

Specification for Monopoles for 66 kV Transmission Lines

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1.0 SCOPE

This specification covers the survey of site, Design, Engineering, manufacturing, supply, fabrication, galvanizing, testing, inspection before dispatch, delivery of various types of 66 kV Transmission Lines monopoles at site, watch & ward , design of foundations, laying of foundations along with supply of complete foundation material , erection of monopoles , hard ware fittings, insulators, complete stringing & sagging on turnkey basis on the 66 kV double circuit feeding line with ACSR Zebra for 66 kV line.

The fabricated steel poles will include base plate with its required accessories for erection on the foundation, monopole body (including extensions, if required), Cross Arms. The accessories shall majorly include strain plates, D-shackles with nuts, bolts and washers, U-Bolts with nuts and washers, space washers, links for providing attachment to the Earth wire and Conductor, anti-climbing devices and any other equipment/ material / article to complete the works as per the scope given in this specification.

The monopoles will be fully galvanized. Provision will be made at the Cross Arm level for fixing phase plates and Bird guards. The holes for fixing the Earthing bonds at the peak and for grounding the monopoles at bottom or any other holes, which the purchaser may require, shall be provided at the convenient locations on the monopoles.

2.0 APPLICABLE STANDARDS

The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of monopoles, 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 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 Business Associate and those specified in this document will be provided by the Business Associate to establish their equivalence. The material and services covered under these specifications shall be performed as per requirements of the relevant standards/codes (with latest revision) referred hereinafter against each set of equipment and services. Other Internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.

Sl. No.	Relevant Indian Standard No.	Title
1	IS:209- Rev	Specification for Zinc.
2	IS:2062- 1992	Steel for general structural purpose.
3	IS:269- 1976	Ordinary rapid hardening & low heat Portland Cement.
4	IS:383- 1970	Coarse and fine aggregates from natural sources for concrete.
5	IS:432- 1966 (Part I&II)	Mild steel and medium tensile Code of practice for plain and reinforced concrete bars and hard drawn steel wire for concrete reinforcement.
6	IS:456- 1978	Code of practice for plain and reinforced concrete.
7	IS:800- 1962	Code of practice for use of structural steel in general Building construction.
8	a) IS:802 b) IS:802 (Part-II)- 1978 c) IS:802 Part-III-1978	Code of Practice for use of structural steel in overhead transmission Line: Part 1: Load and Permissible stresses. Code of Practice for use of structural steel in overhead transmission line: Fabrication, Galvanizing, Inspection and packing. Code of Practice for use of structural steel in overhead transmission line monopoles: Testing
9	IS:808	Dimensions for Hot Rolled steel Beam, Column channel and Angle sections.
10	IS:875	Code of practice for design loads (other than earthquakes) for Buildings & structures
11	IS:1139- 1966	Hot rolled mild steel, medium tensile steel and high yield strength deformed bars for concrete reinforcements.
12	IS:1489- 1976	Portland Pozzolana Cement.
13	IS:1786- 1966	Cold twisted steel bars for concrete reinforcement.
14	IS:1893- 1965	Criteria of Earthquake resistant design of structures.
15	IS:2016- 1967	Plain Washers
16	IS:2131- 1967	Method of Standard penetration test for soils.
17	IS:1367- 1967	Technical supply conditions for threaded fasteners.(First Revision).
18	IS:2251- 1982	Danger Notice Plates.
19	IS:2629- 1966	Recommended practice for hot dip galvanizing of iron & Steel.
20	IS:2633- 1972	Method of testing uniformity of coating of zinc coated articles.
21	IS:3043- 1972	Code of Practice for earthing (with amendment No. 1 &2).
22	IS:3063- 1972	Single Coil Rectangular Section spring washers for bolts, nuts,

		screws.
23	IS:4091- 1967	Code of practice for design and construction of foundation for transmission line monopoles and poles
24	IS:5358-1969	Hot dip galvanized coatings on fasteners.
25	IS:5613(Part- II) 1976	Code of practice for Design, installation & maintenance of overhead power lines (Section- 1: Designs; Section 2: Installation & Maintenance).
26	IS: 6610- 1972	Specification for heavy washers for steel structures.
27	IS:6639- 1972	Hexagonal bolts for steel structures.
28	IS:6745- 1972	Methods for determination of weight of zinc coating of zinc coated iron and steel articles
29	IS:8500- 1977	Specification for weldable structural steel (Medium and High strength qualities).

The letter and spirit of Central Electricity Authority, (Measure relating to Safety and Electric Supply), Regulation, 2010, Central Electricity Authority, (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2010 shall be the supreme guiding factor for resolution of conflicts, if any.

3.0 CLIMATIC CONDITIONS FOR INSTALLATION

Climate conditions of the installation	
Max. Ambient Temperature	55°C
Max. Daily average ambient temp.	40°C
Ref. Temperature For Design	50°C
Min Ambient Temp	-4°C
Maximum Humidity	100%
Minimum Humidity	10%
Average No. of thunderstorm days per annum	50
Maximum Annual Rainfall	750 mm
Average No. of rainy days per annum	60
Rainy months	June to October
Altitude above MSL not exceeding	300 Meters
Wind Pressure	126 kg/sq m up to an elevation at 10 m
Atmosphere	Atmosphere is generally laden with mild acid and dust suspended during dry months and subjected to fog in cold Months. the design of the equipment and accessories shall be suitable to withstand seismic forces corresponding to an acceleration of 0.1 G

4.0 TYPE OF MONOPOLE

The double circuit towers will have two circuits (six cross arms),self-supporting, designed for the specified loading conditions.

There will generally be following type of towers:-

- i) Tangent type tower with maximum line deviation up to 2° to be used with Single/Double suspension insulator strings.
- ii) Medium angle tower to be used for line deviation from 0° to 30° with Single/Double tension insulator strings.
- iii): Heavy angle tower to be used for line deviation from 30° to 60° and also as dead end tower with Single/Double tension insulator strings.

The bidder may also quote for up gradation work using the categories of monopoles available with him. In such case the bidder will have to indicate the type of monopoles and extensions proposed to be used by him for up gradation work and the available type tested designs.

Suitable extension of 3M, 6M and 9M & 12M height shall be designed for use with all type of towers.

The following minimum clearances may be made available between the live parts and the nearest monopole body.

Suspension string		Jumper in case of tension monopoles	
Swing	Clearance	Swing	Clearance
Still air No swing	915 mm	Still air No swing	915 mm
15 deg Swing	915 mm	10 deg swing	915 mm
30 deg swing	760 mm	20 deg swing	610 mm

If Pilot string is used in case of 60° monopole; swing of the pilot string shall be 15 degrees. The clearance shall be available from grading ring if the same happens to be the nearest to the monopole body at any point of time.

DESIGN SPANS:

The wind span for the purpose of computing the wind load on conductors and ground-wire shall be indicated in the offer. Similarly the weight span shall also be indicated.

WIND LOAD:

The wind load on conductors, earth wire, towers and insulator strings shall be taken as per recommendations of IS: 802 (Part-I) -1995with latest revision thereof, for following conditions:-

- (a) Wind zone - 4 (Four)
- (b) Reliability level - 1(one) for 66 kV double circuit monopoles
- (c) Terrain category - 2 (Two).

5.0 GENERAL CONSTRUCTION

MATERIAL:

STEEL: The steel to be used shall be conforming to IS-2062 (grade E-350 B0 or equivalent) as amended to date or its equivalent International Standards with minimum Yield Strength of 350 MPa. In case of International Standards, copies of the same shall be furnished along with the bid in English language. Procurement of all steel material required for the fabrication shall be arranged by the supplier at his cost.

The procurement of steel against this tender shall be arranged by the supplier and progress thereof will be intimated to the purchaser, who will satisfy itself regarding actual availability at firm's works by deputing any representative of the Board. Similarly, the progress of OEM shall also be watched during the progress of the work. The steel sections required for fabrication should be as per ISS: 2062/1999 with latest amendments .RECPDCL reserves the right to inspect the quality of steel.

The steel re-rolled by re-rollers shall have their stamp. The re-rollers should have valid ISI certificate for re-rolling of particular material.

The OEM i.e. the supplier shall maintain complete record of the raw material for fabrication. The complete record in this regard shall be verified by Inspectors before carrying out inspection.

RECPDCL also reserves the right to conduct stage inspection to check fabrication, raw material, galvanizing and other allied activities for which the OEM should give 15 days advance notice for main activities viz procurement of raw material, fabrication and galvanizing.

ZINC:

The Business Associate shall make his own arrangement for the procurement before commencement of work of sufficient quantity of Electrolytic Zinc of Proper quality for galvanizing monopole members. The bidder shall not link the delivery period with availability/procurement/supply of zinc. The purchaser shall be at liberty to have samples of zinc used, test checked in any laboratory at the cost of the bidder and reject the particular supply if it not found up to requisite standard.

All raw material for fabrication, galvanizing etc. for complete execution of work shall be stocked in adequate quantities by the bidder to ensure that the progress of works is not hampered. No extension in delivery time shall be allowed on the pretext of non-availability or short supply of raw material.

QUALITY OF STEEL:

The steel used shall be of tested class & quality not in any way inferior to structural steel conforming to IS:2062 (Gr. E350 B0) as amended to date.

For all steel supplies, whether from indigenous production or from imported stocks, it will be the responsibility of the bidder to verify and ensure that supplies of steel received by him for and used in the fabrication works covered under this specification are of tested class-I quality in accordance with the specification mentioned therein and free from blisters, scales, laminations or other defects. Purchaser may check the quality of steel being used during fabrication/galvanization.

Any material made from steel of inferior quality and below specifications will not be accepted by the Purchaser and shall have to be removed and replaced by the bidder at his own cost on receipt of necessary instructions from the purchaser's Inspecting Officer(s).

TOLERANCES:

1. The tolerances as per IS: 1852/1979 or its latest revision would be applicable for angles, plates & rounds.
2. Fabrication tolerance shall conform to those specified in clause 6.2 to 6.5 of IS: 802(Part-II-1978). Tolerance not specified above shall in general conform to IS: 7215/1974 or the latest revision.

Bolts and Nuts.

Material for anchor bolts shall conform to grade 6.8 as per IS 1367 (latest amendment). Exposed portion of the Anchor bolts shall be galvanized as per relevant IS.

Material for headed bolts shall be of grade 6.8 and shall be galvanized in accordance with relevant ISS. Threaded rod shall be of grade 6.8

Weld Material.

The material used for making welds shall be compatible with the parent material, as defined by relevant ISS related to welding and shall meet the impact requirements specified above for the lowest toughness requirements of the plates being joined.

MODEL ASSEMBLIES:

After the formal approval of the design calculations by the Purchaser, Model Assembly of each type of monopole shall be prepared with reference to Structural drawing approved by the Purchaser. The Supplier after evolving part drawings of connections of the assembly will go ahead with Model Assembly, without waiting for approval of part drawings. After completion of Model Assembly of a monopole, the Supplier shall give a call to Purchaser for inspection and approval of the same and Purchaser shall send Authorized representative/Engineer to check the Model Assembly of the pole with reference to Structural drawing/ part drawings within 15 days of the receipt of call. The Supplier after getting approval of Model Assembly and part drawings will proceed for proto testing of each pole and after successful testing, shall go in for mass fabrication of the same. The schedule of putting up Model Assemblies for approval should be so adjusted that the delivery of the material is done as per delivery schedule.

DETAILING:

Typical Details.

Telescoping splices joining sections (slip joints) shall be designed to assure a minimum lap of 1.5 times the largest inside diameter of the outer section. Anchor bolts shall be provided with top and bottom templates to form a cage at job site.

Circumferential welds.

Shaft-to-shaft, pole shaft-to-base plate, and pole shaft-to-flange shall be full penetration welds. Arm shaft-to-arm bracket shall be partial penetration groove weld with fillet overlay, sized to develop the full strength of the shaft.

Other accessories (lugs and plates for grounding, jacking, climbing and identification) shall be fillet and/or groove welds sized to develop the loading requirements of the attachment.

Longitudinal Welds.

Longitudinal welds in outer section at slip joints and within 76.2 mm (3") of length welding shall be full penetration. Longitudinal welds shall be a minimum of 60% penetration in other locations.

Plate Bends.

The minimum inside radius of plate bends shall be such that cracking does not occur. Care must be taken to prevent the steel from cracking especially at the free ends of the bend either during the bending operation or subsequently due to residual stresses.

FABRICATION:

General.

The Pole OEM shall prepare a detailed drawing of the pole and submit it to RECPDCL for approval. Fabrication shall be performed in strict compliance with RECPDCL's approved detail drawings. Material substitution or deviations from the final approved drawings shall not be made without written approval from RECPDCL. The OEM shall accurately identify all material to assure proper usage.

Pole Shaft.

The pole shaft shall present the most pleasing appearance possible consistent with the strength requirements in the specification and drawings. Pole shall be continuously tapered from top to bottom with a uniform slope. No multi-ply steel plates will be allowed for the pole structure fabrication. Shaft shall be made with number of sections specified in the Standard Drawings. The cross section of the pole shall be as specified in the Standard Drawings with all sides equal.

Pole Slip Joint.

Pole section shall be made with telescopic slip joints for easy assembly either in air or on the ground at the construction site. Overlapping shall not be less than 1.5 times the largest inside diameter of the female section.

The taper of each section at a slip joint should match the taper of the adjacent section to provide proper splice tolerances. No circumferential weld within a shaft section shall be permitted. Other type of connection will not be permitted.

MATERIAL PREPARATION:

Edges shall be in accordance with relevant national / international welding standards. Burrs or sharp notches that may be detrimental to the structure or that pose a safety hazard shall be removed. Re-entry cuts shall be rounded. Care shall be taken to prevent separation of the outer surface and reduction of the cross sectional properties below those required by design. If separation occurs during bending, it shall be repaired in accordance with relevant national / international welding standards.

When hot bending is required, heating shall be done evenly over the entire bend area and shall be of sufficient temperature to minimize separation and necking down of the cross section. The temperature used in hot bending shall be such that the physical properties of the steel are not diminished.

WELDING:

Welding shall conform to the relevant national / international standards. Preheat and interpass temperature as per standards shall be followed. Welding shall be done by the shield metal-arc, gas shielded flux core, gas shield metal arc or submerged-arc processes. Welding electrodes shall be of low hydrogen classification as per national / international standards, for submerged arc welding.

Care shall be taken in assembling and fitting, and welding shall be controlled to minimize shrinkage stresses and distortion. All finished work shall be of good quality and have a neat appearance without warpage.

Caution shall be exercised to obtain full penetration welds where specified.

When inspection of a weld zone is called for, procedures shall be in accordance with non-destructive testing procedures of national / international welding standards and the following additional requirements:

Circumferential and longitudinal welds within the slip joint area of tubular sections shall be shear wave ultrasonically inspected as per relevant standards.

Longitudinal welds in tubular sections, where visual inspection is not adequate, shall be magnetic particle or dye penetrant tested.

Attachment welds shall be examined by visual inspection. Magnetic particle or dye penetrant testing shall be used at questionable area by visual inspection.

GALVANIZING

1. All parts of the monopole members shall be hot dip galvanized after fabrication and the cost of the same shall be included in the price quoted by the bidder for galvanized monopole. No extra cost for increase in weight of the galvanized monopole structures due to galvanizing shall be paid.

2. All material shall be fully fabricated before galvanizing according to IS:802 (Part-II-1978 with latest amendments, if any)/latest ASTM /ASCE standards. In particulars, galvanizing of the structure members shall conform to IS:4759 with latest amendments. No machine or shop work, die work etc will be allowed after galvanizing.

3. The galvanizing coating shall be sufficient thickness and of not less than 650 gms of Zinc per square meter of surface. The galvanizing shall consist of continuous coating of the Zinc of uniform thickness and so applied that it adheres firmly to all surfaces of the steel and will give the proper protection to steel after erection. Galvanizing shall be free from all defects which will affect its service. The finished surface shall be clean smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters (the same terms as defined in IS:2629-1985 as amended to date). Before being galvanized, the steel shall be thoroughly cleaned of all paints, grease, rust scale or such other materials as may interfere with the proper binding of Zinc smelter with the steel by employing accepted methods used in the process of Hot dip galvanizing itself & shall not adversely affect the mechanical properties of the coated material.

4. The galvanized coating shall not flake or be loosened from the steel when struck squarely with chisel faced Hammer.

5. The tests shall be made on the galvanizing from time to time on as many samples as may be considered necessary or min. as per IS:4759-1979 at one time. The Supplier/fabricator shall supply without charge, the samples and equipment necessary to carryout the tests without any extra cost. The galvanizing in all

respect shall conform to the tests specified in IS:2633 (as amended to date) and IS 6745-1972(as amended to date).The bidder shall clearly state in his tender the facilities available at his works to carry out the specified tests.

6. Each bidder shall state his Hot dip galvanizing arrangement, indicating the size of galvanizing bath and maximum out put of the galvanizing plant. In fact each bidder shall give schedule of financial and technical resources. Bidder must have a galvanizing tank at his works to facilitate hot dip galvanizing of longest member of any monopole covered in the scope in a single dip. The bid of bidder having inadequate tank dimensions shall be out rightly rejected.

STRAIN PLATES:

The strain plates for dead ending or stringing of conductors and groundwire on the monopoles is designed for a strength not less than that of the ACSR Zebra and ground wire of size 7/2.24 mm as per IS:12776-1989 as the case may be which they are to hold. The thickness of Strain plates should be provided with necessary control holes for fixing on earthing clips.

LADDER/STEP BOLTS

Each monopole shall be provided with dia 16 mm ladder/Step bolts staggered in both flanges of one of the legs. The ladder / step bolts are required to be spaced not more than 45 cms. Apart starting from 3 m above ground level the supply quantity of ladder step bolts required for each type of structure shall be worked out and indicated on the final structural drawings of monopoles.

MARKING

Each separate member of monopole shall be given an identification number to be shown on the Assembly drawing for each type of monopole along with a mark of Supplier. Each individual member shall be stamped with the typed letters of the monopole to which it belongs, followed by its identification number as shown on the Assembly drawing. Identical parts shall have the same identification number and absolutely interchangeable. The monopole type letter and member identification number shall be stamped into the steel member in letters and figures approx.3/4 inch. deep, before being galvanized in such a manner so as to ensure that marks are visible after galvanizing and remain permanent. The marks shall be readily traceable.

6.0 Monopole Foundations

Foundation Types

a) General

These specifications provide general guide lines for construction of foundations for transmission lines monopoles covered in the tender. The foundation shall be constructed as per design/drawings to be supplied by the bidder and to be approved by RECPDCL. Reinforced Cement concrete foundations , with concrete level at least one meter above the ground level, shall be used for all types of monopoles in conformity with the present day practice followed in the country and the specifications laid herein. Foundation includes supply of materials such as cement, reinforcement steel, sand, coarse aggregates etc. Rates quoted for foundations in appropriate schedule shall include all items of work related to supply and installation of foundations such as form work, excavation and backfilling, setting, providing reinforcement etc.

i) The cement concrete used for the foundations shall be of grade M-25.

ii) All the properties of concrete regarding its strength under compression, tension, shear, punching and bend etc as well as workmanship will conform to IS:456-1978 (with latest amendments).

ii) The Portland Cement used in concrete shall conform to IS:269-1967.

iii) The Pozzolena cement used in concrete shall conform to IS:1489-1976. iv) Concrete aggregates shall conform to IS:383-1970

v) The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Potable water is generally preferred.

vi) Reinforcement shall conform to IS:432-1966 for M.S. bars and hard drawn steel wires and IS:1139-1966 and IS:1786-1966 for deformed and cold twisted bars respectively. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coatings, which may destroy or reduce bond. Business Associate shall supply, fabricate and place reinforcement too shapes and dimensions and indicated or as required to carry out the intent of drawings and specifications. Only one type of steel shall be used for the design.

3) Unit rates and measurements due to any reasons the same shall be re-set in the presence of RECPDCL's representative without any extra cost.

b) Setting templates & equipment

Foundation setting templates and all other related equipment shall be arranged by the Business Associate at his cost for all types of monopoles.

c) Mixing, Placing and Compacting of Concrete

1. The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain hand mixing may be permitted at the discretion of RECPDCL. In case of hand mixing 10% extra cement shall be used without any extra cost. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalies. Saltish or blackish water shall not be used.

2. Mixing shall be continued until there is uniform distribution of material and the mix is uniform in colour and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible, the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods, which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

3. Form boxes shall be used for casting all type of foundations. The concrete shall be laid down in 150 mm layers and consolidated well, so that the cement cream works upto the top and no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compaction of the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of RECPDCL. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge, to drain off any rainwater falling on the coping.

4. In wet locations, the site must be kept complete dewatered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period.

5. After the formwork has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the

satisfaction of the RECPDCL's representative before the foundation pits are backfilled at no extra cost.

d) Back-Filling and Removal of Templates

1. After opening of form work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with excavated soil, unless it consists of large boulders or stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, this shall be done by the Business Associate at his own cost, irrespective of lead.

2. The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled and wetted and tamped properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits, towards the outer ends. After the pits have been backfilled to full depth, the stub template may be removed.

3. The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water.

e) Curing

The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after minimum period of 24 hours and thereafter both the backfilled earth and exposed top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.

7.0 Monopole Erection, Stringing and Installation of Line Materials

a) General

1. The details of the scope of erection work shall include the cost of labour, all tools and plants and all other incidental expenses in connection with erection and stringing work.

2. The Business Associate shall be responsible for transportation of all the materials to be provided by the Business Associate as per the scope of work to site, proper storage and preservation at their own cost till such time the erected line is taken over by the RECPDCL/CED. The Business Associate shall be responsible for transportation, proper storage, safe custody, loss or damage of all supplied items for incorporation in the lines and shall maintain and render proper account for all such materials at all times.

3. All the material which is in scope of RECPDCL shall be issued from the RECPDCL/CED stores to the Business Associate (for which required indemnity bond shall be given by the Business Associate on the prescribed format given elsewhere in this specification). The Business Associate shall be responsible for transportation of all the materials to be provided by the RECPDCL as per the scope of work to site, proper storage and preservation at their own cost till such time the erected line is taken over by the RECPDCL/CED.

4. Business Associate shall set up his own stores along the line at his own cost and the exact location of such stores shall be discussed and agreed to between the Business Associate and the RECPDCL. The RECPDCL shall not be liable for any unpaid rents of the space taken for storing of material or any damage or liability arising out of such arrangement.

b) Treatment of Minor GALVANIZING Damage

In case any minor damage to GALVANIZING is noticed, the same shall be treated with zinc rich paint (commercial grade) (having at least 90% zinc content) before erection.

c) Assembly

The method followed for the erection of monopoles, shall ensure the points mentioned below:

(a) Straining of the members shall not be permitted for bringing them into position. Such a design that the seat is semi-circular and larger than the diameter of the conductor/earthwire and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

The running blocks shall be suspended in a manner to suit the design of the cross arm. All running blocks, especially those at the tension end, will be fitted on the cross-arm 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. In case suspension, or section monopoles are used even for temporary terminations, if this be unavoidable, they shall be well guyed and steps shall be taken by the Business Associate to avoid damage. Guying proposal along with necessary calculations shall be submitted by the Business Associate to RECPDCL for the approval. Proper T&P shall also be made available to the RECPDCL by the Business Associate for checking the tensions in the guy wires. The drums shall be provided with a suitable braking device to avoid damages, loose running out and kinking of the conductor. The conductor shall be continuously observed for loose or broken strands or any other damage. When approaching end of a drum length, at least three coils shall be left when the stringing operations are to be 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 recommendations of the OEMs.

Repairs to conductors, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface shall be done only in case of minor damage, scuff marks etc. keeping in view both electrical and mechanical safe requirements. The final conductor surface shall be clean smooth and without any projections, sharp points, cuts, abrasions etc.

Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The Business Associate shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard. Derricks shall be used where roads, rivers, channels, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shut down shall be obtained when working at crossing of overhead power lines. The Business Associate shall be entirely responsible for the proper handling of the conductor, earthwire and accessories in the field.

The sequence of running out shall be from top to downwards i.e. the earthwire shall be run out first, followed by the conductors in succession. Unbalances of loads on monopoles shall be avoided as far as possible.

The proposed transmission line may run parallel for certain distance with the existing Transmission lines, which may remain, energised during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwires which although comparatively small during normal operations can be severe during switching.

It shall be the Business Associate's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.

All the expenditure on account of the above work is deemed to be included in the bid price and no extra payment shall be made for the same.

g) STRINGING OF CONDUCTOR AND EARTHWIRE

The stringing of the conductor shall be done by standard stringing method.

After being pulled, the conductor/earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

The stringing of Conductor shall be done as per initial stringing chart provided by the RECPDCL.

h) JOINTING

All the joints on the conductor and earthwire shall be compression type, in accordance with the recommendations of the MANUFACTURE for which all necessary tools and equipment like compressors, dies, processes etc. shall have to be arranged by the Business Associate. Each part of the joint shall be cleaned by wire brush to make it free from rust or dirt etc. and properly greased with anti-corrosive compound if required, and as recommended by the Business Associate before the final compression is done with the compressors.

All joints or splices shall be made at least 30 metres away from the structures. No joints or splices shall be made in spans crossing over main roads, Railways, small rivers with tension spans. 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 pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothed.

During stringing of conductor to avoid any damage to the joint, the Business Associate shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint alongwith protection can be passed over it smoothly.

I) Sagging-in-Operation

The conductor shall be pulled upto the desired sag and left in running blocks for atleast one hour after which the sag shall be re-checked and adjusted, if necessary before transferring the conductors from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in. The sag will be checked in the first and the last span of the section in case of sections upto eight spans and in one intermediate span also 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. 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.

At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, the conductor and earthwire shall be checked on the running blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the conductor is clamped.

Tensioning and sagging operations shall be carried out in calm weather when rapid changes in temperatures are not likely to occur.

j) Tensioning and Sagging of Conductors and Earthwire

The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the monopoles through the earthwire clamps for the earthwire and insulator strings for the conductor. The 'Initial' stringing chart shall be used for the conductor and 'final' stringing chart for earthwire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.

k) Clipping In

Clipping of the conductors in position shall be done in accordance with the recommendations of the MANUFACTURE. Conductor shall be fitted with Preformed Armor Rods where it is made to pass through suspension clamps.

The jumpers at the section and angle monopoles shall be formed to parabolic shape to ensure maximum clearance requirements.

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

l) Fixing of Conductor and Earthwire Accessories

Vibration dampers for conductor & earthwire and other conductor & earthwire accessories which are in bidder's scope of supply, shall be installed by the Business Associate as per the design requirement and respective MANUFACTURE's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.

m) Replacement

If any replacements are to be effected after stringing and tensioning or during maintenance, monopole members / sections shall not be removed without reducing the tension on the monopole with proper guying or releasing the conductor. If the replacement of cross arms becomes necessary after stringing, the conductor shall be suitably tied to the monopole at tension points or transferred to suitable roller pulleys at suspension points.

The quantity of conductor and earthwire shall be worked out and provided as per following norms.

(a) Quantity of Conductor = Line length as per detailed / check survey x No. of phases (3) x No. of circuits.

(b) Quantity of Earthwire = line length as per detailed / check survey.

For other line materials, i.e. Disc Insulators, Hardware and Accessories for Conductor and Earthwire, the actual quantity incorporated on transmission line shall be made available.

The Business Associate shall be required to return to the RECPDCL empty Conductor and Earthwire drums and other such material to RECPDCL. Wastage of 1% will be allowed on Conductor & Earth Wire for stringing & sagging.

8.0 TESTS

8.1 General:

All standard tests, including quality control tests in accordance with relevant IS / ASTM / ASCE shall be carried out. The black monopole of each type shall be subjected to design and destruction tests by applying tests equivalent to the specified maximum, in manner approved by the purchaser (i.e RECPDCL). The monopoles shall withstand these tests without showing any sign of failure or permanent distortion in any part. Thereafter the monopoles may be subjected to destruction by increasing the loads further in an approved manner till they fail. *No part of any monopole subject to test shall be allowed to be used in the work. The price will be quoted after allowing rebate for the scrap value for the monopole material which will be retained by the supplier.* **Poles shall be tested at Government approved third party testing facility only.**

In case of premature failure, the monopoles shall be retested. The supplier shall provide facilities to the owner or their representatives for inspection of materials during manufacturing stage and also during testing of the same.

The supplier shall submit documents for approval, proposal for testing monopoles showing the methods of carrying out the tests and manner of applying the test loads. After the owner has approved the test procedures and program, the Business Associate will intimate the owner about carrying out of the tests at least 10 day in advance of the scheduled date of tests during which the owner will arrange to depute his representative to be present at the time of carrying out the tests. Six copies of the test reports shall be supplied.

8.2 MONOPOLE TESTING PROCEDURE

A) Each type of monopole to be tested shall be a full scale proto type black monopole and shall be erected vertically on rigid. The monopole erected on test bed shall not be out of plumb by more than 1 in 360.

B) CALIBRATION OF MEASURING INSTRUMENTS

All measuring instruments shall be calibrated in systematic manner with the help of Universal Testing Machine or by standard weights. In case the calibration is done with the use of UTM, the UTM shall be periodically (once in every six months) calibrated by an external third party. The calibration shall, before commencing the test on each monopole be done up to the maximum anticipated load to be applied during testing. Calibration curves for the instruments shall be drawn and the test load be corrected accordingly.

8.3 LOAD AND DEFLECTION MEASUREMENTS

All loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided, the same shall be measured by means of standards weights and accounted for in the test loads.

Monopole deflections under load shall be measured by suitable procedure at the top cross arm level on the front sides of the transverse faces. Deflection readings shall be recorded for the before load, 'load on' and 'load off' conditions.

8.4 TESTING PROCEDURE DETAILS:

The testing procedures shall be in accordance with the relevant ISS / ASTM / ASCE codes & standards.

8.4.1 SEQUENCE OF TEST LOADING CASES:

Sequence of test loading cases shall be pre-determined. The choice of the test sequence shall largely depend upon simplification of the operations necessary for carrying out the test program.

8.4.2 DETAILS OF TESTS:

Test 1 : (Broken wire Condition) Security and Safety Conditions as well as Anti cascade condition.

Under this conditions (all conditions involving longitudinal loads in addition to the transverse and vertical loads) all the transverse and vertical loads are first increased to about 100%. Longitudinal loads are then increased in steps of 50%- 75%-90%-95% of the ultimate loads. At all stages of loading it shall be ensured that the transverse and vertical loads are not less than the values for corresponding step of the longitudinal load. At each step the loads are maintained for two minute and the deflections are noted. All loads are then increased to 100%. At this final 100% loading stage, monopole is observed for 5 minutes and deflections are noted. The monopole is required to withstand these loads without showing any failure. After every test the loads are brought down and deflection readings are taken for no load condition.

Test 2 : (Normal Condition) Reliability Condition :

These loads are applied as far as possible simultaneously at all points in steps of 50-75-90-95%. The waiting period of two minute shall be maintained at each step. The waiting period at the final 100% loading stage shall be 5 minute. Throughout the process of loading under all tests, the monopole shall be closely observed for any visual sign of deformation. Whenever, such deformation is observed, the loads shall be brought down and remedial measures shall be taken.

Test 3 : Destruction Test :

In continuation to test 2, after the final waiting period, the transverse loads only are increase in step of 5% till the failure occurs. The point of failure is detected from the sudden drop of load indication in the instrument dials in the Control Room.

8.4.3 SPECIAL REQUIREMENTS

i) The test monopole shall be black made up of Steel conforming to IS-2062 (Grade E-350 B0) (latest amendment).

ii) During the process of monopole test, when a number of tests have been completed satisfactorily and a failure occurs as a subsequent test, the design reviewed will be and monopole will be reinforced with a member of higher strength as required. The reinforced monopole will be put to test again and subjected to balance tests, unless the failure is of major nature, which will require all the tests to be repeated, or as mutually agreed between the Purchaser and the Supplier.

iii) Application of Loads on test monopole: As considered in design.

8.4.4 CHECK FOR MECHANICAL STENGTH OF MONOPOLE

The structure is considered to be satisfactory if it is able to support the specified ultimate loads

for 5 minutes as stipulated in 4.4.3 with no visible local deformation after unloading (such as bowing, buckling) and no breakages of elements of constituent parts.

The Contractor shall furnish six (6) copies of a test report in English Language and that shall include;

- a. The designation and description of the pole tested;
- b. The name "RECPDCL";
- c. The name of the person or organization (responsible engineer) that specified the loading, electrical clearances, technical requirements and general arrangement of the prototype;
- d. The name of the Engineer of Record;
- e. The name of the Manufacturer;
- f. A brief description and the location of the test facilities;
- g. The names and affiliations of the test witnesses;
- h. The dates of each test load case;
- i. Design and detail drawings of the pole, including any changes made during the testing program;
- j. A rigging diagram with details of the points of attachment to the pole;
- k. Calibration records of the load-measuring devices;
- l. A loading diagram for each load case tested;
- m. A tabulation of deflections for each load case tested;
- n. In case of failure:
 - Photographs of failure;
 - Loads at the time of failure;
 - brief description of the failure;
 - The remedial action taken;
 - The dimension of the failed members; and
 - Test coupon reports of failed members;
- o. Photographs of the overall testing arrangement and rigging;
- p. Air temperature, wind speed and direction, any precipitation and any other pertinent meteorological data;
- q. Mill test reports of poles used in the test report;

r. Test result of the test coupons taken following the completion of test.

9.0 TYPE TESTS CERTIFICATES

The bidder shall furnish the type test certificates for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at CPRI / ERDA as per the relevant standards. Type test should have been conducted in certified Test Laboratories during the period not exceeding 5 years from the date of opening the bid. In the event of any discrepancy in the test reports i.e. any test report not acceptable or any/all type tests (including additional type tests, if any) not carried out, same shall be carried out without any cost implication to RECPDCL/CED

10.0 PRE-DESPATCH INSPECTION

Equipment shall be subject to inspection by a duly authorized representative of the Purchaser. Inspection may be made at any stage of MANUFACTURE at the option of the purchaser and the equipment if found unsatisfactory as to workmanship or material is liable to rejection. The bidder shall grant free access to the places of MANUFACTURE to the Purchaser's representatives at all times when the work is in progress. Inspection by the Purchaser or its authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by the Purchaser.

Each component shall be inspected for conformance to the fabrication drawings. This inspection shall include, but not limited to:

- a) Ultrasonic inspection of base plate more than 50mm thick prior to welding for laminations.
- b) Visual inspection of dimensions to assure that tolerances are met.
- c) visual inspection of cut edges to ANSI/AWS D.1.1 criteria.
- d) visual inspection of bent surfaces for surface separations(supplemented by magnetic particle in questionable areas);
- e) visual inspection of bolt holes to assure that they are cylindrical, perpendicular, free of burrs and without torn or ragged edges;
- f) visual inspection of all welds to ANSIIAWS 01.1 Section 8 criteria;
- g) ultrasonic inspection of all full penetration welds
- h) ultrasonic inspection of shaft to base plate weld after galvanizing for base plate thicker than 50mm (maybe waived if routine audits show no history of defects);
- i) visual inspection of all structural partial penetration or fillet welds, in questionable area use magnetic particle inspection according to ANSI/AWS D1.1 Section 8 criteria;
- j) visual inspection of finish;

k) magnetic thickness measurement of finish coatings.

Following documents shall be sent along with material

- a) Test reports
- b) MDCC issued by RECPDCL
- c) Invoice in duplicate
- d) Packing list
- e) Drawings & catalogue
- f) Guarantee / Warrantee card
- g) Delivery Challan
- h) Other Documents (as applicable)

10.0 INSPECTION AFTER RECEIPT AT STORES

The material received at the Purchaser's store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.

11.0 GUARANTEE

Bidder shall stand guarantee towards design, materials, workmanship & quality of process / manufacturing of items under this contract for due and intended performance of the same, as an integrated product delivered under this contract. In the event any defect is found by the Purchaser up to a period of at least 60 months from the date of commissioning or 66 months from the date of last supplies made under the contract whichever is later, Bidder shall be liable to undertake to replace/rectify such defects at its own costs, within mutually agreed time frame, and to the entire satisfaction of the Purchaser, failing which the Purchaser will be at liberty to get it replaced/rectified at Bidder's risks and costs and recover all such expenses plus the Purchaser's own charges (@ 20% of expenses incurred), from the Bidder or from the " Security cum Performance Deposit" as the case may be.

Bidder shall further be responsible for 'free replacement' for another period of THREE years from the end of the guarantee period for any 'Latent Defects' if noticed and reported by the Purchaser.

12.0 PACKING

Bidder shall ensure that all equipment covered under this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner as to protect it from damage in transit.

13.0 TENDER SAMPLE

Not Applicable

14.0 QUALITY CONTROL

The bidder shall submit with the offer, Quality assurance plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during MANUFACTURE and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's engineer or its

nominated representative shall have free access to the OEM/sub-supplier's works to carry out inspections.

15.0 MINIMUM TESTING FACILITIES

Bidder shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant International / Indian standards.

16.0 DRAWINGS AND MANUFACTURING FACILITIES

Drawings & Data

a) Drawings & Data to be submitted by the bidder :

i. Fully dimensioned line diagram along with electrical clearance of each monopole including Dimensioned line diagrams of extension.

ii. Various loadings calculated for evolving monopole design in a tabulated form for NC & BW condition for every condition of design. iii. Sag tension calculation in tabulated form.

iv. Loading diagram/Tree for all monopoles under different working condition.

v. Dimensioned drawing of Anti climb devices.

vi. Plate / rolled sheet sections to be used.

vii. Foundation design calculations & fully dimensioned line diagrams.

b) Drawings & Data to be submitted on award of contract:

i) Detailed design calculations based on the complete analysis by space frame method alongwith analytical method.

ii) Tabulation of stresses under different conditions & calculations for maximum permissible stresses for various members / sections employed in the monopoles & cross arms complete with the following information:

a) Member reference for identification on diagrams and calculations.

b) Aggregate loads, compressive and tensile with factors of safety, based on loadings specified under different conditions.

c) Permissible crippling load.

d) Number & size (s) of bolt(s) provided.

e) Net Area of section.

f) Permissible tensile load.

g) Aggregate cross-sectional area of bolts.

h) Shearing stress on bolts

i) Bearing stress on bolts.

iii) Detailed design calculations & detailed drawings of the foundations.

Erection drawings shall be furnished in respect of each type of monopole and shall show assembled diagram of structures, clearly indicating the position of each member and the quantity and the size of bolt for each joint.

Foundation drawings shall be furnished in respect of each type of monopole giving all the relevant details about steel , concrete , foundation bolts & base plate etc.

ii) Bill of material:

Complete B.O.M. for each type of monopole shall be submitted with the erection drawings indicating each part number, quantities required for one monopole, section thickness, length, calculated weight, fabrication process done on each member / section and relevant design drawing reference. The BOM shall also include the list of accessories required to complete the structure.

iii) Bolt & Washer schedule:

Bolts & washers schedule shall list the number of bolts and washers required per monopole, along with the sizes and lengths of bolts and number, type of size of washers.

iv) The designer shall also prepare a sag template for max. span lengths of 200 m & 300 m showing the

sag curve of conductor for 75⁰C nil wind condition and -2.5⁰ C and 36% of full wind condition condition after considering drag and gust response factor for 0.25sq. inch ACSR Zebra with ruling span of 150m and similar curve for 7/20.24mm GSS Wire. In case of GSS Wire the max. temperature to be considered in 75 deg C. These shall be given on reproducible paper/tracing.

The stringing charts i.e. Sag Vs Span, tension Vs span charts for different temperatures varying from 15⁰C to 75⁰C in steps of 5 C for use of stringing of ACSR Zebra Conductor. These are also to be given on reproducible paper/Tracing.

vii) The monopole spotting charts for both types of monopoles on ACSR Zebra Conductor are to be furnished.

iii) STRUCTURAL DRAWINGS:

Provisional Structural Drawings and bill of material of each type of monopole shall be furnished.

C) After Monopole Testing:

After the successful monopole testing the following details/drawings have to be submitted for approval:

i) Erection drawing/structural Drawings:

The successful bidder will have to submit the bar chart for various manufacturing activities clearly elaborating each stage, with quantity. This bar chart should be in line with the Quality assurance plan submitted with the offer. This bar chart will have to be submitted within 15 days from the release of the order.

17.0 GUARANTEED TECHNICAL PARTICULARS

B2.5.1 BIDDER'S / CONTRACTOR'S GUARANTEED DATA – MINIMUM REQUIREMENTS	Unit	Data offered for poles
Description		
General		
System highest voltage for equipment / power frequency	kV / Hz	72.5/50
Nominal voltage	kV	66
Rated lightning impulse withstand voltage (peak)	kV, peak	325
Rated short duration power frequency withstand voltage	kV, r.m.s.	170
System neutral	-	Solid Earth
System highest 3-phase short-circuit current level (3s)	kA	31.5
Short circuit current for thermal stability check of the OPGW (1s)	kA	31.5
Specific insulation creepage distance based on system highest phase to phase voltage for equipment, min.:	mm/kV	
Radio noise limit for radio interference testing of insulator sets, fittings, etc.	dB above 1μV	
Corrosion protection measures:		
Galvanizing for steel sections, fittings, etc.	μm	
Galvanizing of bolts, nuts & washers	μm	
Conductor	-	
Earthwire & OPGW	-	
Main Design Parameters		
Maximum ambient air temperature	°C	
Minimum ambient air temperature	°C	
Maximum conductor temperature	°C	
Minimum conductor temperature	°C	
Every day temperature	°C	
Temperature with maximum wind	°C	
Design wind speed in 10 m height (Vp) (3s peak wind, once in 50 years, terrain category II)	m/s	
Lines Data		
Number of circuits	-	
Number of conductors per phase	-	
Number of OPGW	-	
Number of earthwire	-	

Types of Poles		
Normal Suspension		
Angle of deviation	°	
Type of insulator sets	-	
Wind span	m	
Weight span	m	
Light Angle Tension		
Angle of deviation	°	
Type of insulator sets	-	
Wind span	m	
Weight span	m	
Main Design Data		
Minimum partial factors		
Partial factors for actions (γ_F)		
Deadweight γ_G		
Wind $\gamma_{W,N}$ for normal conditions		
Conductor tension $\gamma_{C,N}$ for normal conditions		
Conductor tension $\gamma_{C,E}$ for exceptional conditions		
Erection/ maintenance loads γ_P		
Partial material factors (M)		
Steel poles cross section areas		
Steel poles net section areas at bolt holes		
Support bolts		
Reinforcing steel for concrete foundations		
Foundation in-situ concrete structure		
Soil property		
Conductors for maximum wind load		
Conductors for every day conditions		
Insulators for normal conditions		
Insulators for exceptional conditions		
Fittings for normal conditions		
Fittings for exceptional conditions		
Clearances		
Minimum Vertical Clearances		
• Minimum vertical clearances from the line conductors at maximum sag to ground or for various crossings:		
Normal ground	m	
Ground in populated areas	m	
Roads and streets	m	
Trees which cannot be climbed	m	
Trees which can be climbed	m	
To residential or other buildings	m	
To roofs of non-residential buildings which can be climbed	m	
To roofs of non-residential buildings which cannot be climbed	m	
Minimum Horizontal Clearances		
Roadside (sidewalk of paved roads)	m	
Roadside of unpaved roads - depending on area	m	

Railway track axis	m	
Parallel running power lines (lattice steel structure)	m	
Parallel running power lines (poles)	m	
Pipelines	m	
Mid-span clearances		
Mid-span phase to phase clearance for horizontal phase arrangement	m	
Mid-span phase to phase clearance for quasi-vertical phase arrangement	m	
Mid-span phase to OPGW clearance for quasi-vertical wire phase arrangement	m	
Minimum clearances between conductors / live fittings and tower steel structure		
Between conductors under still air condition (Dpp)	m	
Clearance between live parts and earthed tower parts in still air (Del)	m	
Clearance between live parts and earthed tower parts for 3 years wind (58 % of maximum wind on conductor)	m	
Clearance under swung insulator string due to maximum wind on conductor	m	
Clearance condition for earthwire/ OPGW		
EW/ OPGW sag, compared to the conductor sag at every day temperature, for the nominal span	-	
shielding angle	(°)	
Foundations		
Soil Data (for Bidding only)		
The foundations will be designed on the basis of the soil investigations performed by the Contractor. As soil investigations are under progress now, the bid shall be based on the soil characteristics given below for the time being.		
Class 1 – Hard rock		
Density	kN/m ³	
Soil pressure	kN/m ²	
Shear friction resistance	kN/m ²	
Class 2 – Soft rock		
Density	kN/m ³	
Soil pressure	kN/m ²	
Angle of frustum	[°]	
Class 3 – Good Soil		
Density	kN/m ³	
Soil pressure	kN/m ²	
Angle of frustum	[°]	
Class 4 – Poor Soil, no Water		

•Gusset plates	mm	
Minimum angle bars: equal angle sections		
unequal angle sections		
Maximum length of structural member	m	
Tolerances of finished members of lattice towers:		
•Max. lateral variations of actual length between points of lateral supports		
•Finished members without ends finished for contact bearing		
- Members up to 3m length	mm	
- Members greater than 3m length		
- 3m to 6m	mm	
- greater than 6m	mm	
Tolerances for poles:	-	
Double Circuit Normal Suspension Tower 2NS		
Specific data:		
Design spans:		
Wind span	m	
Weight span max.	m	
Maximum span	m	
Minimum ratio weight to wind span for clearance check	-	
•Total weight of tower structures including 4 (four) legs and 4(four) stubs for following tower configurations:		
•Basic /normal height tower ± 0	kg	
Double Circuit Light Angle Tension Tower 2LA		
Specific data:		
•Design spans & Line angle:		
Wind span	m	
Weight span	m	
Maximum span	m	
Line angle	(°)	
Steel poles		
Double Circuit Normal Suspension Pole 2NSp		
Specific data:		
•Design spans:		
Wind span	m	
Weight span max.	m	
Maximum span	m	
•Total weight of pole for following configurations:		
•Basic /normal height ± 0	kg	
Double Circuit Light Angle Tension Pole 2LA _p		
Specific data:		
•Design spans & Line angle:		
Wind span	m	
Weight span	m	

Maximum span	m	
Line angle	(°)	
·Total weight of pole for following configurations:		During Detail Engineering
·Basic /normal height tower ± 0	kg	