 kV	NA	NA

5.2 HVDC transmission line

Sl. No.	Parameters	Unit	Value	
			±500	±800
1	Nominal Voltage	kV	±500	±800
2	Maximum system voltage	kV	±525	±840
3	BIL (Impulse)	kV (Peak)	1800	2250
4	Switching surge withstand voltage (Wet)	kV (peak)	1000	1850

5	Minimum Corona extinction voltage under dry condition	kV (rms)	550	880
6	Maximum Radio interference voltage at one MHz for conductor surface gradient of 22 kV/cm (positive)	Micro Volts	1000	1000

6.0 Planning and Designing in Purview of Vulnerability Atlas of India

Vulnerability Atlas of India (VAI) is a comprehensive document which provides existing hazard scenario for the entire country and presents the digitized State/ UT wise hazard, maps with respect to earthquakes, winds and floods for district-wise identification of vulnerable areas. It also includes additional digitized maps for thunderstorms, cyclones and landslides. The main purpose of this Atlas is its use for disaster preparedness and mitigation at policy planning and project formulation stage.

This Atlas is one of its kind single point source for the various stakeholders including policy makers, administrators, municipal commissioners, urban managers, engineers, architects, planners, public etc. to ascertain proneness of any city/ location/ site to multi-hazard, which includes earthquakes, winds, floods thunderstorms, cyclones and landslides. While project formulation, approvals and implementation of various urban housing, buildings and infrastructures schemes, this Atlas provides necessary information for risk analysis and hazard assessment.

The Vulnerability Atlas of India has been prepared by Building Materials and Technology Promotion Council under Ministry of Housing and Urban Affairs, Government of India and available at their website www.bmtpc.org. It is mandatory for the bidders to refer Vulnerability Atlas of India for multi-hazard risk assessment and include the relevant hazard proneness specific to project location while planning and designing the project in terms of:

- i) Seismic zone (II to V) for earthquakes,
- ii) Wind velocity (Basic Wind Velocity: 55, 50, 47, 44, 39 & 33 m/s)
- iii) Area liable to floods and Probable max. surge height
- iv) Thunderstorms history
- v) Number of cyclonic storms/ severe cyclonic storms and max sustained wind specific to coastal region
- vi) Landslides incidences with Annual rainfall normal
- vii) District wise Probable Max. Precipitation

Annexure-A

List of Electrical Equipment Class-I Local Supplier and Minimum Local Content Requirement

Sl. No.	List of Electrical Equipment with sufficient local capacity and competition	Class-I Local Supplier- Minimum Local Content (%)
1	Power Transformers (up to 765 kV, including Generator transformers)	60
2	Instrument Transformer (up to 765 kV)	60
3	Transformer Oil Dry Out System (TODOS)	60
4	Reactors up to 765 kV	60
5	Oil Impregnated Bushing (up to 400 kV)	60
6	Resin Insultated Paper (RIP) bushings (up to 145 kV)	50
7	Circuit Breakers (up to 765 kV AC - Alternating Current)	60
8	Disconnectors/Isolators (up to 765 kV AC)	60
9	Wave trap (up to 765 kV AC)	60
10	Oil Filled Distribution Transformers up to & Including 33 kV [Cold Rolled Grain Oriented (CRGO)/Amorphous, Aluminium/Copper wound]	60
11	Dry Type Distribution Transformer upto and including 33 kV (CRGO/Amorphous, Aluminium/Copper wound)	60
12	Conventional Conductor	60
13	Accessories for Conventional conductors	60
14	High Temperature/High Temperature Low Sag (HTLS) conductors (such as Composite core, GAP, ACSS, INVAR, AL59) and Accessories	60
15	Optical ground wire (OPGW) — all designs	60
16	Fiber Optic Terminal Equipment (FOTE) for OPGW	50
17	OPGW related Hardware and Accessories	60

18	Remote Terminal Unit (RTU)	50
19	Power Cables and accessories up to 33 kV	60
20	Control cables including accessories	60
21	XLPE Cables up to 220 kV	60
22	Substation Structures	60
23	Transmission Line Towers	60
24	Porcelain (Disc/Long Rod) Insulators	60
25	Bus Post Insulators (Porcelain)	60.
26	Porcelain Disc Insulators with Room Temperature Vulcanisation (RTV) coating	50
27	Porcelain Longrod Insulators with Room Temperature Vulcanisation (RTV) coating	50
28	Hardware Fittings for Porcelain Insulators	60
29	Composite/Polymeric Long Rod Insulators	60
30	Hardware Fittings for Polymer Insulators	60
31	Bird Flight Diverter (BED)	60
32	Power Line Carrier Communication (PLCC) System (up to 800 kV)	60
33	Gas Insulated Switchgear (up to 400 kV AC)	60
34	Gas Insulated Switchgear (above 400 kV AC)	50
35	Surge/Lightning Arrester (up to 765 kV AC)	60
36	Power Capacitors	60
37	Packaged Sub-station (6.6 kV to 33 kV)	60
38	Ring Main Unit (RMU) (up to 33 kV)	60
39	Medium Voltage (MV) GIS Panels (up to 33 kV)	60
40	Automation and Control System/Supervisory Control and data Acquisition (SCADA) System in Power System	50

41	Control and Relay Panel (including Digital/Numerical Relays)	50
42	Electrical Motors 0.37 kW to 1 MW	60
43	Energy Meters excluding smart meters	50
44	Control & power cables and Accessories (up to 1.1 kV)	60
45	Diesel Generating (DG) set	60
46	DC system (DC Battery & Battery Charger)	60
47	AC & DC Distribution Board	60
48	Indoor Air Insulated Switchgear (AIS) upto 33 kV	60
49	Poles (PCC, PSCC, Rolled Steel Joist, Rail Pole, Spun, Steel Tubular)	60
50	Material for Grounding/earthing system	60
51	Illumination system	60
52	Overhead Fault Sensing Indicator (FSI)	50
53	Power Quality Meters	50
54	Auxilliary Relays	50
55	Load Break Switch	50

Annexure-B

FORM OF JOINT DEED OF UNDERTAKING BY THE TOWER MANUFACTURER ALONGWITH THE BIDDER/ CONTRACTOR

THIS DEED OF UNDERTAKING executed this day of Two Thousand and by M/s., a Company incorporated under the laws of and having its Registered Office at (hereinafter called the “Tower Manufacturer” which expression shall include its successors, executors and permitted assigns), and M/s., a Company incorporated under the laws of having its Registered Office at (hereinafter called the “Bidder”/”Contractor” which expression shall include its successors, executors and permitted assigns) in favour of (*insert names of the Employer*), a Company incorporated under the Companies Act of 1956 having its registered office at(*insert registered address of the Employer*)..... (hereinafter called the “Employer” which expression shall include its successors, executors and permitted assigns)

WHEREAS the “Employer” invited Bid as per its Specification No. for manufacture, fabrication, supply of tower parts as per Contractor’s/ Employer’s design (**wherever applicable**), casting of foundation, erection of all types of towers, stringing of conductor and earthwire, testing and commissioning ofTransmission Line.

AND WHEREAS Clause No., Section, of, Vol.–... forming part of the Bid Documents inter-alia stipulates that the Bidder and/or Manufacturer must fulfill the Qualifying Requirements and be jointly and severally bound and responsible for the quality and timely supply of tower parts in the event the Bid submitted by the Bidder is accepted by the Employer resulting in a Contract.

AND WHEREAS the Bidder has submitted its Bid to the Employer vide Proposal No. dated based on tie-up with the Tower Manufacturer for supply of tower parts.

NOW THEREFORE THIS UNDERTAKING WITNESSETH as under:

1. In consideration of the award of Contract by the Employer to the Bidder (hereinafter referred to as the “Contract”) we, the Tower Manufacturer and the Bidder/Contractor do hereby declare that we shall be jointly and severally bound unto the (*insert name of the Employer*), for the manufacture, testing, supply of tower parts on FOR destination delivery at site basis in accordance with the Contract Specifications.
2. Without in any way affecting the generality and total responsibility in terms of this Deed of Undertaking, the Tower Manufacturer hereby agrees to depute their representatives from time to time to the Employer’s Project site as mutually considered necessary by the Employer, Bidder/Contractor and the Tower

Manufacturer to ensure proper quality, manufacture, testing and supply on FOR destination delivery at site basis and successful performance of the material in accordance with Contract Specifications. Further, if the Employer suffers any loss or damage on account of non-performance of the material (tower parts) fully meeting the performance guaranteed as per Bid Specification in terms of the contract. We the Tower Manufacturer and the Contractor jointly and severally undertake to pay such loss or damages to the Employer on its demand without any demur.

3. This Deed of Undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in Delhi shall have exclusive jurisdiction in all matters arising under the Undertaking.
4. As a security, the Tower Manufacturer shall apart from the Contractor's performance guarantee, furnish a Contract Performance Guarantee from its Bank in favour of the Employer in a form acceptable to the Employer. The value of such guarantee shall be equivalent to **02%** of the cost of tower parts to be supplied by the Tower Manufacturer as identified in the Contract awarded by the Employer to the Bidder/Contractor and it shall be part of guarantee towards the faithful performance/compliance of this Deed of Undertaking in terms of the Contract. The guarantee shall be unconditional, irrevocable and valid for the entire period of the Contract, namely till the end of the Defect Liability Period of under the Contract. The Bank Guarantee amount shall be payable to the Employer on demand without any reservation or demur.
5. We, the Tower Manufacture/ Bidder/Contractor agree that this Undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this Undertaking shall continue to be enforceable till the Employer discharges it. It shall become operative from the effective date of Contract.

IN WITNESS WHEREOF the Tower Manufacturer and/or the Bidder/Contractor have through their Authorised Representatives executed these presents and affixed Common seals of their respective Companies, on the day, month and year first above mentioned.

WITNESS

Signature

Name

Office Address

(For Tower Manufacturer)

(Signature of the authorized representative)

Name

Common Seal of Company

WITNESS

Signature

Name

Office Address

(For Bidder)

(Signature of the authorized representative)

Name

Common Seal of Company

OPGW FORMS

FORM OF BANK GUARANTEE FOR CONTRACT PERFORMANCE

TO BE SUBMITTED BY THE MANUFACTURER OF OPGW)
STIPULATED IN CLAUSE]
(ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

Bank Guarantee No.

Date.....

Contract No.....

.....[Name of Contract].....

To: [Name and address of the Employer]

Dear Ladies and/or Gentlemen,

We refer to the Contract ("the Contract") signed on(insert date of the Contract)..... between you and M/s..... (Name of Contractor), having its Principal place of business at(Address of Contractor) and Registered Office at(Registered address of Contractor) ("the Contractor") concerning (Indicate brief scope of work) for the complete execution of the (insert name of Package alongwith name of the Project).....

Whereas, the Contractor has agreed to supply the OPGW Manufactured by M/s(Name of Manufacturer), having its Principal place of business at(Address of Manufacturer) and Registered office at(Registered address of Manufacturer)..... (Herein after Referred to as the 'Manufacturer') in collaboration with M/s. (Name of Collaborator/Parent/Principal Company), having its Principal place of business at(Address of Collaborator/Parent/Principal Company) and Registered Office at(Registered address of Collaborator/Parent/Principal Company) (hereinafter referred to as the "Collaborator"), as a pre-requisite for qualification of the the Bidder/Contractor and have submitted a deed of joint undertaking declaring that they are jointly and severally bound and responsible for the successful performance of the said equipment in accordance with the Contract Specifications and that the Manufacturer having agreed to furnish a Contract Performance Guarantee equivalent to (10%) ten per cent of the Ex-works cost of OPGW to be supplied by the Manufacturer/Contractor under the Contract. This CPG shall be in addition to Contract

Performance Guarantee equivalent to 10% (Ten per cent) of the value of the Contract to be provided by the Contractor for the faithful performance of the entire Contract.

By this letter we, the undersigned,(*insert name & address of the issuing bank*), a Bank (or Company) organized under the laws of and having its Registered/Head Office at(*insert address of registered office of the bank*)..... do hereby irrevocably guarantee payment to you up to i.e., ten percent (10%) of the Ex-works cost of OPGW to be supplied by the Manufacturer/Contractor under the Contract until ninety (90) days beyond the Defect Liability Period of the OPGW i.e., upto and inclusive of (*dd/mm/yy*).

We undertake to make payment under this Letter of Guarantee upon receipt by us of your first written demand signed by your duly authorized officer declaring the *Contractor/Manufacturer/ Collaborator/Parent/Principal Company* to be in default under the Contract and without cavil or argument any sum or sums within the above named limits, without your need to prove or show grounds or reasons for your demand and without the right of the *Contractor/Manufacturer/ Collaborator/Parent/Principal Company* to dispute or question such demand.

Our liability under this Letter of Guarantee shall be to pay to you whichever is the lesser of the sum so requested or the amount then guaranteed hereunder in respect of any demand duly made hereunder prior to expiry of the Letter of Guarantee, without being entitled to inquire whether or not this payment is lawfully demanded.

This letter of Guarantee shall remain in full force and shall be valid from the date of issue until ninety (90) days beyond the Defect Liability Period of the said equipment i.e. upto and inclusive of (*dd/mm/yy*) and shall be extended from time to time for such period (not exceeding one year), as may be desired by M/s. on whose behalf this Letter of Guarantee has been given.

Except for the documents herein specified, no other documents or other action shall be required, notwithstanding any applicable law or regulation.

Our liability under this Letter of Guarantee shall become null and void immediately upon its expiry, whether it is returned or not, and no claim may be made hereunder after such expiry or after the aggregate of the sums paid by us to you up shall equal the sums guaranteed hereunder, whichever is the earlier.

All notices to be given under shall be given by registered (airmail) posts to the addressee at the address herein set out or as otherwise advised by and between the parties hereto.

We hereby agree that any part of the Contract may be amended, renewed, extended, modified, compromised, released or discharged by mutual agreement between you and the Collaborator, and this security may be exchanged or surrendered without in any way impairing or affecting our liabilities hereunder without notices to us and without the necessity for any additional endorsement, consent or guarantee by us, provided, however, that the sum guaranteed shall not be increased or decreased.

No action, event or condition which by any applicable law should operate to discharge us from liability hereunder shall have any effect and we hereby waive any right we may have to apply such law so that in all respects our liability hereunder shall be irrevocable and, except as stated herein, unconditional in all respects.

Notwithstanding anything contained herein:

1. Our liability under this Bank Guarantee shall not exceed _____ (*value in figures*) _____ [*value in words*] _____].
2. This Bank Guarantee shall be valid upto _____ (*validity date*) _____.
3. We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only & only if we receive a written claim or demand on or before _____ (*validity date*) _____."

For and on behalf of the Bank

[*Signature of the authorized signatory(ies)*]

Signature _____

Name _____

Designation _____

POA Number _____

Contact Number(s): Tel. _____ Mobile _____

Fax Number _____

email _____

Common Seal of the
Bank _____

Witness:

Signature _____

Name _____

Address _____

Contact Number(s): Tel. _____ Mobile _____
email _____

Note:

1. For the purpose of executing the Bank Guarantee, the non-judicial stamp papers of appropriate value shall be purchased in the name of Bank who issues the 'Bank Guarantee'.
2. The Bank Guarantee shall be signed on all the pages by the Bank Authorities indicating their POA nos. and should invariably be witnessed.
3. **The Bank Guarantee should be in accordance with the proforma as provided. However, in case the issuing bank insists for additional paragraph regarding applicability of ICC publication No: 758, the following may be added at the end of the proforma of the Bank Guarantee [i.e., end paragraph of the Bank Guarantee preceding the signature(s) of the issuing authority(ies) of the Bank Guarantee]:**
"This Guarantee is subject to Uniform Rules for Demand Guarantee, ICC publication No. 758 except that article 15(a) is hereby excluded."
4. At the time of issuance of the Bank Guarantee (including its extensions) through SFMS facility, the issuing bank will input the IFSC code of Beneficiary Bank as mentioned at GCC clause 9.4 in SCC in their Trade Finance Portal.
Additional paragraph regarding issuance of the Bank Guarantee through SFMS Platform (if applicable), the following should be added at the end of the proforma of the Bank Guarantee [i.e., end paragraph of the Bank Guarantee preceding the signature(s) of the issuing authority(ies) of the Bank Guarantee]:
"This Guarantee has been issued using SFMS Platform and the requisite communication in this regard has been forwarded to the Beneficiary Bank."

FORM OF DEED OF UNDERTAKING BY THE CONTRACTOR

**TO BE EXECUTED BY THE BIDDER/MANUFACTURER FOR EXTENDED WARRANTY OF
ONE (01) YEARS OVER AND ABOVE THE WARRANTY PERIOD SPECIFIED FOR OPGW
CABLE**

[STIPULATED IN CLAUSE]
(ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

**(Declaration by Contractor regarding _____ for GTR/Qualifying
Requirements for manufacturer of OPGW)**

THIS DEED OF UNDERTAKING executed this day of Two Thousand and by M/s., a Company incorporated under the laws of having its Registered Office at (hereinafter called the “Contractor” which expression shall include its successors, executors and permitted assigns) in favour of (insert names of the Employer), a Company incorporated under the Companies Act of 1956 having its registered office at(insert registered address of the Employer)..... (hereinafter called the “Employer” which expression shall include its successors, executors and permitted assigns)

WHEREAS the “Employer” invited Bid as per its Specification No. for the execution of (*insert name of the package along with project name*).....

AND WHEREAS Clause No., Section, of, Vol.–... forming part of the Bid Documents inter-alia stipulates that the Contractor must fulfill the General Technical Requirements for OPGW in the event of award/or post award stage and shall be bound and responsible for the successful performance of OPGW offered in the event the Bid submitted by the Contractor is accepted by the Employer resulting in a Contract.

AND WHEREAS the Contractor has submitted its Bid to the Employer vide Proposal No. dated

NOW THEREFORE THIS UNDERTAKING WITNESSETH as under:

- 1.0 In consideration of the award of Contract by the Employer to the Contractor (hereinafter referred to as the “Contract”) we, the Contractor do hereby undertake that we shall be bound unto the (*insert name of the Employer*), for the successful performance of OPGW and shall be fully responsible for the design, manufacture, testing, supply on FOR destination delivery at site basis and unloading at site, storage, erection, testing & commissioning and successful performance of OPGW in accordance with the Contract Specifications.

2.0 We confirm **the extended warranty obligations of additional one (01) year over and above the warranty period specified for the entire quantity of OPGW to be supplied from the Contractor.**

3.0 We, the Contractor agree that this Undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this Undertaking shall continue to be enforceable till the Employer discharges it. It shall become operative from the effective date of Contract.

4.0 We, the Bidder/Manufacturer agree that this Undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this Undertaking shall continue to be enforceable till the Employer discharges it. It shall become operative from the effective date of Contract.

5.0 This Deed of Undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in Delhi shall have exclusive jurisdiction in all matters arising under the Undertaking.

IN WITNESS WHEREOF the Contractor have through their Authorised Representatives executed these presents and affixed Common seals of their respective Companies, on the day, month and year first above mentioned.

WITNESS

(For Contractor)

Signature

Name

Office Address

(Signature of the authorized representative)

Name

Common Seal of Company

WITNESS

WITNESS

Signature

Signature

Name

Name

Office Address

Office Address

Note:

1. For the purpose of executing the Deed of Undertaking, the non-judicial stamp papers of appropriate value shall be purchased in the name of executants parties.
2. The Undertaking shall be signed on all the pages by the authorised representatives of Contractor should invariably be witnessed.
3. This Deed of Joint Undertaking attested by Notary Public of the place(s) of the respective executant(s) shall be submitted by the Contractor after finalization of vendor for OPGW as per TS in the event of award/ post award stage.

* ***Strike-off whichever is not applicable.***

**FORM OF JOINT DEED OF UNDERTAKING BY THE COLLABORATOR/ PARENT COMPANY
ALONGWITH THE BIDDER/MANUFACTURER**

[In line with Clause : Qualifying Requirements for manufacturer of OPGW of
Section-

I: Technical Specifications, Volume-II]

(ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

THIS DEED OF UNDERTAKING executed this day of Two Thousand and by M/s., a Company incorporated under the laws of and having its Registered Office at (hereinafter called the **“Collaborator”** which expression shall include its successors, executors and permitted assigns), and M/s., a Company incorporated under the laws of having its Registered Office at (hereinafter called the **“Manufacturer”** which expression shall include its successors, executors and permitted assigns) and Ms/., a Company incorporated under the laws of having its Registered Office at (hereinafter called the **“Bidder/Contractor”** which expression shall include its successors, executors and permitted assigns) in favour of (*insert names of the Employer*), a Company incorporated under the Companies Act of 1956 having its registered office at(*insert registered address of the Employer*)..... (hereinafter called the **“Employer”** which expression shall include its successors, executors and permitted assigns)

WHEREAS the “Employer” invited Bid as per its Specification No. for the execution of (*insert name of the package along with project name*).....

AND WHEREAS Clause No., Section, of, Vol.—... forming part of the Bid Documents inter-alia stipulates that the Contractor and Manufacturer alongwith its Collaborator must fulfill the Qualifying Requirements for OPGW and be jointly and severally bound and responsible for the successful performance of OPGW offered in the event the proposal for supply of OPGW from the Manufacturer submitted by the Contractor is accepted by the Employer.

AND WHEREAS the Contractor has submitted its proposal to the Employer vide Proposal No. dated for supply of OPGW from the Manufacturer based on the collaboration/association of the Collaborator with the Bidder/Manufacturer.

NOW THEREFORE THIS UNDERTAKING WITNESSETH as under:

1.0 In consideration of the award of Contract by the Employer to the Contractor (hereinafter referred to as the "Contract") we, the Collaborator and the Contractor and the Manufacturer do hereby declare that we shall be jointly and severally bound unto the (*insert name of the Employer*), for the successful performance of OPGW and shall be fully responsible for the design, manufacture, testing, supply on FOR destination delivery at site basis and supervision of unloading at site, storage, erection, testing & commissioning and successful performance of OPGW in accordance with the Contract Specifications.

2.0 Without in any way affecting the generality and total responsibility in terms of this Deed of Undertaking, the Collaborator in particular hereby agrees to depute their technical experts from time to time to the Contractor's/Indian Manufacturer's Works/Employer's Project site as mutually considered necessary by the Employer, Contractor, Manufacturer and the Collaborator to ensure

- (i) A valid technology transfer agreement, including license to manufacture and supply from India, between the Collaborator (the technology provider) and the Manufacturer covering the type, size and rating of the *.....sets specified, valid minimum up to the end of the defect liability period of the contract. The technology transfer agreement necessarily covers transfer of technological know-how for *..... in the form of complete transfer of design dossier, design software's, drawings and documentation, quality system manuals and imparting relevant training to the personnel of the Manufacturer.
- (ii) Proper design, engineering, manufacture, testing, supply transportation and delivery at site and supervision of unloading at site, storage, erection, testing & commissioning and successful performance of the equipment in accordance with Contract Specifications and
- (iii) If necessary, the Collaborator shall advise the Manufacturer suitable modifications of designs and implement necessary corrective measures to discharge the obligations under the contract.

3.0 This Deed of Undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in Delhi shall have exclusive jurisdiction in all matters arising under the Undertaking.

4.0 As a security, the Manufacturer shall apart from the Contractor's performance guarantee, furnish **additional Contract Performance Guarantee** from its Bank in favour of the Employer in a form acceptable to the Employer. The value of such guarantee shall be equivalent to 10% of the Ex works cost of OPGW as identified in the Contract awarded by

the Employer to the Contractor. The guarantee shall be unconditional, irrevocable and valid for the entire period of the Contract, and till the end of the **Defect Liability Period of** under the Contract. The Bank Guarantee amount shall be payable to the Employer on demand without any reservation or demur.

5.0 We, the Collaborator and Contractor and/or Manufacturer agree that this Undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this Undertaking shall continue to be enforceable till the Employer discharges it. It shall become operative from the effective date of Contract.

6.0 This Deed of Undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in Delhi shall have exclusive jurisdiction to adjudicate any dispute arising under or in connection with this agreement.

IN WITNESS WHEREOF the Collaborator, the Manufacturer and the Contractor have through their Authorised Representatives executed these presents and affixed Common seals of their respective Companies, on the day, month and year first above mentioned.

(For Collaborator)

WITNESS	(Signature of the authorized representative)
Signature	Name
Name	Common Seal of Company
Office Address	

(For Contractor)

WITNESS	(Signature of the authorized representative)
Signature	Name
Name	Common Seal of Company
Office Address	

WITNESS

(For Manufacturer)

Signature

(Signature of the authorized
representative)

Name

Name

Office Address

Common Seal of Company
.....

Note:

1. For the purpose of executing the Deed of Joint Undertaking, the non-judicial stamp papers of appropriate value shall be purchased in the name of executants parties. The Undertaking shall be signed on all the pages by the authorised representatives of each of the partners and should invariably be witnessed.
2. This Deed of Joint Undertaking duly certified by the Company Secretary shall be submitted alongwith the bid. Further, the Deed of Joint Undertaking attested by Notary Public of the place(s) of the respective executant(s) or registered with the Indian Embassy/High Commission in that country shall be submitted by the bidder within ten (10) days from the date of intimation of post bid discussion.

ANNEXURE-D

**PROFORMA OF UNDERTAKING BY THE PROPOSED SUPPLIER OF CORE OF HTLS
CONDUCTOR**

(On Non-Judicial Stamp Paper of appropriate value, wherever applicable)

To,

Power Grid Corporation of India Ltd.
B-9, Qutab Institutional Area
Katwaria Sarai
New Delhi - 110016

Dear Sir,

Whereas Power Grid Corporation of India Ltd., with its Registered Office at B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi – 110016 (hereinafter referred to be as the ‘’), having invited bids for (Name of the package & Specification No.), in response to which M/s.(Name of the Bidder), with its Registered office at (Full Address) are submitting the bid vide ref date..... (hereinafter called the ‘Bid’).

We, (Name of the Core supplier) with its Registered Office at..... (Full Address..... (hereinafter referred to as the ‘Core Supplier’, which expression shall unless repugnant to the context and meaning therefore include its successor, administrator, executor and permitted assigns) do hereby undertake in the event of award of the Contract to supply required quantity of HTLS core for supply of HTLS conductor covered under the scope of the Contract, fulfilling all the requirements and construction schedule agreed under the Contract.

Signed on this day of 2021 at.....

(Signature)
Authorised signatory on behalf of
M/s.....
(Name)
(Designation).....

Note: Separate undertaking to be provided in case of more than one core supplier proposed.

ANNEXURE-E

**FORM OF JOINT DEED OF UNDERTAKING BY THE POLE MANUFACTURER ALONGWITH
THE BIDDER/CONTRACTOR**

THIS DEED OF UNDERTAKING executed this day of Two Thousand and by M/s., a Company incorporated under the laws of and having its Registered Office at (hereinafter called the “Pole Manufacturer” which expression shall include its successors, executors and permitted assigns), and M/s., a Company incorporated under the laws of having its Registered Office at (hereinafter called the “Bidder”/”Contractor” which expression shall include its successors, executors and permitted assigns) in favour of (*insert names of the Employer*) , a Company incorporated under the Companies Act of 1956 having its registered office at(*insert registered address of the Employer*)..... (hereinafter called the “Employer” which expression shall include its successors, executors and permitted assigns).

WHEREAS the “Employer” invited Bid as per its Specification No.....for manufacture, fabrication, supply of tower parts as per Contractor’s/ Employer’s design (**wherever applicable**), casting of foundation, erection of all types of poles, stringing of conductor and earthwire, testing and commissioning of Transmission Line.

AND WHEREAS Clause No., Section, of, Vol..... forming part of the Bid Documents inter-alia stipulates that the Bidder and/or Manufacturer must fulfill the Qualifying Requirements and be jointly and severally bound and responsible for the quality and timely supply of pole parts in the event the Bid submitted by the Bidder is accepted by the Employer resulting in a Contract.

AND WHEREAS the Bidder has submitted its Bid to the Employer vide Proposal No. dated based on tie-up with the Tower Manufacturer for supply of pole parts.

NOW THEREFORE THIS UNDERTAKING WITNESSETH as under:

1. In consideration of the award of Contract by the Employer to the Bidder (hereinafter referred to as the “Contract”) we, the Pole Manufacturer and the Bidder/Contractor do hereby declare that we shall be jointly and severally bound unto the (*insert name of the Employer*)..... , for the manufacture, testing, supply of pole parts on FOR destination delivery at site basis in accordance with the Contract Specifications.
2. Without in any way affecting the generality and total responsibility in terms of this Deed of Undertaking, the Pole Manufacturer hereby agrees to depute their representatives from time to time to the Employer’s Project site as mutually considered necessary by the Employer, Bidder/ Contractor and the Pole Manufacturer to ensure proper quality, manufacture, testing and supply on FOR destination delivery at site basis and successful performance of the material in accordance with Contract Specifications. Further, if the Employer suffers any loss or

damage on account of non-performance of the material (pole parts) fully meeting the performance guaranteed as per Bid Specification in terms of the contract. We the Pole Manufacturer and the Contractor jointly and severally undertake to pay such loss or damages to the Employer on its demand without any demur.

3. This Deed of Undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in Delhi shall have exclusive jurisdiction in all matters arising under the Undertaking.
4. As a security, the Pole Manufacturer shall apart from the Contractor's performance guarantee, furnish a Contract Performance Guarantee from its Bank in favour of the Employer in a form acceptable to the Employer. The value of such guarantee shall be equivalent to **02%** of the cost of pole parts to be supplied by the Pole Manufacturer as identified in the Contract awarded by the Employer to the Bidder/ Contractor and it shall be part of guarantee towards the faithful performance/ compliance of this Deed of Undertaking in terms of the Contract. The guarantee shall be unconditional, irrevocable and valid for the entire period of the Contract, namely till the end of the Defect Liability Period of under the Contract. The Bank Guarantee amount shall be payable to the Employer on demand without any reservation or demur.
5. We, the Pole Manufacture/ Bidder/Contractor agree that this Undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this Undertaking shall continue to be enforceable till the Employer discharges it. It shall become operative from the effective date of Contract.

IN WITNESS WHEREOF the Pole Manufacturer and/or the Bidder/Contractor have through their Authorised Representatives executed these presents and affixed Common seals of their respective Companies, on the day, month and year first above mentioned.

WITNESS	(For Pole Manufacturer)
Signature	(Signature of authorize representative)
Name	Name
Office Address	Common Seal of Company
WITNESS	(For Bidder)
Signature	(Signature of authorize representative)
Name	Name
Office Address	Common Seal of Company

**FORM OF JOINT UNDERTAKING BY THE LICENSOR
ALONGWITH THE LICENSEE (APPLICABLE FOR ITEMS OTHER THAN HTLS CONDUCTOR)**

On Non-Judicial Stamp Paper of Appropriate Value

THIS DEED OF UNDERTAKING executed this day of Two Thousand by a Company incorporated under the laws of and having its Registered Office at (hereinafter called the "Licensor" which expression shall include its successors, executors and permitted assigns) and a Company incorporated under the Companies Act, 1956 having its Registered Office at (hereinafter called the "Licensee" which expression shall include its successors, executors and permitted assigns) in favour of Power Grid Corporation of India Ltd., having its Registered Office at B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi-110016 (hereinafter called the "Employer" which expression shall include its successors, executors and permitted assigns).

WHEREAS the Employer invited Bids as per its Specification No. for the construction of transmission line which inter alia include design, manufacture, testing, supply on Final Destination delivery at site basis for Composite Insulator*, Conductor*, Hardware Fittings* and Accessories for Conductor & Earthwire*-for Transmission Lines.

AND WHEREAS Clause no., Section, of, Vol.—... forming part of the Bidding Documents inter alia stipulates that the Licensee along with its Licensor must fulfill the Qualifying Requirements and be jointly and severally bound and responsible for the successful performance of the equipment and shall be fully responsible for the design, manufacture, testing, supply and final destination delivery at site basis in the event the Bid is accepted by the Employer resulting in a "Contract".

AND WHEREAS a company incorporated Companies Act 1956, having its Registered Office at (hereinafter called the "Bidder"/"Contractor" which expression shall include its successors, executors and permitted assigns) the Bidder has submitted its Bid for the Employer for Transmission Line having Specification No. vide Proposal No. dated based on the License of the Licensor.

NOW THEREFORE THIS UNDERTAKING WITNESSETH AS UNDER:

- 1.0 In consideration of the award of Contract by the Employer to the Bidder (hereinafter referred to as the "Contract") we, the Licensor and the Licensee do hereby declare that we shall be jointly and severally bound unto the Power Grid Corporation of India Ltd. (Employer)/the Bidder for the successful performance of the equipment and shall be fully responsible for the design, manufacture, testing, supply and final destination delivery at site basis and successful performance of equipment in accordance with the Contract specifications.
- 2.0 Without in any way affecting the generality and total responsibility in terms of this Deed of Undertaking the Licensor in particular hereby agrees to depute their technical experts to the Licensee's works as considered necessary by the Employer, Bidder and the Licensor to ensure proper design, manufacture, Quality Management, testing, supply on final destination delivery at site basis and successful performance of the equipment in accordance with Contract Specifications and if necessary the Licensor shall advise the Licensee suitable modifications of the designs and implement necessary corrective measures to discharge the obligations under the Contract.
- 3.0 As a security, the Licensor shall apart from the Contractor's performance guarantee, furnish a Performance Security from its Bank in favour of the Employer in a form acceptable to Employer. The value of such guarantee shall be equal to 5% of the Contract Price of equipment/material proposed to be manufactured and supplied by the Licensee under the contract awarded by the Employer to the Contractor and it shall be part of guarantee towards the faithful performance/compliance of this Deed of Undertaking in terms of the Contract. The Guarantee shall be unconditional, irrevocable and valid for the entire period of the contract, namely till the end of the warranty period of package under the Contract. The Bank Guarantee amount shall be payable to the Employer on demand without any reservation or demur.
- 4.0 We, the Licensor undertakes to guarantee sequential and timely supply of equipments and materials and submission of technical information and data as designed of the Employer so as to meet the overall construction schedule.

- 5.0 We, the Licensor and the Licensee confirm that the License agreement shall be valid for a period of at least five (5) years after the guarantee period of the equipment and materials to be supplied under the Contract is over.
- 6.0 This Deed of Undertaking shall be constructed and interpreted in accordance with the Laws of India and the courts in Delhi shall have exclusive jurisdiction in all matters arising under the undertaking.
- 7.0 We the Licensor and the Licensee agree that this undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this undertaking shall continue to be enforceable till the Employer and the Bidder discharge it. It shall become operative from the effective date of Contract.

IN WITNESS WHEREOF the Licensor and the Licensee have through their authorised Representative executed these presents and affixed Common Seals of their respective Companies, on the day, month and year first above mentioned.

WITNESS

FOR LICENSEE

- | | |
|---------------------------------|---|
| 1.
(Signatures) |
(Signature of Authorised Representative) |
|
(Name in Block Letter) |
(Name) |
|
(Office Address) | Designation
Common Seal of Company |

WITNESS

FOR LICENSOR

- | | |
|---------------------------------|---|
| 1.
(Signatures) |
(Signature of Authorised Representative) |
|
(Name in Block Letter) |
(Name) |
|
(Office Address) | Designation
Common Seal of Company |

- Note :** (i) This deed of joint undertaking should be attested by Notary Public of the place of the respective executants.
- (ii) To be filled separately for each package.

Annexure-G

FORM OF JOINT UNDERTAKING BY THE LICENSOR ALONGWITH THE LICENSEE (APPLICABLE
FOR HTLS CONDUCTOR)

On Non-Judicial Stamp Paper of Appropriate Value

THIS DEED OF UNDERTAKING executed this day of Two Thousand and by M/s., a Company incorporated under the laws of and having its Registered Office at (hereinafter called the "Licensor" which expression shall include its successors, executors and permitted assigns), and M/s., a Company incorporated under the laws of having its Registered Office at (hereinafter called the "Conductor Manufacturer / Licensee / Supplier" which expression shall include its successors, executors and permitted assigns) and Ms/., a Company incorporated under the laws of having its Registered Office at (hereinafter called the "Bidder" which expression shall include its successors, executors and permitted assigns) in favour of (*insert names of the Employer*) a Company incorporated under the Companies Act of 1956 having its registered office at(*insert registered address of the Employer*)..... (hereinafter called the "Employer" which expression shall include its successors, executors and permitted assigns).

WHEREAS the "Employer" invited Bid as per its Specification No. for the execution of(*insert name of the package alongwith project name*).....

AND WHEREAS Clause No., Section, of, Vol.-... forming part of the Bidding Documents inter-alia stipulates that the Licensee along with its Licensor must fulfill the Qualifying Requirements and be jointly and severally bound and responsible for the successful performance of the equipment offered in the event the Bid submitted by the Bidder is accepted by the Employer resulting in a Contract.

AND WHEREAS the Bidder has submitted its Bid to the Employer vide Proposal No. dated based on Licensee of the Licensor.

NOW THEREFORE THIS UNDERTAKING WITNESSETH AS UNDER :

- 1.0 In consideration of the award of Contract by the Employer to the Bidder (hereinafter referred to as the "Contract") we, the Licensor and the Bidder/Supplier do hereby declare that we shall be jointly and severally bound unto the(*name of the Employer*)....., for the successful performance of the Contract and shall be fully responsible for the design, manufacture, testing, supply on final destination delivery at site basis and successful performance of the equipment in accordance with the Contract specifications.

- 2.0 Without in any way affecting the generality and total responsibility in terms of this Deed of Undertaking the Licensor in particular hereby agrees to depute their technical experts to the Supplier's Works/Employer's Project site as considered necessary by the Employer, Supplier and the Licensor to ensure proper design, manufacture, Quality Management, testing, supply on final destination delivery at site basis and successful performance of the goods in accordance with the Contract specifications and if necessary the Licensor shall advise the Supplier suitable modifications of the designs and implement necessary corrective measures to discharge the obligations under the Contract.
- 3.0 This Deed of Undertaking shall be constructed and interpreted in accordance with the Laws of India and the courts in Delhi shall have exclusive jurisdiction in all matters arising under the undertaking.
- 4.0 As a security, the Licensor shall apart from the Contract Performance Guarantee and Supplier's performance guarantee, furnish a Contract Performance Guarantee from its Bank in favour of the Employer in a form acceptable to the Employer. The value of such guarantee shall be equal to **5% (Five percent)** of the Ex-works cost of the **HTLS Conductor** proposed to be manufactured and supplied by the Supplier under the contract and it shall be part of guarantee towards the faithful performance/compliance of this Deed of Undertaking in terms of the Contract. The Guarantee shall be unconditional, irrevocable and valid for the entire period of the contract, namely till the end of the Defect Liability Period under the Contract. The Bank Guarantee amount shall be payable to the Employer on demand without any reservation or demur.
- 5.0 We, the Licensor undertakes to guarantee sequential and timely supply of equipments and materials and submission of technical information and data as desired by the Employer so as to meet the overall construction schedule.
- 6.0 We, the Licensor and the Bidder /Supplier confirm that the licensee agreement shall be valid for a period of at least two (2) years after the guarantee period of the goods to be supplied under the Contract is over.
- 7.0 We the Licensor and the Bidder /Supplier agree that this undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this undertaking shall continue to be enforceable till the Employer discharge it. It shall become operative from the effective date of Contract.

IN WITNESS WHEREOF the Licensor and the Bidder /Supplier have through their Authorized Representatives executed these presents and affixed Common Seals of their respective Companies, on the day, month and year first above mentioned.

WITNESS	(FOR LICENSOR)
.....
(Signatures)	(Signature of Authorized Representative)
.....
(Name in Block Letter)	(Name)
.....	Designation
(Office Address)	Common Seal of Company

WITNESS	(FOR SUPPLIER)
Signature	(Signature of the authorized representative)
Name	Name
Office Address	Common Seal of Company

WITNESS	(FOR BIDDER)
.....
(Signatures)	(Signature of Authorized Representative)
.....
(Name in Block Letter)	(Name)
.....	Designation
(Office Address)	Common Seal of Company

Note:

1. For the purpose of executing the Deed of Joint Undertaking, the non-judicial stamp papers of appropriate value shall be purchased in the name of executant(s).
2. The Undertaking shall be signed on all the pages by the Authorized representatives of each of the partners and should invariably be witnessed.
3. This Deed of Joint Undertaking duly attested by Notary Public of the place(s) of the respective executant(s), shall be submitted along with the Bid.
4. In the event the Bidder is a Conductor Manufacturer, then the Joint deed of undertaking shall be modified accordingly.

SECTION-II

GENERAL TECHNICAL CONDITIONS

TECHNICAL SPECIFICATIONS

SECTION-II

GENERAL TECHNICAL CONDITIONS

Revision History

Revision No.	Date	Clause Ref	Description
Rev-0	June'2021		First Release
Rev-1	Sept'2021		First Revision
Rev-2	Feb'2022		Second Revision
Rev-3	Nov'2024		Third Revision

TECHNICAL SPECIFICATIONS

SECTION-II

GENERAL TECHNICAL CONDITIONS

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3.0	Quality Assurance Programme	13

TECHNICAL SPECIFICATIONS

SECTION-II

GENERAL TECHNICAL CONDITIONS

1.1 General Technical Conditions

1.1 General

The following provisions shall supplement all the detailed technical specifications and requirements brought out herein. The contractor's submission shall be based on the use of materials complying fully with the requirements specified herein.

1.2 Drawings

1.2.1 All relevant standard drawings for all the towers/ stubs 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 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 Apart from the standard drawings mentioned above, some other drawings and documents, such as BOM, Shop drawings, structural drawings for towers/extensions/Auxiliary cross-arms may need to be developed based on single line diagram given by the Employer, which are required for the project. These drawings, BOM, shop sketches shall be developed by the Contractor. However, no extra cost on this account shall be payable to the Contractor.

1.2.4 After development, these drawing shall be submitted to the Employer for approval. In ordinary circumstances, the contractor should submit these drawings for approval within 15 days of receipt of the single line drawing from the employer.

1.2.5 Such drawings/ documents developed by the Contractor shall necessarily have sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in the specifications.

- 1.2.6 Each drawing developed by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.
- 1.2.7 The drawings submitted by the Contractor shall be reviewed by the Employer as far as practicable within 15 days and shall be modified by the Contractor if any modifications and/or corrections are required by the Employer. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completion date.
- 1.2.8 The drawings submitted for approval to the Employer shall be returned to the Contractor by the Employer after review. The contractor shall there upon furnish the Employer revised drawings, as may be required, after incorporating all corrections.
- 1.2.9 The work shall be performed by the Contractor strictly in accordance with the standard/approved drawings and no deviation shall be permitted without the written approval of the Employer, if so required.
- 1.2.10 All manufacturing, fabrication work under the scope of Contractor, prior to the approval of the drawings shall be at the Contractor's risk. The contractor may incorporate any changes in the design, which are necessary to conform to the provisions and intent of the contract and such changes will again be subject to approval by the Employer.
- 1.2.11 The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:
- (a) The Contractor has completed the part of the Works covered by the subject document (i.e. confirmation of progress of work).
 - (b) The Works appear to comply with requirements of Specifications.
- In no case the approval by the Employer of any document does imply compliance with all technical requirements or the absence of errors in such documents.
- If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible for consequences.
- 1.2.12 All drawings shall be prepared using AutoCAD/ZWCAD/any other drawing preparation software. After final approval all the drawings (structural drawings, BOMs and shop sketches shall be submitted to the Employer (in PDF & '.DWG' format).

- 1.2.13 The following is the general list of the documents and drawings that are to be approved by the Employer.
- a) Work Schedule (Master Network) Plan.
 - b) Detailed survey report and profile drawings showing ground clearance and tower locations (as applicable).
 - c) Tower schedule and foundation classification for individual tower locations.
 - d) All drawings/ documents which are developed by the contractor based upon the single line drawing given by the Employer.
 - e) Soil Investigation report.
 - g) Tower footing earthing drawing.
 - i) Stringing procedure.
 - j) Tower accessories drawings like danger plate, name plate etc.
 - k) Quality plans for fabrication and site activities including Quality System.
 - l) Sub-vendors approval.
 - m) Line material drawings.
 - n) Type test report for line materials.
- 1.2.14 All rights of the design/ drawing for all types of towers shall be strictly reserved with the Employer only and any designs/ drawings/ data sheets submitted by the contractor from time to time shall become the property of the Employer. Under no circumstances, the Contractor shall be allowed to user/ offer above designs/ drawings/ data sheets to any other authority without prior written permission of the Employer. Any deviation to above is not acceptable and may be a cause for rejection of the bid.
- 1.3 **Design Improvements**
- The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.
- 1.4 **Design Co-ordination**
- Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various

components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.5 Design Review Meeting

The contractor may be called upon to attend design review meetings with the Employer, and the consultants of the Employer during the period of Contract. The contractor shall attend such meetings at his own cost at the Corporate Office of the Employer or at mutually agreed venue as and when required.

1.6 Engineering Data

1.6.1 The furnishing of engineering data by the Contractor shall be in accordance with the Schedule as specified in the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

1.6.2 All engineering data submitted by the Contractor after review by the Employer shall form part of the contract document.

1.7 Employer's Supervision

1.7.1 To eliminate delays and avoid disputes and litigation to the Contract, all matters and questions shall be resolved in accordance with the provisions of this document.

1.7.2 The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the Employer, pursuant to the contract, will include but not be limited to the following:

- a) Interpretation of all the terms and conditions of these Documents and Specifications.
- b) Review and interpretation of all the Contractor's drawings, engineering data etc.
- c) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.
- d) Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.
- e) Issue certificate of acceptance and/or progressive payment and final payment certificate.

- f) Review and suggest modification and improvement in completion schedules from time to time, and
- g) Supervise the Quality Assurance Programme implementation at all stages of the works.

1.8 Tests

1.8.1 The type, acceptance and routine tests and tests during manufacture shall be carried-out on the material and shall mean as follows:

1.8.2 **Type Tests** shall mean those tests which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order.

1.8.3 **Acceptance Tests** shall mean those tests which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

1.8.4 **Routine Tests** shall mean those tests, which are to be carried out on the material to check requirements which are likely to vary during production.

1.8.5 **Tests during Manufacture** shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied.

1.8.6 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Employer.

1.8.7 The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified in **Annexure-A** of the relevant section or as mutually agreed to between the Contractor and the Employer in the Quality Assurance Programme.

1.8.8 For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder, as applicable.

1.8.9 In case of any failure or defect/ deficiency observed in material supplied Employer reserves the right to carry out any tests on the material supplied to site, if required to prove conformity of material to the specification for which testing charges shall be borne by contractor/ manufacturer.

1.9 Standard Technical Particulars

1.9.1 The Standard Technical Particulars of the various items are given in the relevant schedule of the specification, the bidder is required to comply with the same.

1.10 Packing

1.10.1 All the materials shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

1.10.2 The Contractor shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road.

1.10.3 All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.

1.10.4 The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e. fragile, handle with care, use no hook etc. wherever applicable.

1.10.5 Each package shall be legibly marked by the Contractor at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the Contractor etc.

1.10.6 Angle section shall be wire bundled.

1.10.7 Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tested and bolted together in multiples or securely wired through holes.

1.10.8 Bolts, nuts washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents.

1.10.9 The packing shall be properly done to avoid losses & damages during transit. Each bundle or package shall be appropriately marked.

1.11 Storage of Material under Transmission Line Package

Brief guidelines including typical drawing for storage of different type of construction material used in the transmission line projects are as under:

1.11.1 Cement Storage

Cement received at site should be stored in a building or shed which is dry, leak proof and moisture proof. The building should have minimum numbers of windows. Cement bags stored and stacked off the floor on wooden planks in such

a way so as to keep about 150 mm to 200 mm clearance from the ground. The floor may be of lean cement concrete or two layers of dry bricks laid on well consolidated earth. A minimum space of 600 mm shall be kept around and between the exterior walls and the stacks. In stacks, bags shall be kept close together to reduce air circulation. The height of the stack shall not be more than 12 bags and the width of the stack shall not be more than four bags or 3 meters. For extra safety during monsoon, or when it is expected to store for an unusually long period, the stack shall be completely enclosed by a waterproofing membrane such as polyethylene etc. Different type and make of cement shall be stacked and stored separately.

1.11.2 Aggregates

Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or floor bricks or a thin layer of lean concrete shall be made so as to prevent contamination with clay, dust, vegetable and other foreign matter.

The stacks of fine and coarse aggregates shall be kept in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from getting intermixed. Fine aggregate shall be stacked in a place where loss due to the effect of wind is minimum.

1.11.3 Reinforcement Steel

For each classification of steel, separate areas shall be earmarked. It is desirable that ends of bars and sections of each class be painted in distinct separate colors. Steel reinforcement shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting in case of storage time exceeding one month. In store, reinforcement bars shall be stacked above ground level by at least 150 mm either on brick/ cement/ stone platform or concrete/bricks planks.

1.11.4 Structural Steel for Tower Parts

The structural steel of different classification, sizes and lengths shall be stored separately. These shall be stored above ground level at least 150 mm upon platforms, skids or any other suitable supports to avoid any distortion of sections. Also, in order to prevent white rust formation sufficient care should be exercised while storing, handling and transporting galvanized products. The structural steel/ tower parts shall be stored in an adequately ventilated area. The article shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the structural steel/ tower parts.

1.11.5 Conductor & Earthwire Drums

It is essential to save the conductor drums from damage during storage and transportation and the wooden battens and main wheel should be intact so that same can be successfully mounted on the conductor jacks to release the conductor during stringing. All the conductor and earthwire drums should be stored on a proper hard platform above ground to avoid deterioration of the drum and further avoiding the damage of conductor. The conductor & earthwire drums should be stored in such a manner that each drum can be accessed at any time for inspection purposes.

1.11.6 Hardware fitting, Accessories & Insulators

All the hardware fittings, accessories and insulators should be stored on raised platform above ground so as not to damage the packaging and to avoid further damage or denting on the fittings and chipping of insulators. All the aluminum parts should be stored on a plain/ raised platform under a cover shed in such a way that the aluminum fittings cannot be distorted during storage.

2.0 Employer's Environment and Social Policy and its Implementation

2.1 Development and growth of mankind through Industrialization and unwarranted use of natural resources has inflicted considerable impact on Environment and Society. As a result, Environmental and Social issues have emerged as the focal point of global debate.

Employer's activities by their inherent nature and flexibility have negligible impacts on environmental and social attributes. In order to address these issues and to match the rising expectations of a cleaner, safer and healthier environment, Employer has evolved its Environmental and Social Policy and Procedures (ESPP). The key principles of Employer's Environmental and Social Policy are: -

- i) Avoidance of environmentally and socially sensitive areas while planning project activities.
- ii) Minimisation of impacts when project activities occur in environmentally and socially sensitive areas.
- iii) Mitigation of any unavoidable adverse impacts arising out of its projects.

2.2 Basic issues to be kept in mind while carrying out construction activities are to

- i) Avoid socially sensitive areas with regard to human habitations and areas of cultural significance.
- ii) Secure the interest of people affected by Employer's projects.
- iii) Involve local people affected by transmission line projects as per requirement and suitability.

- iv) Consult affected people in decisions having implication to them if considered necessary.
 - v) Apply, efficient and safe technology/ practices.
 - vi) Keep abreast of all potential dangers to people's health, occupational safety and safety of environment and the respective mitigatory measures.
 - vii) Establish preventive mechanisms to guarantee safety.
 - viii) Mitigation measures in case of accidents.
 - ix) Avoid unwarranted cutting of trees in forest area.
- 2.3 While constructing the lines through forest stretches the contractor will provide alternate fuel to its employee e.g. working labours/ supervisors etc. in order to avoid cutting of forest woods.
- 2.4 Contractor will ensure safety to the wild life, during working/ camping near to the National park.
- 2.5 Contractor during construction of lines in agricultural fields will ensure minimum damages to the crops, trees, bunds, irrigation etc. If the same is un-avoidable, the decision of Engineer- in-charge shall be final.
- 2.6 The waste/ excess material/ debris should be removed from the construction site including agricultural field, forest stretches, river etc. immediately after construction work.
- 2.7 The Contractor will ensure least disturbance to the hill slope and natural drainage so as to avoid soil erosion. Natural drainage in plain area if disturbed is to be trained to the satisfaction of Engineer- in-charge.
- 2.8 As far as possible existing path/ kutchha road/ approach shall be used for the construction.
- 2.9 The Contractor will ensure supply of stone chips/sand from authorised/ approved quarry areas.
- 2.10 Proper documentation of above, if any.
- 2.11 The Environment & Social Policy and Procedures (ESPP) evolved by POWERGRID is available at the POWERGRID's website, www.powergrid.in, which shall be referred by the Bidder for further information.

2.12 Facilities to be incorporated for labourers

The Contractor shall provide his/ their laborer with sufficient number of the following facilities with the indicated specifications:

A) Tents:

- i) Tent should be with double layer canvas, outer layer being water-proof. The size/ number should be sufficient to accommodate required number of people comfortably.
- ii) The preferred size of tent should be 20ft x 20ft with Centre height of 7 ft and side height of 2.5 ft.
- iii) Tent windows should have arrangement for mosquito net with waterproof outer covering.
- iv) Doors of the tents shall have Velcro or any other closing system.
- v) The site selected for the camp shall be on high ground, removed from Jungle.
- vi) Efficient arrangement for draining away stagnant water should be provided so as to keep the camp neat and tidy.
- vii) The tents should have illumination at night by providing battery operated LED lanterns or equivalent lighting system.

B) Portable (tyre- mounted) Bio toilet

- i) The toilet seats should be 'Indian'.
- ii) The number of Toilets should be not less than 2 per 50 laborers with separate toilets for female laborers.
- iii) Bio-tank should be of sufficient capacity to allow bacteria present to decompose.
- iv) the excreta and only waste water (odourless and harmless) gets discharged out of the toilet through a sewerage channel away from the tent areas and working areas.
- v) Water tank of adequate capacity should be installed with the Portable Toilet.

Bidder shall quote for the above facilities in the BPS, wherever indicated .

3.0 Quality Assurance Programme

Enclosed with this Technical Specification as Section-II, Annexure-A (Quality Assurance Programme).

SECTION-III

SURVEY & SOIL INVESTIGATION

TECHNICAL SPECIFICATIONS

SECTION-III

SURVEY & SOIL INVESTIGATION

Revision History

Revision No.	Date	Clause Ref	Description
Rev-0	June'2021		First Release
Rev-1	Sept'2021		First Revision
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Rev-7	May'25		Seventh Revision

TECHNICAL SPECIFICATIONS

SECTION-III

SURVEY & SOIL INVESTIGATION

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TECHNICAL SPECIFICATIONS

SECTION- III

SURVEY & SOIL INVESTIGATION

1. General Information & Scope Of Work

- 1.1 The technical specifications cover detailed survey including route alignment, profiling, tower spotting, optimization of locations, check survey, contouring, and soil investigation for the transmission lines/ part of the transmission lines covered under this specification as included in the BPS.
- 1.1.1 The scope of work inter-alia shall include the following: -
- a) Detailed Survey using Total Work stations or alternatively using ALTM (Airborne Laser Terrain Modeling) techniques , inter-alia including:
 - i) Digitised profiling along the selected route along with plan details.
 - ii) Computer aided tower spotting & optimization
 - iii) Soil resistivity measurement along the route
 - b) Check survey including digitised contouring at undulated / hilly tower locations.
 - c) Soil Investigation
 - d) Preparation of Survey reports including estimation of Bill of Quantities, identification and explanation of route constraints (like Forest, Animal/ Bird sanctuary, reserve coal belt areas, oil pipe line/ underground inflammable pipe lines etc.), infrastructure details available en-route etc.
 - e) Collection of data/ details of ownership of land within the line corridor & tower base.
- 1.2 The Provisional quantities for the scope of work are indicated in relevant Price Schedules of BPS. The final quantities for route alignment, detailed survey and check survey (quantities in “kms” unit) shall be as approved by Site Engineer-in-charge and shall be along the approved route alignment. For contouring at undulated/hilly tower locations and soil investigations (quantities in “Locs.” unit), the actual quantities to be executed shall be decided by Site Engineer-in-charge during execution stage and the final quantities shall be as approved by Site Engineer-in-charge. The route alignment, detailed survey, including profiling & tower spotting, contouring, soil investigation, check survey etc. shall be carried out by the Contractor as per the technical specifications stipulated herein. Contractor shall indemnify the Employer for any loss or damage to properties, trees etc. during the survey work.
- 1.3 The Contractor should note that Employer will not furnish topographical maps prepared by survey of India but will make available assistance that may be required

in obtaining these by providing letters of recommendation to the concerned authorities. Further, in case the contractor opts for use of ALTM techniques for detailed survey, he shall be responsible for obtaining necessary clearances/permissions, as may be required from concerned authorities. The Employer will provide assistance that may be required in obtaining these clearances / permissions by providing letters of recommendation to the concerned authorities.

- 1.4 The work shall be carried out by the contractor using modern surveying techniques. The bidder shall indicate in his offer, the detailed description of the procedure to be deployed. The details of the equipment & facilities including software for image processing, computer aided tower spotting etc. available with the bidder or his associates shall also be furnished with the bid.
- 1.5 The Contractor shall also engage services of a reputed geo-technical consultant or experts from independent educational/ research institutions for examining stability aspects of the selected transmission line route/ locations in hilly terrain wherever required.
- 1.6 After carrying out the detailed survey and soil investigations, the contractor shall submit complete BOQ of the transmission lines, Tower schedule, Profiles, Survey reports and other details as per technical specification requirements to the Employer.

2. Route Alignment

- 2.1 The route Alignment shall be carried out by the contractor using Survey of India topographical maps.

2.2 Requirement of Transmission Line Routing

- 2.2.1 The Re-alignment/ routing, if any required, of the transmission line shall be most economical from the point of view of construction and maintenance. The contractor shall identify & examine alternative route alignments and suggest to the Employer the optimal route alignment.
- 2.2.2 Routing/ Re-routing of transmission line through protected/reserved forest area should be avoided. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that involvement of forest area and cutting of trees is minimum.
- 2.2.3 In case, it is not possible to avoid protected areas, the towers of the transmission line upto 400 kV level which are installed in protected areas shall be designed for Multi Circuit (4 circuits) configuration of same voltage level considering reliability level of at least two (2). The top two circuits of these multi-circuit towers shall be used for stringing of the transmission line under present scope and the bottom two circuits shall be made available for stringing of any future transmission line of any transmission service providers/ State transmission utilities/Central transmission utilities passing through the same protected area. Further, the configuration and coordinates of such transmission towers shall be submitted to CEA, CTU & BPC (In case of TBCB Projects) by POWERGRID.

- 2.2.4 The route should have minimum crossings of Major river, Railway lines, National/ State highways, overhead EHV power line and communication lines.
- 2.2.5 The number of angle points shall be kept to minimum.
- 2.2.6 The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.
- 2.2.7 Marshy and low-lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.
- 2.2.8 It would be preferable to utilize level ground for the alignment.
- 2.2.9 Crossing of power lines shall be minimum. Alignment of a transmission line with respect to existing line will be kept considering ROW and tower falling distance.
- 2.2.10 Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them.
- 2.2.11 Areas subjected to flooding such as nalah shall be avoided.
- 2.2.12 Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches.
- 2.2.13 All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.
- 2.2.14 Certain areas such as quarry sites, tea, tobacco and saffron fields and rich plantations, gardens & nurseries which will present the Employer problems in acquisition of right of way and way leave clearance during construction and maintenance should be avoided.
- 2.2.15 Angle points during survey should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line.
- 2.2.16 The line routing should avoid large habitations, densely populated areas, Forest, Animal/Bird sanctuary, reserve coal belt areas, oil pipe line/underground inflammable pipe lines etc. to the extent possible.
- 2.2.17 The areas requiring special foundations and those prone to flooding should be avoided.
- 2.3 For examination of the alternatives & identification of the most appropriate route, besides making use of information/ data/ details available/ extracted through Survey of India Topographical maps, the contractor shall also carryout reconnaissance/ preliminary survey as may be required for verification & collection of additional information/ data/ details.
- 2.4 The contractor shall submit his preliminary observations & suggestions along with various information/ data /details collected, topographical map data marked with the alternative routes etc. The final evaluation of the alternative routes shall be conducted by the contractor in consultation with Employer's representatives and

optimal route alignment shall be proposed by the contractor. Site visit and field verification shall be conducted by the contractor jointly with the Employer's representative for the proposed route alignment.

- 2.5 Final route alignment drawing with latest topographical and other details/features including all rivers, railway lines, canals, roads etc. up to 8 km on both sides of selected route alignment shall be submitted by the contractor for Employer's approval along with report containing other information/details as mentioned above.
- 2.6 Changes in the route alignment, if any, during detail survey, shall be incorporated in the final route alignment drawings.

3. Detailed Survey

- 3.1 The detailed survey shall be carried out using Total stations etc. along the approved route alignment. As an alternative, the contractor may also use ALTM (Airborne Laser Terrain Modeling) techniques of equal or better accuracy for the detailed survey.
- 3.2 Soil resistivity, along the route alignment shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 meters. For calculating soil resistivity formula 2ρ (Where $a=50$ m and r = megger reading in ohms) shall be adopted. Measurement shall be made at every 2 to 3 km along the length of the route. In case soil characteristics changes within 2 to 3 km, values shall have to be measured at intermediate locations also. Megger reading and soil characteristics should also be indicated in the soil resistivity results.

3.3 Route Marking

- 3.3.1 The route of the transmission line shall be recorded using GPS/ DGPS of positional accuracy less than 3m.
- 3.3.2 The co-ordinates of all the angle points as well as other important crossings, landmarks etc. shall be recorded using GPS for easy relocating.
- 3.3.3 At the starting point of the commencement of route survey a suitable peg/spike shall be driven firmly into the ground to indicate location of the survey instrument. The co-ordinates of the location of the survey instrument shall also be recorded. Further, the co-ordinates at prominent position at intervals of not more than 750 meters along the transmission line to be surveyed up to the next angle point shall also be recorded. Wooden peg of 50x50x650mm size shall also be driven at prominent position at intervals of not more than 750 meters along the transmission line to be surveyed up to the next angle point. Wire nails of 50 mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100 mm only above ground level. Wherever the line alignment crosses the EHT line, Railway line, P&T line or roads, the contractor shall record co-ordinates on the points of crossing. Wherever line route alignment passes over permanent land marks such as rock, boulders, culverts etc. suitable white paint marks with directional and POWERGRID

markings shall be made and co-ordinates recorded.

3.4 Profiling

- 3.4.1 The complete profiling along the route shall be carried out using modern surveying equipment viz. total stations. Reference levels at every 20 meters along the route are to be recorded. RLs at other undulations along the route as well as in the route plan and other En-route details viz. crossings, building & structures, trees & other infrastructure etc. shall also be recorded. Areas along the route, which in the view of the contractor, are not suitable for tower spotting, shall also be marked in profile. Any undulation keeping conductor location as reference may also be indicated as dotted line in profile.
- 3.4.2 The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided tower spotting software.
- 3.4.3 A printed/ plotted output of the digitized profiling shall be submitted by the contractor to Employer's site-in-charge for review before taking up computer-aided tower spotting.
- 3.4.4 For reconductoring packages, the Contractor shall then plot the profile of the HTLS Conductor under hot and cold conditions using the above ground profile & existing tower details, verify the various statutory electrical clearances & span limitations on the profile using sag tension calculations of the HTLS Conductor.
- 3.4.5 The profile and computer aided tower spotting prepared by contractor shall also cover the following with respect to clauses mentioned in technical specification, tower spotting data and statutory requirement:
- (i) Wind and weight spans (under maximum and minimum temperature of conductor and no wind condition i.e. hot and cold condition)
 - (ii) Clearances from ground, power lines, highways, communication lines, rivers etc with conductor curves under hot and cold condition)
 - (iii) Clearances from earth wire & OPGW with top conductor at midspan for maximum and minimum temperature combination of earth wire & OPGW and top conductor.

3.5 Optimisation of Tower Location/ Tower Spotting

- 3.5.1 Optimisation of tower locations including profiling shall be done by the contractor using computer-aided tower spotting software - PLSCADD and shall furnish sample calculations and manual tower spotting drawings for some typical sections.
- 3.5.2 The sag-tension characteristics of the conductor as well as tower spotting data shall be furnished by the Employer to the contractor during execution stage. Sag template curves, if any required for tower spotting, shall be prepared by the contractor and two sets of sag-template curves shall be given to POWERGRID for checking of profile.
- 3.5.3 General description of towers is indicated in **Section-I** of this specification for

information of the Bidders.

3.5.4 **Tower Spotting**

While profiling & spotting the towers, the following shall be borne in mind:

a) Span

The number of consecutive spans between the section points shall not exceed 15 spans or 5 km in plain terrain and 10 spans or 3km in hilly terrain as well as in coastal area. A section point shall comprise of tension point with B/DB/QB type or C/DC/QC type or D/DD/QD type towers as applicable.

b) Extension/Truncation

An individual span shall be as near to the normal design span as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body/ leg extension. In case of locations where the ground clearance is available, truncated towers may be spotted. The provisions kept in the design of towers w.r.t. body/ leg extensions, truncations shall be intimated to the contractor by the Employer during execution stage.

c) Loading

There shall not be any upward force on suspension towers under normal working conditions and the suspension towers shall support at least the minimum weight span as provided in the designs. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the towers failing which tension towers designed for the purpose shall be deployed at such positions.

d) Road Crossing

At all important road crossings, the tower shall be fitted with normal suspension and tension insulator strings depending on the type of tower, but the ground clearance at roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than specified minimum ground clearances.. At all national highways, any tension tower based on span and angle of crossing may be used and crossing span shall not be more than 250 meters, unless higher span is permitted by national highways authority in case of highways having more lanes.

e) Railway Crossings

All the railway crossings coming En-route the transmission line shall be identified by the Contractor. At the time of detailed survey, the railway crossings shall be finalised based on the following and also confirming to the regulation laid down by the Railway Authorities.

i) The crossings shall be supported on D/DD/QD type tower on either side.

- ii) The crossing shall normally be at right angle to the railway track.
- iii) The minimum horizontal distance measured at right angles from the center of nearest track to any part of a structure (all structures shall be rigid and well founded), carrying electrical conductors crossing a railway shall be equal to the height of the structure in meters above normal ground level plus 6 meters.
- iv) No crossing shall be located over a booster transformer, traction switching station, traction sub-station, Overlap Section or a track cabin location in an electrified area.
- v) The crossing span will be limited to 300 meters or 80% of the normal span for which the structure is designed whichever is less.
- vi) Minimum ground clearance between crossing conductor under condition of maximum sag and railway line shall maximum of following:

(I) Vertical Clearance for OHE (other than high rise OHE):

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line Crossing or Crossing Planned for Alteration
1	Above 66 kV & upto 132 kV	15.56 m
2	Above 132 kV & upto 220 kV	16.46 m
3	Above 220 kV & upto 400 kV	18.26 m
4	Above 400 kV & upto 500 kV	19.16 m
5	Above 500 kV & upto 800 kV	21.86 m

(II) Vertical Clearance for high rise OHE:

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line Crossing or Crossing Planned for Alteration
1	Above 66 kV & upto 132 kV	17.56 m
2	Above 132 kV & upto 220 kV	18.46 m
3	Above 220 kV & upto 400 kV	20.26 m
4	Above 400 kV & upto 500 kV	21.16 m
5	Above 500 kV & upto 800 kV	23.86 m

Note: Applicable only for electrification of routes where double stack container

having maximum height of 6809mm is plying.

(III) Minimum Clearances between Highest Traction Conductor & Lowest Crossing Conductor

1	Above 66 kV & upto 132 kV	3.05 m
2	Above 132 kV & upto 220 kV	4.58 m
3	Above 220 kV & upto 400 kV	5.49 m
4	Above 400 kV & upto 500 kV	7.94 m
5	Above 500 kV & upto 800 kV	7.94 m

f) River Crossings

In case of major river crossing, river crossing towers shall be of suspension type alongwith anchor towers of D/DD/QD type tower on either side of the main river crossing. Alternately on the basis of economics and / or site/ execution constraints crossing of rivers using normal extended angle towers (+18/+25/+30M Extensions) also shall be considered. For navigable rivers, clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to highest flood level (HFL).

g) Power line Crossings

Where the line is to cross over another line, towers with suitable extensions may be used, depending upon the merit of the prevailing site condition.

For power line crossing of 400 kV or above voltage level, large angle & dead-end towers (i.e. D/DD/QD) shall be used on either side of power line crossing (i.e. D/DD/QD - D/DD/QD arrangement).

For power line crossing of 132 kV and 220 kV voltage level, angle towers (B/C/D/DB/DC/DD/ QB/QC/QD) shall be used on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

For power line crossing of 66 kV and below voltage level, suspension/ tension towers shall be provided on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

Use of D/DD/QD towers for crossing of 66kV, 132kV or 220kV voltage lines shall however be permitted for cases where more than +25 m extension are required due to site conditions.

In case of crossing with B/C/DB/DC/QB/QC towers proper guying shall be provided to facilitate stringing of the power line crossing sections separately on obtaining line shutdowns.

Clearance between lines crossing each other shall be kept in accordance with the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2010 as amended up-to-date. In order to reduce the height of the crossing towers, it may be advantageous to remove the ground-wire of the line to be crossed (if this is possible and permitted by the Employer of the line to be crossed).

Minimum clearance in meters between lines when crossing each other:

Sl. No.	Nominal	110-132 kV	220 kV	400 kV	765 kV	500 kV HVDC	800 kV HVDC	1200 kV
1	110-132KV	3.05	4.58	5.49	7.94	6.86	9.04	10.44
2	220KV	4.58	4.58	5.49	7.94	6.86	9.04	10.44
3	400KV	5.49	5.49	5.49	7.94	6.86	9.04	10.44
4	765KV	7.94	7.94	7.94	7.94	7.94	9.04	10.44
5	500KV HVDC	6.86	6.86	6.86	7.94	7.94	9.04	10.44
6	800KV HVDC	9.04	9.04	9.04	9.04	9.04	9.04	10.44
7	1200 KV	10.44	10.44	10.44	10.44	10.44	10.44	10.44

h) Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degree possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations.

When the angle of crossing has to be below 60 degree, the matter will be referred to the authority in charge of the telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Employer.

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

i) Oil Pipe-Line Crossings

Wherever transmission line crosses an oil/ gas pipeline, the angle of crossing shall be as near to 90 degree possible and in no case less than 75 degrees. Further, a minimum separation of 25 m should be maintained between pipe line and transmission line footings & pipe/ counterpoise earthing.

j) Details En-route

All topographical details, permanent features, such as trees, building etc. within following distance on either side of the alignment shall be detailed on the profile plan: -

1	1200 kV Single Circuit	44.5 m
2	765 kV Double Circuit	33.5 m
3	765kV Single Circuit Delta	32 m
4	765kV Single Circuit Horizontal	37m
5	±800 kV HVDC	34.5 m
6	400kV Single Circuit	26.0 m
7	400kV Double Circuit	23.0 m
8	±500 kV HVDC	26.0 m
9	220 kV	16m
10	132 kV	12.5 m

3.6 Clearance from Ground, Building, Trees etc.

Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the CEA’s Regulations 2023 (Measures relating to Safety and Electric Supply).

3.6.1 The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut by the Employer at the time of actual execution of the work as detailed below. Contractor may please note that Employer shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor’s work.

3.6.2 To evaluate and tabulate the trees and bushes coming within following distance on either side of the central line alignment the trees will be numbered and marked with quality paint serially from angle point 1 (I) onwards and the corresponding number will be painted on the stem of trees at a height of 1 meter from ground level.

1	1200 kV Single Circuit	44.5 m
2	765 kV Double Circuit	33.5 m
3	765kV Single Circuit Delta	32 m
4	765kV Single Circuit Horizontal	37m

5	+800 kV HVDC	34.5 m
6	400kV Single Circuit	26.0 m
7	400kV Double Circuit	23.0 m
8	+500 kV HVDC	26.0 m
9	220 kV	16m
10	132 kV	12.5 m

The trees list should contain the following:

- a) Girth (circumstances) measured at a height of 1 meter from ground level.
- b) Approximate height of the tree with an accuracy of +2 meters.
- c) Name of the type of the species/ tree.
- d) The bushy and under growth encountered within following distance should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement: -

1	1200 kV Single Circuit	89 m
2	765 kV Double Circuit	67 m
3	765kV Single Circuit Delta	64 m
4	765kV Single Circuit Horizontal	74 m
5	+800 kV HVDC	69m
6	400kV Single Circuit	52 m
7	400kV Double Circuit	46 m
8	+500 kV HVDC	52 m
9	220 kV	32m
10	132 kV	25m

3.6.3 The contractor shall also intimate the Employer, his assessment about the likely amount of tree & crop compensation etc. required to be paid by the Employer during execution stage. This assessment shall be done considering prevailing practices/guidelines, local regulations and other enquiries from local authorities.

- 3.6.3.1 The contractor shall also collect data/ details of ownership of land within the line corridor and tower base from the concerned revenue/ local authorities and submit the same to owner as per format enclosed with this technical specification at Annexure-E.
- 3.6.4 The Contractor shall also identify the forest/ non-forest areas involved duly authenticated by concerned authorities.
- A statement of forest areas with survey/ compartment Number (all type of forest RF/ PF / Acquired forest/ Revenue forest/ Private forest/ Forest as per dictionary meaning of forest etc.)
 - A statement of non-forest areas with survey/ compartment nos.
 - Tree cutting details (Girth wise & specie wise)
 - Marking of forest areas with category on topo sheets 1:2,50,000 showing complete line route, boundaries of various forest divisions and their areas involved.
 - Village forest maps of affected line and affected forest area and marking of the same.
 - Forest division map showing line and affected forest area.
- 3.6.5 The Contractor shall finalize the forest clearance proposal on the prescribed format, as per requirements of the state/ MOE & F, duly completed in all respects for submission by the Employer to the Forest Department.

3.7 Preliminary Schedule

The profile sheets showing the locations of the towers together with preliminary schedules of quantities indicating tower types, wind & weight spans, angle of deviation, crossing & other details etc. shall be submitted by the contractor for review & approval by Employer's site-in-charge.

3.8 Check Survey of Tower Locations

- 3.8.1 The check survey shall be conducted to locate tower locations on ground conforming to the approved profile and tower schedule.
- 3.8.2 The co-ordinates of all the tower locations shall also be recorded using GPS / DGPS of positional accuracy less than 3m for easy relocating. The position of all tower locations shall be marked in the final digitized route alignment drawing with relative distances from any permanent bench mark area.
- 3.8.3 The contractor shall also collect required data at each tower location in respect of soil strata, ground water level, history of water table in adjacent areas/surface water, distance from permanent bench mark (these details to be furnished in a tabulated form) and classify the suitable type of foundation at each tower location based on the data collected at each location and detailed soil investigations carried out at selected locations etc.

3.9 Contouring at hilly/ undulated locations

3.9.1 The levels up or down of each pit centre with respect to centre of tower location shall be recorded at intervals of 2m using total stations/ GPS/ digital theodolite and digitized contour plans shall be made. Based on the digitized elevation plans, the quantities of benching & protection work vis-à-vis possible unequal leg extensions shall be optimized using suitable computer-aided techniques/ software or manual method. Required tower and foundation details, cost data for comparative valuation for benching & protection work vis-à-vis unequal leg extensions shall be provided by the Employer to the Contractor during execution stage.

3.10 The changes desired by the Employer in the preliminary tower schedule or as may be required based on detailed survey of tower locations & contouring by the contractor, shall be carried out by the contractor and the final tower schedule shall be submitted for approval of Employer. The tower schedule shall show position of all type of towers, span length, type of foundation for each tower, benching & revetment requirement, unequal leg extensions, deviation at all angles, crossings & other details etc.

3.11 Survey Methodology & Precision

3.11.1 All elevations shall be referenced to benchmarks established by the survey of India. Survey operations shall begin and end at benchmarks approved by the Employer.

3.11.2 During the leveling of the profile, check surveys will be affected at intervals not exceeding 50 km with benchmarks of known elevations. The difference in elevations as surveyed by the contractor and as declared by Survey of India for these benchmarks shall not exceed the precision required for 3rd order surveys $e \leq 24k$, where k is the distance between benchmarks in km and e is the difference between elevations in mm.

3.11.3 In the absence of suitable benchmarks, the leveling shall be done by two independent leveling parties working in opposite directions along the same line. The difference in elevations between the two surveys shall not exceed the precision required for 3rd order surveys as stated above.

3.11.4 All-important objects and features along the transmission line centerline (railways, highways, roads, canals, rivers, transmission lines, distribution lines, telephone lines etc.) shall be surveyed and located with a positional accuracy of 1:2000 between points of known horizontal position.

3.12 Survey Report

3.12.1 Complete BOQ of the transmission lines as per format enclosed with this technical specification at Annexure-A shall be furnished in the survey report.

3.12.2 Each angle point locations shall be shown with detailed sketches showing existing close by permanent land marks such as specific tree(s), cattle shed, homes, tube wells, temples, electric pole/ tower, telephone pole, canal, roads, railway lines etc. The relative distance of land marks from the angle points and their bearings shall be indicated in the sketch. These details shall be included in the survey report.

- 3.12.3 Information w.r.t infrastructure details available en-route, identification and explanation of route constraints, etc. shall also be furnished in the Survey report and shall inter-alia include the following:
- 3.12.3.1 Information regarding infrastructural facilities available along the final route alignment like access to roads, railway stations, construction material sources (like quarry points for stone, sand and availability of construction water), labour, existing transport facilities, fuel availability etc. shall be furnished in the survey report.
- 3.12.3.2 All observations which the Contractor thinks would be useful to the construction of the transmission lines mentioned under scope of work are to be reported.
- 3.12.3.3 Suggestions regarding the number of convenient zones (line segments/ portions) in which the entire alignment can be divided keeping in view the convenience of construction/project implementation are to be given.
- 3.12.3.4 Suggestions regarding location for setting up stores during line construction in consultation with Employer's representative shall also be provided by the contractor.
- 3.12.3.5 Working months available during various seasons along the final route alignment, with period, time of sowing & harvesting of different type of crops and the importance attached to the crops particularly in the context of way leave problems and compensation payable shall be stated by the Contractor.
- 3.12.3.6 Some portions of the line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, Electricity Boards and Zonal railways, Divisional Forest Authorities etc.
- 3.12.4 All the requisite data for processing the case for statutory clearances such as PTCC, Forest and Railway shall be provided along with the report.
- 3.12.5 The contractor shall also collect & report (as per Formats enclosed at B) details pertaining to pollution levels envisaged along the transmission line.
- 3.12.6 Four copies of survey reports shall be furnished by the contractor to the Employer.

4. Geotechnical Investigations

4.1 General

- 4.1.1 Employer requires that a detailed Geotechnical investigation be carried out at various tower locations to provide the designer with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation of transmission line towers can be classified and designed rationally.
- 4.1.2 These specifications provide general guidelines for geotechnical investigation of normal soils. Cases of marshy locations and locations affected by salt water or saltpeter shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations

shall be obtained by Contractor and furnished to Employer.

4.2 Scope

- 4.2.1 The scope of work includes detail soil investigations and furnishing bore log data at various tower locations. The provisional quantities have been indicated in Bill Of Quantities. Detailed soil investigations shall be carried out as decided by site in-charge besides critical locations like railway crossing, river crossing etc. However, during actual execution of work, the quantities shall be decided by the Engineer - in - Charge, depending upon the soil strata and terrain. Based on the bore log data/ soil parameter/ soil investigation results, the Contractor shall recommend the type of foundations suitable for each location and the same shall be got approved by the Employer. For other locations, trial pit is to be done in every location for foundation classification up to foundation depth. No separate payment for trail pit shall be done.
- 4.2.2 These specifications cover the technical requirements for a detailed Geotechnical investigation and submission of a detailed Geotechnical Report. The work shall include mobilization of all necessary tools and equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire field investigation as well as laboratory tests, analysis and interpretation of data collected and preparation of the Geotechnical Report. Contractor shall also collect data regarding variation of subsoil water table along the proposed line route. The aforementioned work shall be supervised by a graduate in Civil Engineering having at least 5 years of site experience in geotechnical investigation work.
- 4.2.3 Contractor shall make his own arrangements to establish the co-ordinate system required to position boreholes, tests pits and other field test locations as per the drawings/ sketches supplied by Employer. Contractor shall determine the reduced levels (RL's) at these locations with respect to benchmarks used in the detailed survey. Two reference lines shall be established based on survey data/details. Contractor shall provide at site all required survey instruments to the satisfactions of the Employer so that the work can be carried out accurately according to specifications and drawings. Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and nalas, etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details at the tower location including maximum velocity discharge, highest flood level (H.F.L), scour depth etc. of the concerned rivers, major streams and nalas (canals).
- 4.2.4 The field and laboratory data shall be recorded on the proforma recommended in relevant Indian Standards. Contractor shall submit to Employer two copies of field bore logs (one copy each to Employer site and Corporate Office) and all the field records (countersigned by the Employer) soon after the completion of each boreholes/ test.
- 4.2.5 Whenever Contractor is unable to extract undisturbed samples, he shall immediately inform the Employer. Payment for boring charges shall be subject to Employer being satisfied that adequate effort has been made to extract undisturbed samples. Special

care shall be taken for locations where marshy soils are encountered and Contractor in such cases shall ensure that specified numbers of vane shear tests are performed and the results correlated with other soil parameters.

- 4.2.6 One copy of all field records and laboratory test results along with soil investigation report shall be sent to Employer. Employer may observe, at the laboratory testing procedures.
- 4.2.7 The Contractor shall interact with the Employer to get acquainted with the different types of structures envisaged and in assessing the load intensities on the foundation for the various types of towers in order to enable him to make specific recommendation for the depth, founding strata, type of foundation and the allowable bearing pressure.
- 4.2.8 After reviewing Contractor's geotechnical investigation draft report, Employer will call for discussions, to be held normally within one week at Employers site Office, in order to comment on the report in the presence of Contractor's Geotechnical Engineer. Any expenditure associated with the redrafting and finalising the report, traveling etc. shall be deemed included in the rates quoted for the geotechnical investigations.
- 4.2.9 Contractor shall carry out all work expressed and implied in these specifications in accordance with requirements of the specification.
- 4.2.10 The contractor shall prepare and submit soil profile along the transmission line route (in digitized form, with digitized route alignment drawing as base) indicating salient soil characteristics/ features, water table etc. based on detailed soil investigations and other details/ information collected during detailed survey.

4.3 General Requirements

- 4.3.1 Wherever possible, Contractor shall research and review existing local knowledge, records of test pits, boreholes, etc., types of foundations adopted and the behavior of existing structures, particularly those similar to the present project.
- 4.3.2 Contractor shall make use of information gathered from nearby quarries, unlined wells excavation etc. Study of the general topography of the surrounding areas will often help in the delineation of different soil types.
- 4.3.3 Contractor shall gather data regarding the removal of overburden at the tower location area either by performing test excavations, or by observing soil erosion or land slide in order to estimate reconsolidation of the soil strata. Similarly, data regarding recent landfills shall be studied to determine the characteristics of such land fill as well as the original soil strata.
- 4.3.4 The water level in neighboring streams and water courses shall be noted. Contractor shall make enquiries and shall verify whether there are abandoned underground works e.g. worked out ballast pits, quarries, old brick fields, mines, mineral workings etc.
- 4.3.5 It is essential that equipment and instruments be properly calibrated at the

commencement of the work. If the Employer so desires. Contractor shall arrange for having the instruments tested at an approved laboratory at its cost and shall submit the test reports to the Employer. If the Employer desires to witness such tests, Contractor shall arrange for the same.

4.4 Codes and Standards for Geotechnical Investigations

4.4.1 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail. Internationally accepted standards which ensure equal or higher performance than those specified shall also be accepted.

4.4.2 All work shall be carried out in accordance with the following Indian Standards and Codes:

Indian Standards	Title	International Standard
IS 1080	Codes of Practice for Design and Construction of Shallow Foundations on soils (other than Raft, Ring & Shell)	
IS1498	Classification and Identification of Soils for General Engineering purposes.	ASTM D 2487 ASTM D2488
IS 1892	Code of Practice for Subsurface Investigation for Foundation	
IS 1904	Code of Practice for Design and Construction of foundation in Soils: General Requirements.	
IS 2131	Method of Standard Penetration Test for Soils	ASTM D 1586
IS 2132	Code of Practice for Thin Walled Tube Sampling of Soils	ASTM D 1587
IS 2720 (Part 1-39) (relevant parts)	Method of Test for Soils (Relevant Parts)	
IS 2809	Glossary of Terms and symbols Relating to Soil Engineering	ASTM D 653-14
IS 2911 (Part I-VI)	Code of Practice for Design and construction of Pile Foundations (Relevant Parts)	
IS 3043	Code of Practice for Earthing	
IS 4078	Code of Practice for Indexing and Storage of Drill Cores.	
IS 4091	Code of Practice for Design and Construction of Foundations for	

	Transmission Line Towers and Poles	
IS 4434	Code of Practice for In-situ Vane Shear Test for Soils	ASTM D 2573(M)-15 ASTMD 4648(M)-16
IS 4453	Code of Practice for Sub-Surface Exploration by Pits, Trenches, Drifts and Shafts	
IS 4464	Code of Practice for Presentation of Drilling information and core description in Foundation investigation	
IS 4968(Part-II)	Method for Subsurface sounding for soils, dynamic method using cone and Bentonite slurry	
IS 5313	Guide for Core Drilling observations	
IS 6403	Code of Practice for Determination of Bearing Capacity of Shallow Foundation	
IS 6926	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects	
IS 6935	Method of Determination of Water level in a Bore Hole	
IS 2809	Glossary of Terms and symbols Relating to Soil Engineering	ASTM D 653-14
IS 2911 (Part I-VI)	Code of Practice for Design and construction of Pile Foundations (Relevant Parts)	
IS 3043	Code of Practice for Earthing	
IS 4078	Code of Practice for Indexing and Storage of Drill Cores	
IS 4091	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles	
IS 4434	Code of Practice for In-situ Vane Shear Test for Soils	ASTM D2573 (M)-15 ASTMD 4648(M)-16
IS 4453	Code of Practice for Sub-Surface Exploration by Pits, Trenches, Drifts and Shafts	
IS 4464	Code of Practice for Presentation of Drilling information and core description in Foundation investigation	
IS 4968 (Part-II)	Method for Subsurface sounding for soils, dynamic method using cone and Bentonite slurry	

IS 5313	Guide for Core Drilling observations.	
IS 6403	Code of Practice for Determination of Bearing Capacity of Shallow Foundation	
IS 6926	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects	
IS 6935	Method of Determination of Water level in a Bore Hole	
IS 7422 Part(I-V)	Symbols and Abbreviations for use in Geological Maps Sections and subsurface Exploratory Logs (Relevant parts).	
IS 8009(Part-I)	Code of Practice for Calculation of Settlements of Foundations (Shallow Foundations subjected to symmetrical Vertical Loads).	
IS 8764	Method of Determination of Point Load Strength Index of Rocks.	
IS 9143	Method of Determination of Unconfined Compressive Strength of Rock Materials	ASTM D 7012-14e1
IS 9179	Method of Preparation of Rock Specimen for Laboratory Testing	
IS 9259	Specification for Liquid Limit Apparatus	ASTM D4318-17
IS 9640	Specification for Split Spoon Sampler	ASTM D1586-11
IS 10050	Method of Determination of Slake Durability Index of Rocks.	ASTM D4644-16
IS 11315 (Part 1-12)	Method for the Quantitative Description of discontinuities in Rock Mass	

4.5 Field Investigation for Soils

Tentative numbers of detailed soil investigation to be done is given in BPS

4.5.1 Boring

Boreholes are required for detailed soil investigations.

4.5.1.1 General Requirements

- a) Boreholes shall be made to obtain information about the subsoil profile, its nature and strength and to collect soil samples for strata identification and for conducting laboratory tests. The minimum diameter of the borehole shall be 150mm and boring shall be carried out in accordance with the provisions of IS 1892 and the present specification.
- b) All boreholes shall be 10m deep for normal soil conditions. The depth of boreholes at river crossings and special locations shall be 40m. If a strata is encountered where the Standard Penetration Test Records N values greater than 100, with characteristics of rock, the borehole shall be advanced by coring

at least 3m further in normal locations and at least 7m further for the case of river crossing locations with prior approval of the Employer. When the boreholes are to be terminated in soil strata an additional Standard Penetration Test shall be carried out at the termination depth. No extra payment shall be made for carrying out Standard Penetration Tests.

- c) Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test of sampling level but not more than 15 cm above the borehole bottom. In case of cohesionless soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall preferably be advanced by slowly rotating the casing pipe and not by driving.
- d) In-situ tests shall be conducted and undisturbed samples shall be obtained in the boreholes at intervals specified hereafter. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water table in the bore hole shall be carefully recorded and reported following IS 6935. No water or drilling mud shall be used while boring above ground water table. For cohesion less soil below water table, the water level in the borehole shall at all times be maintained slightly above the water table.
- e) The borehole shall be cleaned using suitable tools to the depth of testing or sampling, ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned by using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.
- f) On completion of the drilling, Contractor shall backfill all boreholes as directed by the Employer.

4.5.1.2 Auger Boring

Auger boring may be employed in soft to stiff cohesive soils above the water table. Augers shall be of helical or post hole type and the cuttings brought up by the auger shall be carefully examined in the field and the description of all strata shall be duly recorded in the field bore log as per IS 1498. No water shall be introduced from the top while conducting auger boring.

4.5.1.3 Shell and Auger Boring

- 4.5.1.3.1 Shell and auger boring may be used in all types of soil which are free from boulders. For cohesion less soil below ground water table, the water level in the borehole shall always be maintained at or above ground water level. The use of chisel bits shall be permitted in hard strata having SPT-N value greater than 100 Chisel bits may also be used to extend the bore hole through local obstructions such as old construction. Boulders rocky formations, etc. The requirements in **Clause 4.5.1.2** shall apply for this type of boring also.

4.5.1.3.2 Rotary method may be used in all types of soil below water table. In this method the boring is carried out by rotating the bit fixed at the lower end of the drill rod. Proper care shall be taken to maintain firm contact between the bit and the bottom of the borehole. Bentonite or drilling mud shall be used as drilling fluid to stabilise and protect the inside surface of the borehole. Use of percussion tools shall be permitted in hard clays and in dense sandy deposits.

4.5.2 **Standard Penetration Test (SPT)**

4.5.2.1 This test shall be conducted in all types of soil deposits encountered within a borehole, to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. Structure sensitive engineering properties of cohesive soils and silts such as strength and compressibility shall not be inferred based on SPT values.

4.5.2.2 The test shall be conducted at every change of stratum or at interval of not more than 1.5 m whichever is less as per IS 2131, for a depth up to 10 m in case of normal soils and 40 m in case of special locations.

4.5.2.3 The Equipment, accessories and procedures for conducting the test shall conform to IS 2131 and IS 9640. The test shall be conducted immediately after reaching to the test depth and cleaning of bore hole.

4.5.2.4 The test shall be carried out by driving a standard split spoon sampler in the bore hole by means of hammer of standard weight as specified in IS 2131, having a free fall of 750 mm. The sample shall be driven using the hammer for 450 mm recording the number of blows for every 150 mm. The number of blows for the last 300 mm drive shall be reported as N value.

4.5.2.5 This test shall be discontinued when the blow count is equal to 100 or the penetration is less than 25 mm for 50 blows. At the level where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labeled.

4.5.3 **Sampling**

4.5.3.1 **General**

- a) Sufficient number of soil samples shall be collected. Disturbed soil samples shall be collected for soil identification and for conducting tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate the physical bearing capacity and settlement properties of the soil.
- b) All accessories and sampling methods shall conform to IS 2132. all disturbed and undisturbed samples collected in the field shall be classified as per IS 1498.
- c) All samples shall be identified with date, borehole or test pit number, depth of

sampling, etc. The top surface of the sample in-situ shall also be marked. Care shall be taken to keep the core and box samples vertical, with the mark directing upwards. The tube samples shall be properly trimmed at one end and suitably capped and sealed with molten paraffin wax. The Contractor shall be responsible for packing, storing in a cool place and transporting all the samples from site to the laboratory within seven days after sampling with probe, protection against loss and damage.

4.5.3.2 Disturbed Samples

- a) Disturbed soil samples shall be collected in boreholes at regular intervals. The weight of sample as per table 2 of IS 1892 shall be collected at 0.5 m intervals starting from a depth of 0.5 m below ground level and at every identifiable change of strata to supplement the boring records. Samples shall be stored immediately in air tight jars which shall be filled to capacity as much as possible.
- b) In designated borrow areas, bulk samples, from a depth of about 0.5 m below ground level shall be collected to establish the required properties for use as a fill material. Disturbed samples weighing about 25 kg (250 N) shall be collected at shallow depths and immediately stored in polythene bags as per IS 1892. The bags shall be sealed properly to preserve the natural moisture content of the sample and placed in wooden boxes for transportation.

4.5.3.3 Undisturbed Samples

In each borehole undisturbed samples shall be collected at every change in stratum or at intervals not more than 1.5 m, whichever is less as per IS 2132, for a depth up to 10 m in case of normal soils and 40 m in case of special locations.

4.5.3.3.1 The spacing between the top levels of undisturbed sampling and standard penetration testing shall not be less than 1.0 m. Undisturbed samples shall be of 100 mm diameter and 450 mm in length. Samples shall be collected in a manner to preserve the structure and moisture content of the soil. Accessories and sampling procedures shall conform to IS 1892 and IS 2132

- a) Undisturbed sampling in cohesive soil:

Undisturbed samples in soft to stiff cohesive soils shall be obtained using a thin walled sampler. In order to reduce the wall friction, suitable precautions, such as oiling the surfaces shall be taken. The sampling tube shall have a smooth finish on both surfaces and a minimum effective length of 450 mm. The area ratio of sampling tubes shall be less than 12.5%. However, in case of very stiff soils area ratio up to 20% shall be permitted.

- b) Undisturbed sampling in very loose, saturated, sandy and silty soils and very soft clays:

Samples shall be obtained using a piston sampler consisting of a cylinder and piston system. In soft clays and silty clays, with water standing in the casing pipe,

piston sampler shall be used to collect undisturbed samples in the presence of expert supervision.

Accurate measurements of the sampling depth, dimensions of sampler, stroke and length of sample recovery shall be recorded. After the sampler is pushed to the required depth, the cylinder and piston system shall be drawn up together, preventing disturbance and changes in moisture content of the sample;

c) Undisturbed sampling in cohesion less soils

Undisturbed samples in cohesion less soils shall be obtained in accordance with IS 8763. Sampler operated by compressed air shall be used to sample cohesion less soils below ground water table.

4.5.4 Ground Water

4.5.4.1 One of the following methods shall be adopted for determining the elevation of ground water table in boreholes as per IS 6935 and the instructions of the Employer:

a) In permeable soils, the water level in the borehole shall be allowed to stabilize after depressing it adequately by bailing before recording its level. Stability of sides and bottom of the boreholes shall be ensured at all times.

b) For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observations on the rise or fall of water level shall be made at each depth. The level at which neither fall nor rise is observed shall be considered the water table elevation and confirmed by three successive readings of water level taken at two hours interval.

4.5.4.2 If any variation of the ground water level is observed in any specific boreholes, the water level in these boreholes shall be recorded during the course of the field investigation. Levels in nearby wells, streams, etc., if any, shall also be noted in parallel.

4.5.4.3 Subsoil water samples

a) Subsoil water samples shall be collected for performing chemical analysis. Representative ground water samples shall be collected when first encountered in boreholes and before the addition of water to aid boring or drilling.

b) Chemical analysis of water samples shall include determination of pH value, turbidity, sulphate, carbonate, nitrate and chloride contents, presence of organic matter and suspended solids. Chemical preservatives may be added to the sample for cases as specified in the test methods or in applicable Indian Standards. This shall only be done if analysis cannot be conducted within an hour of collection and shall have the prior written permission and approval of the Employer.

4.5.5 Dynamic Cone Penetration Test (only at Special locations)

a) With bentonite slurry

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity of granular soils, etc. The test shall be conducted to the specified depth or refusal, whichever comes first. Refusal shall be considered when the blow count exceeds 100 for 300mm penetration. Equipment, accessories test procedures, field observations and reporting of results shall conform to IS 4968 (Part-II). The driving system shall comprise of hammer of standard weight as specified in IS 4968 (Part-II), having a free fall of 750mm. The cone shall be of 60° and of 62.5mm diameter provided with vents for continuous flow of bentonite slurry through the cone and rods in order to avoid friction between the rods and soil. On completion of the test the results shall be presented as a continuous record of the number of blows required for every 300mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300mm penetration vs. depth. On completion of the test, the results shall be presented on the proforma approved by the Employer.

b) Without bentonite slurry

This test shall be conducted with 50mm diameter 60° cone fitted loosely to the driving rod through a cone adopter. The cone shall be driven in to the soil by allowing hammer of standard weight as specified in IS 4968 (Part-II), having a free fall of 750mm. The number of blows for every 100mm penetrations shall be recorded. The process shall be repeated till the cone is driven to the required depth. The penetration depth shall be limited to 5m in cohesion less soil and 10m in mixed soil with some binding material. The cone driving rods, driving head, hoisting equipment shall conform to IS 10589. The test report should be prepared as per guidelines of IS 4968 (Part I).

4.5.6 Vane Shear Test. (required for boreholes where UDS is not possible) (Only at Special Locations)

Field vane shear test shall be performed inside the borehole to determine the shear strength and bearing capacity of cohesive soils, especially of soft and sensitive clays, which are highly susceptible to sampling disturbance. Equipment, accessories, test procedures, field observations shall correspond to IS 4434. Tests may also be conducted by direct penetration from ground surface. If the cuttings at the test depth in the borehole show any presence of gravel, sand shells, decomposed wood, etc., which are likely to influence the test results substantially, the test at that particular depth may be omitted with the permission of the Employer. However, the test shall be conducted at a depth where these obstructions cease to occur. On completion of the test, the results shall be reported in an approved proforma as specified in IS 4434, Appendix-A.

4.6 Field Investigation for Rock

4.6.1 Rock Drilling

- 4.6.1.1 If, during the investigations, large hard fragments or natural rock beds are encountered, work shall proceed with core drilling methods. The equipment and procedures for this operation shall conform to IS 1892. The starting depth of drilling in rock shall be certified by the Employer. At the end of the investigation, the hole drilled in rock shall be backfilled with grout consisting of 1-part cement and 3-parts sand by weight.
- 4.6.1.2 Drilling shall be carried out with NX size tungsten carbide (TC) or diamond tipped drill bits, depending on the type of rock and according to IS 6926. Suitable type of drill bit (TC/Diamond) and core catchers shall be used to ensure continuous and good core recovery. Core barrels and core catchers shall be used for breaking off the core and retaining it when the rods are withdrawn. Double tube core barrels shall be used to ensure better core recovery and to retrieve cores from layers of bedrock. Water shall be circulated continuously in the hollow rods and the sludge conveying the rock cuttings to the surface shall be collected. A very high core recovery ratio shall be aimed at in order to obtain a satisfactory undisturbed sample. Attempt shall be made to recover cores of 1.5 m in length. Normally TC bit shall be used. Change over to a diamond bit shall require the specific written approval of the Employer, and his decision as to whether a TC or a diamond bit is to be used shall be final and binding on Contractor.
- 4.6.1.3 No drilling run shall exceed 1.5 m in depth. if the core recovery is less than 80% in any run, the length of the subsequent run shall be reduced to 0.75 m. During drilling operations observations on return water, rate of penetration etc. shall be made recorded and recorded as per IS 5313.
- The colour of return water at regular intervals, the depth at which any change of colour of return water is observed, the depth of occurrence and amount of flow of hot water, if encountered, shall be recorded.
 - The depth through which a uniform rate of penetration was maintained, the depth at which marked change in rate of penetration or sudden fail on drill rod occurs, the depth at which any blockage of drill bit causing core loss, if any, shall be recorded.
 - Any heavy vibration or torque noticed during the drilling should be recorded together with the depth of occurrence.
 - Special conditions like the depth at which grouting was done during, drilling, presence of artesian conditions, loss of drilling fluid, observations of gas discharge with return water, etc., shall also be observed and recorded.
 - All the observations and other details shall be recorded as per daily drill and reported in a proforma as given in IS 5313, Appendix-A.

4.6.2 Core Sampling

- 4.6.2.1 Core samples shall be extracted by the application of a continuous pressure at one end of the core with the barrel held horizontally without vibration. Friable cores shall be extracted from the barrel directly into a suitably sized half round plastic channel

section. Care shall be taken to extrude the samples in the direction of coring to avoid stress reversal.

- 4.6.2.2 Immediately after withdrawal from the core barrel, the cores shall be placed in a tray and transferred to boxes specially prepared for this purpose. The boxes shall be made from seasoned timber or any other durably material and shall be indexed on top of the lid according to IS 4078. The cores shall be numbered serially and arranged in the boxes in a sequential order. The description of the core samples shall be recorded as instructed in IS 4464. Where no core is recovered, it shall be recorded as specified in the standard. Continuous record of core recovery and rock quality designation (RD/DD/QD) are to be mentioned in the bore log in accordance with IS 11315 (Part-II).

4.7 Laboratory Testing

4.7.1 Essential Requirements

- a) Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, water and rock samples as per relevant IS codes. One copy of all laboratory test data records shall be submitted to Employer progressively every week. Laboratory tests shall be carried out concurrently with the field investigations as initial laboratory test results could be useful in planning the later stages of field work. A schedule of laboratory tests shall be established by Contractor to the satisfaction of the Employer within one week of completion of the first bore hole;
- b) Laboratory tests shall be conducted using approved apparatus complying with the requirements and specification of Indian Standards or other approved standards for this type of work. It shall be checked that the apparatus is in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely at an approved laboratory.
- c) All samples, whether undisturbed or disturbed shall be extracted, prepared and examined by competent personnel properly trained and experienced in soil sampling. examination, testing and in using the apparatus in conformance with the specified standards;
- d) Undisturbed soil samples retained in liners or seamless tube samplers shall be removed, without causing any disturbance to the samples, using suitably designed extruders just prior to actual testing. If the extruder is horizontal, proper support shall be provided to prevent the sample from breaking. For screwtube extruders, the pushing head shall be free from the screw shaft so that no torque is applied to the soil sample in contact with the pushing head. For soft clay samples, the sample tube shall be cut by means of a high-speed hacksaw to proper test length and placed over the mould before pushing the sample into it with a suitable piston;
- e) While extracting a sample from a liner or tube, care shall be taken to assure that

its direction of movement is the same as that during sampling to avoid stress reversal;

4.7.2 Tests

4.7.2.1 Tests as indicated in these specifications and as may be requested by the Employer, shall be conducted. These tests shall include but may not be limited to the following: -

a) Tests of undisturbed and disturbed samples

- Visual and engineering classification;
- Sieve analysis and hydrometric analysis;
- Liquid, plastic and shrinkage limits;
- Specific gravity;
- Chemical analysis;
- Swell pressure and free swell index determination;
- Proctor compaction test.

b) Tests of undisturbed samples:

- Bulk density and moisture content;
- Relative density (for sand),
- Unconfined compression test;
- Box shear test (for sand);
- Triaxial shear tests (depending on the type of soil and field conditions on undisturbed or remoulded samples):
 - i) Unconsolidated undrained;
 - ii) Consolidated drained test;
- Consolidation

c) Tests on rock samples

- Visual classification;
- Moisture content, porosity and density;
- Specific gravity;
- Hardness
- Stake durability
- Unconfined compression test (both saturated and at in-situ water content);

- Point load strength index;
 - Deformability test (both saturated and dry samples).
- d) Chemical analysis of sub soil water.

4.7.3 Salient Test Requirement

- a) Triaxial shear tests shall be conducted on undisturbed soil samples, saturated by the application of back pressure. Only if the water table is at sufficient depth so that chances of its rising to the base of the footing are small or nil, the triaxial tests shall be performed on specimens at natural moisture content. Each test shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300 KPa respectively or as required depending on the soil conditions:
- b) Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300 KPa or as required for the soil conditions;
- c) Consolidation test shall have loading stages of 10, 25, 50, 75, 100, 200, 400 and 800 KPa. Rebound curve shall be recorded for all samples by unloading the specimen at its in-situ stress. Additional rebound curves shall also be recorded wherever desired by the Employer;
- d) Chemical analysis of subsoil shaft includes determination of PH value, carbonate, sulphate (both SO₃ and SO₄), chloride and nitrate contents, organic matter, salinity and any other chemicals which may be harmful to the foundation material. Their contents in the soil shall be indicated as percentage (%);
- e) Chemical analysis of subsoil water samples shall include the determination of properties such as colour, odour, turbidity, PH value and specific conductivity, the last two chlorides, nitrates, organic matter and any other chemical harmful to the foundation material. The chemical contents shall be indicated as parts per million (PPM) based on weight.

4.8 Geotechnical Investigation Report

4.8.1 General

Contractor shall submit a formal report containing geological information of the region, procedures adopted for geotechnical investigation, field observations, summarised test data, conclusions and recommendations. The report shall also include detailed bore logs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, supporting calculations for the conclusions drawn, etc. Initially, Contractor shall submit three copies of the report in draft form for Employer's review;

- a) Contractor's Geotechnical engineer shall visit Employer's Office for a detailed review based on Employer's comments in order to discuss the nature of

modifications, if any, to be done in the draft report. Contractor shall incorporate in the report the agreed modifications and resubmit the revised draft report for approval. Ten copies of the detailed final approved report shall be submitted to Employer together with one set of reproducible of the graphs, tables etc.

- b) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different types of structures.

4.8.2 Data to be furnished

4.8.2.1 The report shall also include the following

- a) A plot plant/ location plan showing the locations and reduced levels of all field test e.g. boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, etc., property drawn to scale and dimensioned with reference to the established grid lines;
- b) A true cross section of all individual boreholes and test pits with reduced levels and co-ordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted, samples collected at different depths and the rock stratum, if encountered;
- c) Geological information of the area including geomorphology, geological structure, lithology, stratigraphy and tectonics, core recovery and rock quality designation (RD/DD/QD), etc.,
- d) Observations and data regarding change of course of rivers, velocity, scour depths, slit factor, etc., and history of flood details for mid-stream and river bank locations;
- e) Past observations and historical data, if available, for the area or for other areas with similar soil profile, or with similar structures in the surrounding areas;
- f) Plot of Standard Penetration Test (uncorrected and corrected N values) with depth for each test site;
- g) Results of all laboratory test summarised according to Table 4.0 (i) for each sample as well as (ii) for each layer, along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores,
- h) For all triaxial shear tests, stress vs. strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity (E) shall be furnished for all tests along with relevant calculations;
- i) For all consolidation tests, the following curves shall be furnished
 - i) e vs. log p;
 - ii) e vs. p;
 - iii) Compression vs log t or vs $\dot{\sigma}t$

depending upon the shape of the plot, for proper determination of coefficient of consolidation. The point showing the initial condition (e_0 , p_0) of the soil shall be marked on the curves;

- j) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

Table 4.0

A) SUMMARY OF RESULTS OF LABORATORY TESTS ON SOIL

Date of Boring:						Name of the Project:										Bore hole no.:								
Ground elevation: (R.L. in m.)						Co-ordinates:					Termination Depth:					Water table:								
Soil details						Grain Size Distribution				Atterberg limits			Soil Density (kg / m ³)					Moisture content		Triaxial / Direct shear Test			Remarks	
Depth	Sample nos. & type	IS Classification of soil	Description of layers	N – Value (observed)	N – Value (corrected)	Specific Gravity	Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity index	Bulk / Natural Density	Dry Density	Submerged Density	Proctor Density	Relative Density	Natural	Optimum	Confining Pressure	Co-hesion	Angle of Repose	Remarks

Following additional information should also be provided:

- (i) Maximum expected yearly rise / fall of water table
- (ii) General topography of the location: whether cultivated or barren, hilly / plain location, river bank location etc.

Note: where ever undisturbed sampling is not possible, reasons must be clearly indicated and all the tests shall be conducted on re-moulded samples.

(Signature)
Prepared by
Soil investigator

(Signature)
Checked & Reviewed by
Line Contractor

(Signature)
Checked & Approved by
POWERGRID Site / RHQ Engg.

**B) SUMMARY OF ULTIMATE BEARING CAPACITIES CONSIDERING MAXIMUM RISE OF WATER
TABLE**

Location no.	Foundation Classification	Depth of footing considered for bearing capacity calculation	Size of footing considered for bearing capacity calculation	Bearing capacity*		
				Based on settlement criteria (for 40mm total settlement)	Based on settlement criteria (for 50mm total settlement)	Based on shear failure criteria
		3.0m	3.0m x 3.0m			
		3.0m	5.0m x 5.0m			
		3.0m	7.0m x 7.0m			
		3.0m	9.0m x 9.0m			
		3.5m	3.0m x 3.0m			
		3.5m	5.0m x 5.0m			
		3.5m	7.0m x 7.0m			
		3.5m	9.0m x 9.0m			

* Detailed calculations of all the bearing capacities should be enclosed with soil investigation reports.

(Signature)	(Signature)	(Signature)
Prepared by Soil investigator	Checked & Reviewed by Line Contractor	Checked & Approved by POWERGRID Site / RHQ Engg.

C) For Chemical Test

As per Specifications - Clause 4.8.4

4.8.3 Recommendations

4.8.3.1 Recommendations shall be provided for each tower location duly considering soil type and tower spotting data. The recommendations shall provide all design parameters and considerations required for proper selection, dimensioning and future performance of tower foundations and the following:-

- a) The subsurface material must provide safe bearing capacity and uplift resistance by incorporating appropriate safety factors thereby avoiding rupture under ultimate loads;

- b) Movement of the foundation, including short-term and long-term components under transient and permanent loading, shall be strictly controlled with regard to settlement, uplift, lateral translation and rotation:
- c) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

Core resistance, frictional resistance total resistance, relation between core resistance, Standard Penetration Test N value, and settlement analysis for different sizes of foundation as specified in para 4.1.8.3 (I) based on static cone penetration test.

- d) For shallow foundation the following shall be indicated with comprehensive supporting calculations: -
 - i) Net Safe allowable bearing pressure for isolated square footing of sizes 4.0, 5.0, 6.0 & 7.0 m at three different founding depths of 1,2 and 3 & 3.5m below ground level considering both shear failure and settlement criteria giving reasons for type of shear failure adopted in the calculation.
 - ii) Net safe allowable bearing pressure for raft foundations of widths greater than 5m at 2.0, 3.0 and 4.0m below ground level considering both shear failure and settlement criteria.
 - iii) Rate and magnitude of settlement expected of the structure.
 - iv) Net safe bearing capacity for foundation sizes mentioned in para(i) above, modulus of sub grade reaction, modulus of elasticity from plate load test results along with time settlement curves and load settlement curve in both natural and log graph, variation of Modulus of sub grade reaction with size, shape and depth of foundation.
- e) The stable slopes for shallow and deep excavations, active and passive earth pressure at rest and angle of repose for sandy soils shall be furnished. The loading of the foundations shall not compromise the stability of the surrounding subsurface materials and the stability of the foundation shall be ensured against sliding or overturning.
- f) Depending on the subsurface material, water table level and tower type, either reinforced concrete isolated pad and chimney, cast-in-situ bored pile of special foundations shall be installed at a given location.
- g) Net Safe allowable bearing pressure and uplift resistance shall be provided for the various sizes of isolated square footings founded at various depths below

ground level considering both shear failure and movement criteria; rate and magnitude of movement expected of the structure (settlement, uplift, rotation) shall also be given.

- h) In cases where normal open cast/ pile foundations appear to be impractical, special pile foundations shall be given due consideration along with the following:
- i) Type of pile foundation and reasons for recommending the same duly considering the soil characteristics.
 - ii) Suitable founding strata for the pile.
 - iii) Estimated length of pile for 500, 750 and 1000 KN and 4500 KN capacities; end bearing and frictional resistance shall be indicated separately.
 - iv) Magnitude of negative skin friction or uplift forces due to soil swelling.
- i) Where the subsoil water and soil properties are found to be chemically aggressive. Contractor shall take suitable precautions during construction including any protective coating to be applied on the foundations; susceptibility of soil to termite action and remedial measures for the same shall be dealt with.
- j) Suitability of locally available soils at site for filling, backfilling and adequate compaction shall be investigated.
- k) If expansive soil such as black cotton soil is encountered recommendation of removal or retainment of the same shall be given in the latter case, detailed specifications of special requirements shall also be given.
- l) Susceptibility of subsoil strata to liquefaction in the event of earthquake and remedial measures, if required, shall be considered.
- m) Any other information of special significance such as dewatering schemes, etc. which may have a bearing on the design and construction shall be provided.
- n) Recommendations for additional soil investigations, beyond the scope of the present work, shall be given if Contractor considers such investigations necessary.

4.8.4 Hydrogeological Conditions

- 4.8.4.1 The maximum elevation of ground water table, amplitudes of its fluctuations and data on water aggressivity with regard to foundation structure materials shall be reported. While preparing ground water characteristics the following parameters should be specified for each aquifer:

- a) bicarbonate alkalinity mg-eq/(deg)
- b) pH value
- c) content of aggressive carbon dioxide, mg/l;
- d) content of magnesia salts. mg/l, recalculated in terms of ions Mg^{+2} ;
- e) content of ammonia salts, mg/l, recalculated in terms of ions NH^{4+}
- f) content of caustic alkalis, mg/l, recalculated in terms of ions Na^{+} and K^{+}
- g) contents of chlorides,mg/l recalculated in terms of ions Cl^{-}
- h) contents of sulphates, mg/l, recalculated in terms of ions SO_4^{-2}
- i) aggregate content of chlorides, sulphates, nitrates, carbonates and other salts, mg/l

4.9 Rates and Measurements

4.9.1 Rates

The contractor's quoted rates shall be inclusive of making observations, establishing the ground level and co-ordinates at the location of each borehole, test pit etc. No extra payments shall be made for conducting Standard Penetration Test, collecting, packing, transporting of all samples and cores, recording and submittal of results on approved formats.

4.10 Specific Requirements for Geotechnical Investigation at River Crossings

4.10.1 The entire soil investigation work at river crossing locations (if required) shall be carried out in accordance with the relevant parts of the specifications for geotechnical investigation modified to the extent given below.

4.10.2 Requirements

4.10.2.1 Boreholes shall be executed to specified depth of 40m (refer clause 4.5.1.1 (b). If refusal strata is reached (i.e. SPT-N value is greater than 100 continuously for 5m depth) with characteristics of rock the borehole may be terminated at shallower depth i.e. at 5m in refusal strata, with prior approval of the Employer.

4.10.2.2 Laboratory testing shall be conducted on all soil samples to determine grain size distribution, liquid limit and plastic limit of the different soil strata encountered.

4.10.2.3 Geotechnical Report must furnish the following:

- a) Geotechnical investigation scheme;
- b) Bore-logs indicating soil stratification, with IS classification, sampling details and
- c) SPI 'N' values;

- d) Soil cross-sections along various boreholes in two orthogonal directions indicating soil stratification based on field and laboratory tests;
 - e) Grain size distribution curves;
 - f) IS classification of soils;
 - g) Shear tests (UU), to be done on saturated soil samples;
 - h) Bearing capacity of soil at different levels;
 - i) Highest flood level (HFL);
 - j) Maximum discharge, velocity etc. (from authenticated source such as CWC or appropriate State authorities);
 - k) Recommendations regarding type of foundation to be adopted at the location
- 4.10.3 A check list for reporting results of river crossing locational details, detailed soil investigation and river values for river crossing locations is enclosed at Annexure-C.
- 4.11 Special Terms and conditions for Geotechnical Investigation in the River bed**
- 4.11.1 Contractor is required to mobilise a suitable arrangement (floating pontoon, plant, equipment etc.) to carry out geotechnical investigation work in creek/ river locations identified by the Employer.
 - 4.11.2 In the event of storm or stoppage of work, etc., Contractor shall not be paid extra for mobilization/ remobilisation of floating pontoon, plant, equipment, etc.
 - 4.11.3 Contractor shall fully satisfy himself about the conditions of creek/ river (depth of water, wave currents, wind conditions, etc.) prevailing in the area of proposed investigation and plan the necessary tools and plant to be deployed before quoting. Any claim resulting from lack of data collection in this respect shall not be entertained.
 - 4.11.4 Contractor shall make his own arrangements for locating the coordinates and position of boreholes in creek/ river with respect to two grid-lines indicated by Employer.
 - 4.11.5 Boring in creek or river shall be payable only below the bed level and no payment shall be made for lowering the casing in water.
 - 4.11.6 Contractor shall arrange for necessary transportation on water (e.g. motor boat) to facilitate the supervision of work by officials of Employer at its own cost.
 - 4.11.7 Full details of the construction plant, proposed working method for boring and sampling in water shall be submitted along with the Tender.
 - 4.11.8 The unit rate quoted for underwater boring shall include complete work required as per specification and no separate payment shall be made on any account.

5 Statutory Regulations and Standards

- 5.1 Contractor is required to follow statutory regulations stipulated in Electricity Act 2003, Indian Electricity Rules and other local rules & regulations.
- 5.2 The codes and standards referred to in these specifications shall govern. In case of a conflict between such codes/ standards and these specifications, the provisions of the specifications shall prevail. Such codes, standards referred to shall mean latest revisions, amendments, changes adopted and published by relevant agencies.
- 5.3 Other Internationally acceptable standards which ensure equivalent or better performance than those specified shall also be acceptable.

BOQ FORMAT FOR TRANSMISSION LINE PACKAGE

Annex-A (1/2)

Name of line :

----- KV ----- associated with -----

Sl. No.	Description	Unit	Quantity
1	Line length	KM	
a)	Plain Terrain	KM	
b)	Hilly Terrain		
i.)	Hilly Terrain	KM	
ii.)	Mountaineous Terrain	KM	
2	GPS cordinates		
a)	Start point		
b)	End point		
3	Route marked on google earth/ bhuvan map	YES/NO	
4	Detail of wind zone (lengthwise)		
a)	WZ-....	KM	
b)	WZ-.....	KM	
5	States		
a)	KM	
b)	KM	
c)	KM	
d)	KM	
6	Length of RC section	KM	
7	No of Circuits	No.	
8	No. of bundle Conductor	No.	
9	Earthing		
a)	Pipe type		
i)	Normal Earthing	No.	
ii)	Chemical Earthing	No.	
b)	Counterpoise Type	No.	
i)	Normal Earthing	No.	
ii)	Chemical Earthing	No.	
c)	Shieldwire Earthing	No.	
i)	PipeType Earthing	Sets	
ii)	Counterpoise type Earthing	Sets	
d)	Rod type (Qty same as pipe type earthing)	No.	
e)	Earthing for RC Location	No.	
10	Survey		
a)	Detailed survey	KM	
b)	Check Survey	KM	
11	Soil Investigation		
a)	All kind of soil except FR & HR	Loc.	
b)	Fissured rock	Loc.	
c)	Rocky Soil	Loc.	
d)	River Crossing Location	Loc.	

Sl. No.	Description	Unit	Quantity
12	Benching		
a)	All kind of soil except FR & HR	m3	
b)	Fissured rock	m3	
c)	Hard rock	m3	
13	Tower Protection		
a)	Random rubble	m3	
b)	Stone Bound	m3	
c)	Back Filling	m3	
d)	M-15 Cover seal	m3	
14	Aviation Requirements		
a)	Painting of towers	No.	
b)	Unit wt of Towers to be painted	MT	
c)	Span markes	No.	
d)	Avaiation Lights		
i)	1 Medium+2 low intensity	No.	
ii)	1 Medium+ 4 low intensity	No.	
15	No. of Transposition towers	No.	
16	River Crossings		
	Name of river		
	Crossing span (Bank-Bank)	M	
	Type of foundation for river crossing tower pile or open		
17	Road/Railway Crossings		
	Road Crossings (NH/SH)	No.	
	Power Line Crossings (132kV & above)	No.	
	Railway Crossing-electrified	No.	
	Railway Crossing-non- electrified	No.	
18	Forest Details:		
	Reserved Forest	kms	
	Protected Forest	kms	
	Social/Revenue Forest	kms	
	Other Area	kms	
19	Power Line Crossings		
	765 KV	No.	
	400 KV	No.	
	220 KV	No.	
	132 KV	No.	
20	Stringing of power line crossing under Live line condition	No.	
21	Pollution details		
	Line stretch in polluted areas/fog prone area/near costal/creeks/backwaters	Kms	
22	Other Imporatnt details		

Name of line : ----- KV ----- associated with -----

Tower Type	Unit	Quantity	Foundation classification													
			Dry	Wet	Wet cultiv	PS	FS	WBC	DFR	WFR	SFR	HR	Sandy	Pile	Well	
A/DA/QA Type tower	Nos.	0	0	0		0	0	0	0	0	0	0	0	0	0	
Normal Tower	Nos	0														
+3M Extn	Nos	0														
+6M Extn	Nos	0														
+9M Extn	Nos	0														
+18M Extn	Nos	0														
+25M Extn	Nos	0														
B/DB/QB Type tower	Nos.	0	0	0		0	0	0	0	0	0	0	0	0		
Normal Tower	Nos	0														
+3M Extn	Nos	0														
+6M Extn	Nos	0														
+9M Extn	Nos.	0														
+18M Extn	Nos	0														
+25M Extn	Nos	0														
C/DC/QC Type tower	Nos.	0	0	0		0	0	0	0	0	0	0	0	0		
Normal Tower	Nos	0														
+3M Extn	Nos	0														
+6M Extn	Nos	0														
+9M Extn	Nos	0														
D/DD/QD Type tower	Nos.	0	0	0		0	0	0	0	0	0	0	0	0		
Normal Tower	Nos	0														
+3M Extn	Nos	0														
+6M Extn	Nos	0														
+9M Extn	Nos	0														
+18M Extn	Nos	0														
+25M Extn	Nos	0														
Gantry	Nos.	0														
Total		0	0	0		0										

	D/C	M/C	TOTAL
Total suspension Towers	0	0	0
Total Tower Type 'D/DD/QD'	0	0	0
Total Tension Towers	0	0	0
total Normal Towers	0	0	0
Total Anchor Towers			
Total RC Towers			
Total Towers	0	0	0

#FORMAT FOR REPORTING DETAILS OF POLLUTED STRECHES OF TRANSMISSION LINES:

Project: _____ Name Of Line: _____ Voltage Level (kV) _____ Total Line Length (Kms.): _____

Sl no.	Section Details				Source of Pollution (Indicate S.no. of source)	Distance of source of Pollution from line section	Details Source of Distance Details of pollution measurement undertaken on dummy insulators viz						Details of existing lines in vicinity w.r.t insulator design, performance & pollution measurement			
	From	To	Length of Line Section	No. of Suspension Towers			Details of Dummy Insulators			Periodicity of Measurement	SDD (mg/cm ²)	NSDD (mg/cm ²)	Voltage Level	No. & Type of Insulators per Susp. String	Performance (Indicate Category)**	Remarks***
							Dia (mm)	Spacing (mm)	Creepage (mm)							

Not applicable for Transmission Lines with Composite Long Rod Insulators.

* Source of pollution -(a): sea, (b): power stations, (c): cement factories, (d): Fertiliser plants, (e): oil refineries, (f): brick kilns, (g):Coal mines, (h): salt farms, (i) bird drops near butcheries/ . sanctuaries, (j): fertilisers, (k): soil with high salt content, (l): Any other (Please mention)

** Performance category -(1): Satisfactory, (2): Occasional tripouts, (3): Frequent tripouts/ line drops

***Remarks – Indicate additional information like special maintenance practices followed, levels of pollution measurements if carried out etc.

For further details please refer the following Format

QUESTIONNAIRE FOR COLLECTION OF POLLUTION DATA IN RESPECT OF TRANSMISSION LINES

1. Distance from sea-Coast (Route alignment indicating distances from sea coast may be enclosed) :
2. Details of industries along the proposed route (Power stations, Cement factories, Fertiliser plants, Oil refineries Brick-kilns, Coal mines, Salt Furnaces etc.) :
 - a. Type of Industry :
 - b. Distance from the proposed route (please mark position of industries in the route map) :
 - c. Nature of pollutants. :
 - d. Details of stretches of lines (in kms) expected to be affected by above industries). :
3. Details of proposed industries along the Proposed route (Data may be collected From concerned authorities) :
4. Details of existing lines in the vicinity Of proposed route alignment :
 - a. Name of line, voltage level, Utility :
 - b. How long in service. :
 - c. Type of insulators used (Standard! Antifog) :
 - d. Details of insulator strings . (Nos. per string) :
 - e. Has ever pollution measurement carried out by the utility. :
 - f. Any specific steps being taken to counter pollution problems (Like hot line washing, insulator surface coating, cleaning of insulators etc.) :
 - g. Performance of line (No. of ; tripouts/flashovers, failure of insulators etc. as collected from concerned utility) :
 - h. Approx. distance between the Line and proposed route. :
 - i. Any other information (Corrosion of insulator pin, towers, line drops etc.) :
5. Any butcheries / Bird sanctuaries along the route Alignment where bird drops may be anticipated (indicate position of the route map) :
6. Vicinity of highways :
 - a. Distance from proposed route. :
 - b. Length of parallelism :
7. Any specific area along the route alignment where soil may have salt content which may affect the insulator performance (Identify area on route maps) :
8. Details of cultivated fields where fertilisers are frequently used (Identify areas on the route maps) :

- 9. Details of natural rain :
 - a. Duration of rainy season :
 - b. Extent of rain. :
- 10. Details of thunderstorm conditions (Very frequent/frequent/less frequent) :
- 11. Details of Pollution measurement if any, carried out using dummy insulators/ existing lines nearby:- :
 - i. Measurement conducted on insulator - Type, dia, spacing & creepage :
 - ii. SDD , :
 - iii. NSDD :
 - iv. Type of pollutant :
 - v. Periodicity of measurement: Values corresponding to :
 - a. Quaterly :
 - b. Half yearly :
 - c. Yearly :
 - d. Two yearly :
- 12. Any other information. :

FORMAT FOR REPORTING RESULTS OF SURVEY OF RIVER CROSSING STRETCH OF TRANSMISSION LINE

Inputs:

River crossing profile, ground profile, GL, HFL, Tower type, Reference bench mark details:

- Base width
- Slope
- Loads
- Stub sections/ Leg sections

Soil Report (up to 40m. depth)

- N Value
- Cohesion © and friction angle (ϕ)
- Dry Density & Submerged density of soil
- Soil composition including bore log data.
- Soil Strata distribution details depth wise
- R.L of ground (Soil investigation and foundation location)
- Mean grain size
- Silt factor calculations
- Scour depth calculations
- Special Recommendations, if any.
- River crossing profile showing the position of R.C towers and Anchor towers with span details.
- Any other details like bunds, roads, bridges etc. with their R.L.S.

River Values

- Max. discharge
- Max. velocity (Vmax.)
- HFL
- Clear water way
- River Meandering history.
- Navigable/ Non Navigable
- Location reference of above River values for crossing details.
- River bed level. (RL)

FIELD QUALITY PLAN FOR TRANSMISSION LINES
Document No. C/A/DA/QA&I/SFQP/TL/030, Rev 01

S.No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref documents	Check/Testing		Counter Check/Test By Employer	Accepting authority in Employer
					Agency	Extent		
1.	Detailed Survey	a. Route alignment	Optimisation of route length	a. Preliminary survey. b. Topographical map c. Tower spotting datas given by Engg.	Contractor - do - - do -	100% at Field - do - - do -	100% based on record docuements - do -	Project incharge
		b. Route profiling & tower spotting	1. Ground clearance. 2. Cold Wt. Span 3. Hot Wt. Span 4. Sum of Adj span (wind span) 5. Angle of Devn.	a. Sag template b. Tower Spotting data c. Route alignment	Contractor - do - - do - - do - - do -	- do - - do - - do - - do -	100% based on record documents - do - - do - - do -	Line incharge

2	Check Survey	Tower Location & Final Length	i. Alignment ii. Final Length	a. Route alignment b. Tower Schedule c. Profile	Contractor	100% at Field	i). All angle towers in plains and 50% in hilly terrains ii).Final length to be checked on 100% basis based on records/documents	Section Incharge
3.	Details Soil Investigation	a. Borelog	1. Depth of bore log. 2. SPT Test 3. Collection of samples	As per Employer Specification	Contractor	100% at Field	To witness 20% at Field	Section incharge.
		b. Tests on samples	As per tech. Specs	- do -	Lab appd by Employer	100% by testing lab	Review of lab test results	Line incharge based on the report review by CC Engg.

FORMAT-1**FORMAT FOR OWNERSHIP DATA FOR LAND SCHEDULING FOR TOWER BASE****Name of Transmission line:****State & District:****Tehsil/circle:****Loc No. Tower Type..... Tower Base Area *SqM.**

S.No	Owner Name (as per land records)	Occupied owner name at site if any (kabza)	Mouza/Village	Tehsil/Circle	Sheet no.	Plot No.	Khata No/ Khasra No.	Total Area Khata No./Khasra No.(in SqM)	Kissam/Type of land /Land use (farming/waste/residential etc.	Circle Rate (Rs.)per SqM	Remarks on land use / Any dispute/court case over land
1											
2											
N											

Note:

1. Tower base area (between four legs) shall be calculated inSqM (as per MoP guidelines) or as per prevailing /local authority compensation norms.
2. Separate table as per above to be generated for each locations.
3. Any additional data to implement the compensation may be provided.

FORMAT-2**FORMAT FOR OWNERSHIP DATA FOR LAND SCHEDULING FOR ROW CORRIDOR LENGTH****Name of Transmission line:****State & District:****Tehsil/circle:****Loc No. FromTo..... , Span LengthM , Total ROW area of span *SqM.**

S.No	Owner Name (as per land records)	Occupied owner name at site if any (kabza)	Mouza/ Village	Tehsil/ Circle	Sheet no.	Plot No.	Khata No/ Khasra No.	Total Area Khata No./Khasra No.(in SqM)	Kissam/Type of land /Land use (farming/ waste/ residential etc.	Circle Rate (Rs.)per SqM	Remarks on land use / Any dispute/court case over land
1											
2											
N											

Note:

- 1 Area should be calculated in the width of ROW corridor (excluding tower base area considered for tower) for each span.....SqM . or as per prevailing /local authority compensation norms.
- 2 Separate table as per above to be generated for each span.
- 3 Any additional data to implement the compensation may be provided .

Appendix – IV

**LIST OF SPECIAL TOOLS & TACKLES USED IN STRINGING OF HTLS
CONDUCTOR**

List of Special Tools & Tackles for Stringing of HTLS Conductor

Sr. No.	Item Description	Quantity (Nos.) required for One Set	Broad Technical Parameters & Standards	Remarks
1	Pulling Eye/String Clamp	24	Suitable for offered size of HTLS Conductor	Only Applicable for GAP type
2	Core Retainer	6	Suitable for offered size of HTLS Conductor	Only Applicable for Composite Core type
3	Automatic Conductor Come Along Clamp	12	Long Jaw Clamps, Lever Type Suitable for offered size of HTLS Conductor	
4	Automatic Core (Steel) Come Along Clamp	12	Long Jaw Clamps, Lever Type Suitable for offered size of HTLS Conductor core	Only Applicable for GAP type
5	Tandem Sheaves/Rollers	3	Suitable for conductor bundle & offered size of HTLS Conductor	Only Applicable for Composite Core type
6	Motorized Hydraulic Compression Machine with Compression Head & Die set	1	Light weight, 100 T compression capacity, Compression Head & Die set shall be suitable for offered size of HTLS Conductor	
7	Tensioner Feed Sheave	2	Sheaves - Al alloy rubber lined mounted on ball bearing, Frames - Mild Steel	
8	Hoist Hook or Lifting Hook	2	With Broad base for avoiding sharp bending of composite core conductor during lifting.	Only Applicable for Composite Core type

Note:

1. Contractor may also use/deploy special tools & tackles other than those listed above, if required for proper stringing of offered HTLS conductor.
2. Above technical parameters indicate the basic minimum requirements of T&Ps. All T&Ps shall confirm to Indian standards, wherever applicable. Other International standards, which ensure equal or better properties/performance shall also be acceptable.

SECTION-IVC

TOWER: MATERIALS, FABRICATION, ERECTION & STRINGING

TECHNICAL SPECIFICATIONS

SECTION-IV C

TOWER: MATERIALS, FABRICATION, ERECTION & STRINGING

Revision History

Revision No.	Date	Clause Ref	Description
Rev-0	June'2021		First Release
Rev-1	Sept'2021		First Revision
Rev-2	Jan'2022		Second Revision
Rev-3	Feb'2022		Third Revision
Rev-4	July'2022		Fourth Revision
Rev-5	Aug'2022		Fifth Revision
Rev-6	April'2023		Sixth Revision
Rev-7	Dec'2023		Seventh Revision
Rev-8	Jan'2025		Eight Revision
Rev-9	Jan'2025		Ninth Revision
Rev-10	May'25		Tenth Revision

TECHNICAL SPECIFICATIONS

SECTION-IV C

TOWER: MATERIALS, FABRICATION, ERECTION & STRINGING

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2.0	Inspection & Tests	26
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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 including plates 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 including plates 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 3.5 meters and 4.5 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 3.5 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 3.5m 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^o C and maximum 50^o 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°C to 85°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 than $15,000\text{ mm}^2$

(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.

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- 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: -
- Holes must be perfectly circular and no tolerances in this respect are permissible.
 - 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.
 - 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.

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- (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 $450 \pm 10^{\circ}$ 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° 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 (earhwire/ 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 these 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.
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

Sl. No.	Indian Standard	Title
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
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

Sl. No.	Indian Standard	Title
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, 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**.

3.1.8 For crossing of 33kV/11kV/LT lines during stringing, shut down (if required) shall be obtained by the contractor. Suitable support, documents, etc. for obtaining shutdown shall be provided by the employer. However, contractor shall be required to arrange bypass arrangement for such lines with suitable LT/HT power cables whenever shutdown cannot be arranged during stringing.

The bypassing work shall be executed with suitable 33kV/11kV/LT cables, following all electrical guidelines and proper safety measures in co-ordination with concern DISCOM/agency/authority. However, the healthiness of cables shall be ensured by the contractor before installation at each crossing. The 33kV/11kV/LT line shall be restored after the completion of stringing work, with confirmation from Employer. The work shall be carried out as per the direction of the Engineer-in-Charge.

The payment of bypass arrangement shall be inclusive of suitable cables and all necessary items/arrangements/works required for successful bypassing of existing 33kV/11kV/LT lines that includes de-stringing of existing 33kV/11kV/LT conductors and their restoration after completion of stringing. The provisional quantities for bypass arrangements are indicated in the BPS. The bidders are required to quote unit rates for the same in appropriate schedule of BPS.

The Contractor shall be entirely responsible for repair/rectification/replacement of any damage to the existing 33kV/11kV/LT line of DISCOM/agency/authority during the execution of the work.

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.

3.3.1 Erection by conventional method

For erection of towers using normal 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).

Bidder shall quote against the quantities for conventional erection in the BPS item mentioned below:

“Erection of various types of towers, tower extensions (complete), bolts & nuts, hangers, d-shackles, step bolts, pack washers etc. including tack welding & supply & application of zinc rich paint: Normal towers/River crossing towers/Multi circuit towers (as the case may be)”

3.3.2 Mechanized erection using crane

For erection of towers (complete or in parts) using telescopic crane of minimum boom height of 30m 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. Local bolting for connecting the different panels/members may be done using wrenches/torque wrenches/power wrenches. The locations where the telescopic crane is to be used shall be decided by the site-in-charge. Bidder shall quote against the quantities for mechanized erection using telescopic crane in the BPS item mentioned below:

“Mechanized erection using telescopic crane of various types of towers, tower extensions as per technical specification.”

However , during execution , if quantities of the above item are going beyond as indicated in BPS , the same shall be executed with the approval of Head of Region.

Tack welding of the bolts, application of zinc rich paint and fixing of towers accessories (i.e. D shackle, hanger, etc.) shall be done by the contractor in case of both above erection methods.

3.3.3 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.

3.3.4 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.

3.3.5 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 (if required) shall be obtained by the contractor when working at crossings of overhead power lines. Suitable support, documents, etc. for obtaining shutdown shall be provided by the employer. 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°C for ACSR or AACSR BERSIMIS, SNOWBIRD & LAPWING /26°C 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 smoothed.

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 for approval. 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° for Insulation sleeve and Tape	Sample shall not develop any cracks/ fissures after subjecting to 180° for 4 hours.
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* 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.

$$\begin{aligned} \text{Quantity of Conductor} &= \text{Line length* as per detailed survey} \times 3 \text{ phases} \times \text{Nos. of conductor per phase (for Single Circuit Line)} \\ &= \text{Line Length* as per detailed survey} \times 3 \text{ phases} \times \text{Nos. of conductor per phase} \times 2 \text{ (for Double Circuit Line)} \end{aligned}$$

$$\text{Quantity of Earthwire} = \text{Line length* as per detailed survey} \times \text{nos. of earthwire}$$

$$\text{Quantity of OPGW} = \text{Line length* as per detailed survey} \times \text{no. of OPGW}$$

* 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.

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

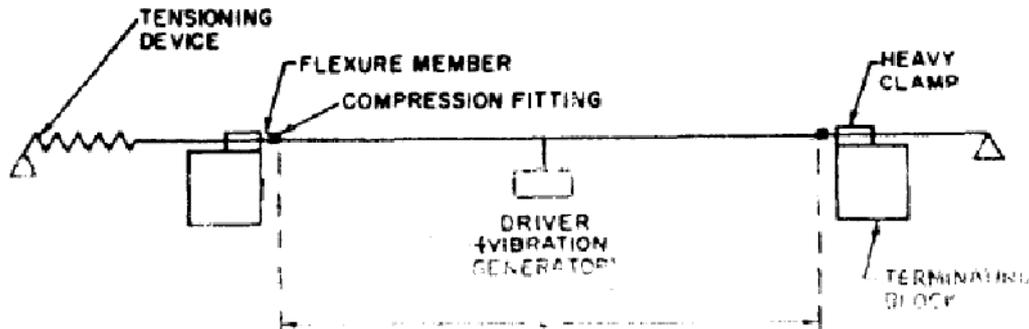
$$f^{1.8} Y_{\max} > 1000 \text{ mm/sec.}$$

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 earthwire/ 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 $\pm 5^\circ\text{C}$ 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.

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

Appendix - IV

LIST OF MAJOR T&P USED IN TOWER ERECTION & STRINGING

List of Major T&P used in Tower Erection & Stringing

Sl No	Item Discription	Broad Technical Parameters & Standards
1	Derrick Pole	Made of seamless steel pipe: Material confirming to IS:1161, Grade Yst 240
		For 220kV & 132kV: ID-116 mm, OD-127mm, Thickness 5.4mm, Length 6m/9m (6+3)
		For 400kV & 765kV: ID-155mm, OD-168.30 mm, Thickness 8mm, Length 6m/9m(6+3)/12m (6+6)
2	Gin Pole	Made of high-tensile aluminum and have swivel head & base. Length 12 to 24 m .Breaking strength 100/80/16kN with lifting capacity of 50/40/8kN.
3	Motorised Power Winch	As per IS 9507
4	Hydraulic Power Winch	Maximum pull capacity of 35kN with negative breaking system, independent mechanical stabilizer (front & rear) and emergency stop push button.
5	Single sheave Pulley close & open type	Conforming to IS:13156, Withstand load - 8 MT(min.)
6	Double sheave Pulley	Conforming to IS:13156, Withstand load - 5/10 MT(min.)
7	"D" Shackle	FORGED SHACKLES, IS/ISO 2415, Minimum Ultimate Strength - 5/8/10 T
8	Steel Wire rope	Steel wire rope DIA - 16/18/20 mm Conforming to IS 2266
9	PP (Polypropylene) Rope	Dia- 12 mm/16 mm/18 mm/20 mm/22mm/24 mm Conforming to IS 5175
10	Turn Buckle	Confirming to IS:3121,
11	Trifor - (For tower erection with Gin pole)	Confirming to IS 5604
12	Motorised Joint Machine	Light weight 100 T – for Zebra/ Moose Conductor & Earthwire and 120 T – Bersmis/ Lapwing Conductor
13	Single sheave aerial rollers	Dia. 300/450/660 mm Sheaves - Al alloy mounted on ball bearing Frames - Mild Steel
14	Three sheave aerial rollers	Side Rollers - Al alloy Centre Rollers - Al alloy or Mild Steel
15	Five Sheave aerial Rollers	Frames - Mild Steel
16	Seven Sheave Rollers	
17	TSE - TWIN/QUAD/HEXA Bundle	Capacity of TSE 8T for Twin Bundle, 16T for Quad Bundle & 24T for Hexa Bundle with negative hydraulic brakes for safety.
18	Sagging Platform	Superior Aluminium Alloy in trapezoidal structure with antiffall barrier.
19	EarthWire Roller	Steel Sheave mounted on Double Ball Bearing.
20	Head Board - OPGW	Frames - Mild Steel, Front & Back Tail with Pin - High Tensile Steel
21	Head Board - Twin/Quad/Hexa	Made with heat treated alloy steel
22	Pilot Wire	Anti-Twisting Galvanized Braided Steel Rope 16 mm, 18mm for Twin Moose , 22mm for Quad Moose, 28 mm for Hexa Lapwing -800kV Stringing.
23	Four sheave Pulley	Material Conforming to IS:13156
24	Turn Table	Earth Wire-3 MT, Conductor-5MT
25	Equilizer Pulley	Material Conforming to IS:13156, Capacity - 10/15 MT
26	Single End Socks Conductor	High Tensile Galvanized Steel Wires
27	Double End Socks Conductor	High Tensile Galvanized Steel Wires
28	Drum Lifting Jack	Frame Material- M. S. Pipe, Class C
29	Bull Dog Clamp - 18mm	Conforming to IS:2361

Sl No	Item Discription	Broad Technical Parameters & Standards
30	Spacer Cycle /Trolley	Made of light Aluminium alloy material .
31	Ratchet Lever Hoist	IS:11340
32	Swivel/Articulate Joint	Made with High Tensile steel, 3/11/22/36 MT (BL)
33	Bolted Come Along Clamp - E/W & Conductor	Body - SG Iron Hook & Eye Bolt - HT steel Liners - Al Alloy

Note: Above technical parameters indicate the basic minimum requirements of T&Ps. All T&Ps shall confirm to Indian standards, wherever applicable. Other International standards, which ensure equal or better properties/performance shall also acceptable.