SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

TOWER PARTS (MS)

APPLICABLE TO KSEBL	**Rev#0**	DOC. NO.: **SCM-SPEC/XT/ Tower**
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Technical Specification and Evaluation Committee for Transmission Material

(i) Document Approval & Control Status

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Date	09/12/21	09/12/21	09/12/21
Signature	**Sd/-**	**Sd/-**	**Sd/-**

(ii) Amendments and History

Sec. #	*Rev. #*	*Date*	*History of Change*

1. PURPOSE:

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **Tower Parts (MS)** in a professional manner

2. SCOPE:

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL. Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **Tower Parts (MS)** used in field by KSEBL

3. RESPONSIBILITY:

The Executive Engineer (T), Office of Chief Engineer, Supply Chain Management shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions

4. PROCEDURE FOR REVISION:

Modifications if any, in the technical specification will be incorporated as **Revisions.** Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev. No.0.1, 0.2 etc.**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev. No.1.0, 2.0 etc.**

All the details of regarding the revisions (both minor and major) will be incorporated in **"(ii)-Amendments and history"** above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer (SCM).** Those who notice any discrepancy or have any suggestion regarding revision, may bring the matter to the attention of Chief Engineer (SCM) in writing or through e-mail id:**cescm@kseb.in**

CONTENTS

TECHNICAL SPECIFICATION FOR THE SUPPLY OF TOWERS (MS) FOR 220KV & 110kV TRANSMISSION LINES

1) **Nature of work:-** The work covered by this specification is design, manufacture, galvanizing, fabrication, testing/inspection, and supply of 220kV & 110kV towers (MS) suitable for "ACSR Moose / Kundah / Wolf" conductor including hot dip galvanized bolts, nuts, earthing sets and all required accessories. The supply shall be as per the schedule of requirement and according to the latest edition of the following standards (as mentioned up-to-date) except where otherwise specified in the specification.

1.	Specification for zinc	IS : 209-1992
2.	Code of practice for use of structural steel in general Building Construction.	IS : 800-1991
3.	Hexagon head bolts, screws and nuts of product grade 'C'.	IS : 1363-1992 . (Part 3)
4.	Technical supply conditions for threaded fasteners (First Revision)	IS : 1367-1992
5.	Plain washers	IS : 2016-1992
6.	Mild Steel for general structural purposes Specification.	IS : 2062-1999
7.	Recommended practice for hot-dip galvanizing of iron and steel.	IS : 2629-1990
8.	Methods of testing weight thickness and uniformity of coating on hot-dip galvanized articles.	IS : 2633-1992
9.	Single Coil Rectangular Section spring washers for bolts, nuts, screws.	IS : 2063-1972

10.	Specification for hot-dip zinc containing on structural steel and other allied products.	IS : 4759-1990
11.	Specification for hot-dip galvanised coating on fasteners.	IS :5358-1969
12.	Code of practice for design, installation and maintenance of overhead power lines.	IS : 5613-1976
13.	Heavy washers for steel structures.	IS : 6610-1991
14.	Hexagonal bolts for steel structures.	IS : 6639-1972
15.	Methods for determination of weight of zinc coating of zinc coated iron and steel articles.	IS : 6745-1972
16.	Transmission Tower bolts of property class 5.6.	IS : 12427-1992
17.	Specification for weldable structural steel (Medium & High strength quality)	IS :8500 – 1992
18.	Galvanized steel barbed wire	IS:278 -1991
19.	Code of practice for use of Structural steel in overhead Transmission line towers - Material, Loads & stress, Fabrication, Inspection, Packing & Testing	IS:802
20.	Dimensions for Hot Rolled Steel	IS:808 -1991
21.	Rolling & Cutting Tolerance for Hot Rolled Steel products	IS: 1852-1993
22.	Code of practice for earthing	IS:3043-1991
23.	High Strength Structural bolts	IS:3757-1992
24.	High Strength Structural nuts	IS:6623-1992
25.	Measures relating to safety and electric supply Regulations, 2010	

26.	Regulation for Electrical Crossing of Railway Tracks.	

2) **General particulars of the system:-** Electricity is generated at a number of power stations on three phase A.C.System at a frequency of 50Hz and are transmitted by a number of transmission lines interconnecting substations of voltage 400kV, 220kV, 110kV & 66kV and then distributed through 11kV lines. The system is effectively earthed.

3) **Extent of work:-** The work included are as follows:

The design , manufacture, fabrication, galvanizing, fabrication, testing & inspection of towers (MS) and all accessories as per drawing, furnished by KSEB Limited. Galvanizing and delivery at specified destination in accordance with this specification and the conditions of contract using supplier's steel at the prices stated in the Part-III of the tender specification (Quality of steel and galvanizing should be as per the relevant Indian standards). The towers mentioned in the schedule of requirement includes the supply of stub and cleat, super structure, extension, step bolts, HDG Bolt & Nut, Earthing sets and other accessories such as U-Bolt, D-shackle, anti climbing device including barbed wire, bird guard, Number plate, Phase plate, Danger-plate, Circuit plate, Washers Strain plate/ extension link/ hanger etc. (as required for each type of towers/Drawings attached). Bolts and Nuts required for the Number, Danger and Phase plates are also to be supplied. The tower shall be of fully galvanized structure. The most efficient grade of structural steel angle section and plates (as per IS: 2062 Grade-A & IS:8500 Grade Fe490B) shall be used in order to yield the lowest combined tower and foundation cost. The type and grade of steel shall conform to latest applicable National/International standards.

4) **Completeness of Contract**:- All fittings, accessories or apparatus which may not have been specifically mentioned in this specification but which are essential and necessary for the fulfillment of the contract shall be deemed to be included in this contract and shall be provided by the contractor without any extra cost.

5) **Inspection and Testing**:- The materials covered by the specification will be subject to inspection and quality control by the representatives of the KSEB Limited, if desired, during the course of manufacturing and shall conform to specifications in as clause 1.

6) **Drawings**:- After award of the contract, one copy of the KSEBL adopted standard structural drawings of the Towers, Extensions and accessories with Bill of materials will be issued to the contractor for necessary action. See clause (31) for more details.

7) **Standard specifications**:- The contract work shall comply with the relevant Indian standard specifications. In the absence of relevant Indian Standard Specifications the relevant British standard specification shall be followed.

8) **General Design:-** The towers are designed to carry the Transmission line conductors with necessary insulators, earth conductors and all fittings under all loading conditions and factors of safety and will generally conform to the outlines shown in the specification. The dimensions, disposition and methods of connections of tower members are shown in the general arrangement drawing etc. which will be issued to the supplier. Tower accessories such as hanger, D shackle, strain plate, extension link etc. required for attachment of suspension, pilot suspension and tension hardware of conductor and earth wire shall be designed by the supplier and shall be submitted for approval to KSEB Limited before procurement / fabrication of the same. Design and supply of hanger, D shackle, strain plate, extension link etc. are also in the scope of supplier and any other item which is not specified in this specification but required for successful completion of the line work shall be deemed to be considered in scope of the supplier. A strain plate is to be provided on the tension towers for the attachment of the tension insulator strings to the cross arm. For the attachment of suspension insulator strings, swinging hangers or droppers of adequate strength are to be provided on the suspension towers. The droppers or hangers shall be free to swing in the longitudinal direction but rigid in the transverse direction. The earth conductor is to be attached to each tower by means of

suspension or tension clamps of approved design. Suspension clamps are to be used on towers with suspension insulator strings and tension clamps on the others. On tension towers, tension clamps are to be provided at the top of either side and the earth conductor terminated on either side shall be connected together by means of jumper clamps. All the suspension and tension clamps for earth conductor have to be electrically binded to the tower. Necessary provision shall be made on the towers for the attachment of the suspension and tension clamps for the earth conductor. The towers are to be fabricated of good quality rolled steel sections as per the standards and the technical requirements and all joints shall be of bolted type.

9) **The towers are of the types shown below:**-

Sl.No.	Type of Towers	Tension / Suspension	Angle of deviation	Type of Insulators
1	110kV DC D3	Suspension	0^0-30	70kN
2	110kV DC D30	Tension	30-30^0	90kN
3	110kV DC D60	Tension /Dead End	30^0-60^0	90kN
4	110kV MC M3	Suspension	0^0-30	70kN
5	110kV MC M30	Tension	30-30^0	90kN
6	110kV MC M60	Tension /Dead End	30^0-60^0	90kN
7	220kV DC P	Suspension	0^0-20	90kN
8	220kV DC Q	Tension	20-15^0	120kN
9	220kV DC R	Tension	15^0-30^0	120kN
10	220kV DC S	Tension /Dead End	30^0-60^0	120kN
11	220 kV MC Z	Tension	30^0-60^0	120kN

10) i) **Peak:-** It is the portion of tower above the top cross arm in case of vertical configuration tower and above the boom in case of horizontal configuration tower. The function of the peak is to support the ground wire in suspension clamp and tension clamp at

suspension and angle tower location respectively. The height of the Peak depends upon specified angle of shield and mid span clearance.

ii) **Cage:-** cage is the portion between peak and tower body in vertical configuration towers. The cross section of the cage is generally square and it may be uniform or tapered throughout its height depending up on loads. It comprises tower legs interconnected by bracing used in the panel of cage where cross arms are connected to the cage or where slope changes for proper distribution of torsion.

iii) **Cross-arm:-** The function of a cross-arm in case of vertical configuration towers is to support conductor /ground wire. The function of a cross arm depends upon number of circuits, tower configuration and conductor / ground wire arrangement. The cross arm for ground wire and conductor consists of fabricated steel work. The dimension of cross arm depends up on the line voltage, type and configuration of insulator string, minimum framing angle from the requirement of mechanical stress distribution etc.

iv) **Tower Body:-** It is the main portion of the tower for connecting cage to the tower foundation or body extension or leg extension.

v) **Tower extension:-** It is used to increase the height of tower with a view to obtaining the required minimum ground clearance over road crossings, river crossings, ground obstacles etc.

vi) **Angle of Shielding:-** The angle of shielding is defined as the angle formed by the line joining the centre lines of the earth wire and outer power conductor, in still air, at tower supports, to the vertical line through the centre line of the earth wire. The tower is designed in such a way that the angle of shielding does not exceed 30^0. The angle of shield, which is governed by the height of tower and adopted for various voltage transmission lines in India, is given:

Line Voltage(KV) Highest System	72kV	145kV	245kV	420kV
Angle of shield of Earthwire degree	30	30	30	20

11) **Earthing of towers**:- Each tower of the transmission line is to be efficiently earthed by means of a 50mm inner dia galvanized iron pipe 2.85 meters in length buried with top end of the pipe not less than 500mm below normal ground level. The towers are dual earthed and the pipes are to be electrically connected to one of the tower legs by a GI strip of size 50x6mm at either ends (Drawings attached). The supply of earthing sets are the part of this contract.

12) **Construction:-** The fabrication works shall conform to approved standards as clause-1 . Where lap splices are used to back of the inside angle shall be chambered to fit in the fillet of the outside angle. Log splices shall be located near strut connection but clear of the strut. Joints shall be so designed and detailed as to avoid eccentricity as far as possible. Gusset plates and spacer plates shall be used in conformity with modern practice. The structure shall be constructed to facilitate their being bolted together easily at site. Pockets and recesses likely to hold water, shall be avoided. Holes necessary for providing earthing connections shall be provided on each leg of every tower above the top of the concrete muffing. No bolt hole shall be more than 2mm larger in diameter than the corresponding bolt.

13) **Bolts, Nuts and Washers:-** Bolt & Nut should be Hot dip galvanized shall confirm to IS 12427/1988,IS 6639/1972&IS1368(Part 3)/1984 & Spring washers should be Electro galvanized.

The minimum diameter of the bolt used shall be 16mm unless otherwise approved. Supply of HDG bolts and nuts for the Towers are the part of the scope of this contract. There shall be no bolt holes on faces of angles less than 45mm wide. No bolt shall connect aggregate thickness of more than three times its diameter. Assembled towers, shall have bolt heads on the outer surface of towers and nuts on the inside. For horizontal members the bolts should be

fixed with their heads at the top and nuts below. Bolts at a joint shall be so staggered that nuts can be tightened with spanners with out fouling. Welding is not permitted at any point on the tower.

14) **Materials:-** The steel required for fabrication of tower structure member, stub & stub setting template shall conform to IS: 2062 -1999 Grade A (Designated Yield Strength 250MPa) & IS: 8500(latest revision) Grade Fe 490 B(Designated Yield Strength 350MPa) as required. The zinc required for galvanizing shall be of Zn-99.95% and shall conform to IS: 209-1992. The bolts and nuts shall conform to above referred relevant standards. The bolts and nuts shall be of minimum class 5.6 & 5.0 respectively. The plain washers shall conform to IS:2016-1992. Heavy washers shall conform to IS:6610- 1991. Spring washers for bolts and nuts shall conform to IS:3063- 1994. All bolts and nuts shall have hexagonal heads. The heads, being forged out of the solid, truly concentric and square with the sha 490 Bnks, must be perfectly straight. Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend to the place of contact of the member. All bolts shall be threaded as per IS: 1363 (1992) to take full depth of the nut and shall be threaded enough to permit firm gripping of the member, but no further threaded portion of each bolt shall project through the nut at least 6mm when fully tightened. All nuts shall fit hand tight to the point where the shank, of the bolt connects to the head. Flat and tapered washers shall be provided where necessary. The diameter of bolts shall be 16mm and 20mm as per requirement. The thickness of spring washers shall be 2.5 mm, 3.5 mm and 4.5 mm respectively. Spring washers shall be provided under all nuts.

These washers shall be positive lock type electro galvanized. Each structure shall be provided with step-bolt of not less than 16mm diameter having length 175mm. The step-bolt shall be fixed on two diagonally opposite leg up to top of structure as indicated in approved drawing. Each step-bolt shall be provided with two nuts and one washer.

15) **Procurement of Steel-KSEB Limited Design and bidder's steel**: For Designing of towers, preferably rationalized steel sections shall be used. The supplier shall make necessary arrangements for the procurement of Best quality steel sections required (as per ISS and Technical requirements and standards for the proper and satisfactory performance of the Towers etc.) for the fabrication of towers, extension to towers etc as per the drawings furnished by the KSEB Limited from,SAIL,RINL,TATA steel Limited (TSL) JSW Steel Limited ,ESSAR Steel Limited ,Ispat Industries Limited, Jindal Steel & Power Limited or any approved make. The fabricated materials are to be delivered at the KSEB Limited's destination, Transmission Store, Angamaly or anywhere in Kerala as specified in the Purchase Order. The rates shall be quoted taking the above aspects also into consideration. The unloading is suppliers' liability.

16) **Weight and Cutting lists:-** After the award of contract the supplier shall furnish detailed cutting lists for the tower showing calculated weights as per tables for such items of the tower. For purpose of payments, the weight given in the cutting lists will form the basis. The increase in weight due to galvanizing will not be taken into account for payments. The weight of fabricated structures will be computed by applying the Standard sectional weight to the sizes shown in the approved cutting lists, not taking into account deductions for holes drilled, notches, level cuts etc or increase in weight due to galvanizing. Size of fabricated plates shall be taken as the smallest rectangle covering it, for purpose of calculating weight.

17) **Workmanship:-** All members shall be cut to jig. All holes on sections above 16mm thick shall be drilled and on sections less than 16mm thick punched to jig, but in all cases drilled holes will be preferred. All burns left by drill or punch shall be removed completely. The cutting, bending, drilling and punching of all fabricated steel work shall be carried out with care and of all accuracy in order to prevent inaccuracies which might cause difficulty in the erection of the towers at site. When the tower members are in position, the holes shall be truly opposite to each other before being bolted up. Drifting of holes shall be prevented. Similar parts shall be

made strictly interchangeable. All finished members shall be true and free from kinks, twists, rough edges and open joints and the materials shall not be defective or strained in any way.

The workmanship and finish shall be equal to the best modern practice for transmission line tower works. Materials which are slightly bent in transit or stacking shall be thoroughly straightened and made true in the shop by methods which will not impair their specified strength in any manner. The workmanship shall be subject to tests specified.

18) **Step Bolts: (Shall conform to IS.5613 Part II 1976,IS 10238/1982:-** Two diagonally opposite legs of each tower is to be provided with step bolts of not less than 16mm diameter, 175mm long and spaced at not more than 400mm center to centre, starting from about 2500 mm above ground level and continuing to the top of the tower. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower main member and a button head at the other end to prevent the foot from slipping and shall be capable of withstanding a vertical load of not less than 1.5 KN. The step bolt shall be of hexagonal head.

19) **Anti-climbing Device:-** Each tower shall be fitted with an anti-climbing device of approved design, arranged on the tower at approximately '3' metres height from ground level to have three circles of barbed wire in the form of an umbrella on the outside of the tower and a similar number inside the tower. Barbed wire for the anti-climbing device shall be supplied by the Bidder as scheduled Quantity as drawings approved. (IS.5613, Part-II, / Sec. 1-1976). The barbed wire shall conform to IS.278-1978. The barbed wire shall be given chromating dip as per procedure laid down in IS.1340-1959.

20) **Bird Guard:-** The suspension type of tower shall be fitted with guards of approved design to prevent birds perching on the cross arms immediately above the insulator strings. The bird guards shall be of horn type. The bird guard shall be fitted to the cross arm members in an approved manner. Bird Guards shall be supplied by the Bidder as scheduled Quantity as drawings approved.

21) **Danger Notice plates:-** Shall conform to IS.2551-1963. Size of the danger notice plate shall as per approved drawings. The plate shall be made from mild steel at least 2mm thick and vitreous enameled white with letters, figures and the conventional skull and bones in signal red colour on the front side. The rear side of the plate shall also be enameled. The corners of the danger plate shall be rounded off to remove sharp edges. The word Danger in English or Malayalam and also the voltage of the circuit shall be inscribed. Danger plates shall be supplied by the Bidder as scheduled Quantity as drawings approved.

22) **Phase plate:-** These shall be in sets of red, yellow & blue colours and shall conform to IS.5613/Part II/1976. Two sets of each consisting of 3 plates having red, blue and yellow colour shall be required for Double circuit line. The plate shall be of minimum 1.6mm thick mild steel sheet. Front and back of the plate shall be enameled. Front of each set shall be with colours red, yellow & blue and shall be enameled and back black enameled. Phase plates shall be supplied by the Bidder as scheduled Quantity as drawings approved.

23) **Number Plate:-** Shall conform to IS.5613 Part II/1976 lettering should be in red enameled on white background. The rear side of the plate shall be enameled black. The plate shall be minimum of 1.6mm thick mild steel sheet with a size of 200 x 150mm .The corners of the plate shall be rounded off to remove sharp edges. Number plates shall be supplied by the Bidder as scheduled Quantity as drawings approved.

24) **Circuit plate:**- Shall conform to IS.5613 / Part II/1976. The lettering should be in red enameled on white background. Rear side of the plate shall be enamelled black. The material of the plate shall be of mild steel having minimum thickness 1.6mm. Circuit plates shall be supplied by the Bidder as schuduled Quantity as drawings approved.

25) Insulator Strings and Earth wire Clamps Attachments:-

i) 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.

ii) 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 item shall be same rating/strength as that of as that of corresponding rating/ Ultimate tensile Strength of Insulator string.

iii) 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.

iv) 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.

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

i) The details of fabrication shall conform to IS.802 Part II 1978 or the relevant International standards in clause-1.

ii) Butt splices shall be used and the inside cleat angle and outside plate shall be designed to transmit the load. The inside cleat angle shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used for connecting members of unequal size and the inside angle of lap splice shall be rounded at the heal to fit the fillet of the outside angle. All splices shall develop full stress in the member connected through bolts. Butt as well as Lap splice shall be made as above and as close to the main panel point as possible.

iii) Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacer plates may be used in conformity with modern practices. Thickness of the gusset plates, required to transmit stress shall not be less than that of the members connected.

iv) The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.

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

vi) No angle member shall have the two leg flanges brought together by closing the angle.

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

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

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

x) **Drilling and Punching**:- 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. 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:-

1. Holes must be perfectly circular and no tolerances in this respect are permissible.
2. 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. 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.

27) **Quantities and weights:-** The quantities of the following items have been envisaged in Metric Ton (MT) under the category of Towers (MS) for various types of towers:

i) Basic Body

ii) Body Extensions.

iii) Leg Extension.

iv) Stubs & Cleats

v) Accessories

vi) Bolts & Nuts including spring washers and step bolts etc.

The manufacturing of the above items shall be taken up in such a manner that the Equipment/Material offered for inspection to KSEB Limited 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 KSEB Limited representative(s), Material Dispatch Clearance Certificate (MDCC) 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 despatched Panel wise as per mutually agreed procedure with KSEB Limited's representative for Quality Assurance & Inspection. 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, 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 and fasteners based on the unit rates incorporated in the contract.

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 KSEB Limited. The rate quoted by the bidder for tower/tower parts supply, is deemed to be inclusive of galvanising charges including the cost of zinc.

The supplier shall supply up to 2.5% extra fasteners to take care of losses during erection. No payment shall be admissible for these extra supplies.

28) **Erection marks:-** Before leaving the manufacturer's works all members shall be stamped with distinguishing number and / or letters corresponding to distinguishing number and / or letters on approved drawings. The distinguishing number and / or letters should also be neatly stenciled with black paint in addition to the stamping. The letters and numbers shall be of approved sizes. The erection marks shall be stamped before galvanizing and shall be clearly legible after galvanizing. The marking on the member shall be such that it shall be possible to distinguish the type of tower extension of which the member forms component.

29) Galvanizing:-

29.1. **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. Unless otherwise specified the fabricated tower parts and stubs shall have a minimum overall Zinc coating of 610 gms per sq. m of surface area except for plates & sections below 5mm which shall have Zinc coating of 460 gms 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. Under marine environment, as specifically mentioned in BPS the fabricated tower parts and stubs shall have a minimum overall zinc coating of 900 gms / sq m of surface area except for plates and sections below 5mm which shall have a minimum overall zinc coating of 610gms/ 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 2629-1985. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.

ii) **Pickling:-** Pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629 -1985. 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 or other comparable international standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminum alloy shall be added as per IS 2629.

vii) **Dipping Process:-** The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450+/ - 10 degree 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 degree 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 KSEB Limited for approval as part of Quality Assurance Plan.

29.2. **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.

30) Proto Assembly:-

i) The Bidders/ suppliers, who have not done the proto-assembly of the towers/ tower extensions or have not supplied the same towers / tower extensions against any earlier projects of KSEB Limited, shall arrange one number proto assembly for each type of tower and extension and offer the proto type of each tower/ tower extension for inspection before taking up mass fabrication. KSEB Limited reserves the right to get the same witnessed by their representative. After proto-assembly, the supplier 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 proto corrected drawing/documents shall be submitted for final approval by KSEB Limited. After obtaining proto type approval of towers/ tower

extension, the supplier shall commence the mass production of each tower/ tower extension/ stub and offer again the items for mass quantity inspection. This mass quantity inspection approval is required for issuing the Material Despatch Clearance Certificate (MDCC).

ii) The bidders/ suppliers who have already done the proto-assembly of the towers / tower extensions or have supplied the same towers / tower extensions against any earlier projects of KSEB Limited, 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 previously approved structural drawings and BOM of tower / tower extensions after endorsing the projects name for further distribution by KSEB Limited.

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 supplier/contractor. Any defect, if found during erection at site, the same has to be rectified by the contractor without any additional financial implication to KSEB Limited.

31) **Design and Drawings:-** The relevant drawings for all tendered items (Towers, Extensions, Accessories etc.) shall be furnished to the successful bidders by KSEB Limited which shall include structural drawings and Bill of Materials for the above mentioned items tendered.

The supplier is required to prepare shop fabrication drawings based on the above structural drawing, of their own, in addition to the structural/ erection drawings with required fabrication details. They shall prepare the same without any additional financial implication to KSEB Limited. Four sets of Hard copies of proto corrected structural drawings for each items (A0 SIZE) and bills of material duly approved by KSEB Limited shall be submitted to the Office of the Chief Engineer (SCM), KSEB Limited. One Soft copy of shop fabrication drawings and proto

corrected structural drawings in AUTOCAD format and approved bills of material in Excel format shall be submitted to the Office of the Chief Engineer (SCM), KSEB Limited before commencing the mass production.IFC(Issued for construction) drawing will be duly approved from this office within one month from the date of submission of drawing in A0 size by the supplier.

While submitting the structural drawings, bills of material, shop drawings and any other drawings pertaining to the supply of tendered items, the supplier/ contractor shall clearly indicate on each drawing the KSEB Limited's Specification No., Name of the specific 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.

The tower accessories drawings like Number plate, Danger plate, phase plate, Circuit Plate, Step Bolt, Anti-climbing device, pole plate and Earthing Arrangement have been standardized (except Bird guard) are enclosed in drawing section of this specification. The supplier/ 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 Purchaser, in three (3) copies for approval. This drawing shall be prepared in A0 size only.

The mass fabrication shall be taken up from the standard shop drawings approved by Chief Engineer(SCM). The overall responsibility of fabricating tower members correctly lies with the supplier only and the supplier shall ensure that all the tower members can be assembled/ fitted while erecting without any undue strain on them.4 sets of approved drawings shall be submitted with each consignment at the place of delivery.

32) **Quality Assurance Plan:-** The bidder shall invariably furnish following information along with his offer, failing which his offer shall be rejected.

i) Statement giving list of important raw materials, proposed to be used in the fabrication against this Specification, names of subsuppliers for the raw materials, list of standards

according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Bidder's representative as routine and / or acceptance during production and on finished goods, copies of test certificates.

ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.

iii) List of manufacturing facilities available.

iv) Level of automation achieved and list of areas where manual processing exists. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections

List of testing equipment available with the Bidder for final testing as per relevant IS specified. In the case if the Bidder does not possess all the Acceptance testing facilities the same tests shall be carried out at Govt. approved third party lab.

The KSEB Limited reserves the right for factory inspection to verify the facts quoted in the offer. If any of the facts are found to be misleading or incorrect the offer of that Bidder will be out rightly rejected and he may be black listed.

Special features provided to make it maintenance free.

The Field Quality Plan (FQP) is to be submitted along with Technical Bid.

The bidder shall also submit following information to the purchaser along with the technical Bid.

i) List of raw materials as well as bought out accessories, and the name of suppliers of raw materials as well as bought out accessories.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality assurance plan (QAP) with hold points for purchaser's inspection.

The Bidders shall submit the routine test certificates of all the bought out items, accessories etc.

33) **Inspection:-** The supplier has to offer inspection of fabricated tower material by giving minimum time of not less than 20 days. The inspection of fabricated tower material shall be carried out at manufacturer's works for Acceptance tests as per relevant Indian standard. The inspection of bolts-nuts, hanger, washers, step-bolts and other bought out items shall be carried out at Manufacturer's works as per relevant IS. The testing charges shall be borne by the bidder. If the testing facilities are not available for the tests to be carried out, the same shall be carried out at third party laboratory at no extra cost to the KSEB Limited.

The KSEB Limited reserves right to pick-up sample of any material from the lot received at site and get the same tested as per ISS at third party Laboratory (preferably Government approved Laboratory or Educational Institution). The material should pass these tests and if the material fails, they will be summarily rejected and Bidder should make immediate arrangement to replace them with standard materials and after getting them duly inspected. Rejected/ defective material if found during inspection shall be destroyed in presence of KSEB Limited's Inspecting Engineer. The supplier shall replace the material if not found as per specific requirements, at no extra cost to the KSEB Limited, including testing charges. All the gauges and templates required for measurement of bend angles shall be provided by the Supplier. The inspection shall be carried out as per guideline given here under:-

General Guide-Line For Inspection :-

Fabricated Structure Members:-

i) Visual examination and quantity verification of offered lot.

ii) Sample selection from the offered lot at a ratio of 50 MT (or part thereof) 1 no. for all tests.

iii) Dimension, fabrication and trueness verification of structure member from fabrication sketch.

iv) Galvanizing test of each sample i.e. dip test, hammer test and mass of zinc test.

v) Random verification Zinc coating over galvanized surface by Elcometer.

vi) Tensile test and bend test on each sample.

vii) Chemical composition test on at least one sample per lot offered for inspection.

viii) Verification of manufacturer's test certificate for Mild Steel (MS) used in structure members and submission of copy of the same along with inspection report, failing in which the dispatch instruction will not be issued.

Bolts-Nuts, Washers, Accessories, Attachments etc.: (To be carried out at manufacture's works.)

i) Visual examination and quantity verification of offered lot.

ii) Sample selection from the offered lot as per relevant IS for each item.

iii) Dimension, fabrication and trueness verification from fabrication sketch.

iv) Galvanizing test on each sample.

v) Other acceptance tests for respective item as per relevant Indian Standard and as per latest IS revision.

vi) The inspection report shall be along with size and quantity shall be mentioned in each type of bolt-nuts and attachment.

No member once rejected shall be resubmitted for inspection. Such member shall be destroyed in presence of the KSEB Limited's Inspecting Engineer.

The acceptance of any lot shall in no way relieve the Bidder for any of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection of any item of that lot later found defective.

34) **Packing:-(IS:802-Part-II/1978):-** The materials shall be bundled for the transport in the following manners. Angles shall be packed in bundles securely wrapped four times around every three feet, with No. 9 gauge wire with ends twisted tightly. Gross weight of any bundle shall not

exceed approximately 500 Kg and the length of any individual member 6 metres. Cleat angles, brackets, gusset plates, fillet plates, hanger and similar small loose pieces shall be nested, bolted together in multiples and securely wired together through holes, wrapped round at least four times with No. 9 gauge wire with ends twisted tightly. Cross weight of each bundle shall not exceed approximately 60 Kg. The contractor shall state in his bid the maximum dimensions and gross weight of a single package for transport.

35) **Marking of packages:-** Each bundle or package shall be clearly marked "**Kerala State Electricity Board Limited**" **220kV/110kV Tower Parts** and shall also have the following details marked on it.

The name of the consignee.

Order number and date.

Ultimate destination, as required by KSEB Limited.

The relevant mark number of tower members or reference number of bolts, nuts and small components like gusset plates, various attachment etc. for easy identification.

Name of the fabricator.

Order No.

The marking shall be stenciled in indelible ink/paint on the top members in the bundles of tower steel and on wooden boxes or gunny bags carrying smaller components. Each package shall contain a detailed packing list.

The contractor shall asked for detailed despatch instructions from KSEB Limited at least 4 weeks ahead of the scheduled date of despatch.

36) **Marking of Members**:- The identification marks allotted to each member shall be distinctly stamped before galvanizing with marking dies of 16mm size.

37) **Atmospheric conditions for Design Data:-**

Sl. No.	**Atmospheric conditions**	
1	Maximum temperature of air in shade	40 0 C
2	Minimum temperature of air in shade	100 C
3	Maximum temperature of air in sun	550C
4	Maximum humidity	100%
5	Average No. of thunderstorm days per annum	50
6	Average no. of dust storms per annum	5
7	Maximum rainfall per annum	4500mm (Approx.)
8	Average rain fall per annum	3000 mm (approx.)
9	Limits of amb ient temperature over a period of 24 hrs.	15 0peak
10	Wind pressure	140Kg/Sq.metre
11	Altitude	Upto 1000 metre above MSL
12	Wind Zone	2

Technical Specification for Bolts & Nuts

1) The bolts and nuts to be supplied shall conform to,

   a) IS.12427 – 1988 Specification for transmission tower bolts.

   b) IS.6639 – 1972; Specification for hexagonal bolts for steel structures with latest amendments and

   c) IS.1363 (Part-3) –1984 Hexagon head bolts, screws and nuts of product grade "C" part-3 Hexagon nuts. Tables 1 and 2 attached show the minimum desired values.

2) **Mechanical properties**:- The mechanical properties of the bolt shall conform to the property class 5.6 as specified in IS.1367 (Part –3) –1991. Fasteners – Threaded Steel – Technical supply conditions. Part –3 Mechanical properties and test methods for Bolts, screws and studs with full loadability. Bolts with shank length more than nominal diameter shall withstand a minimum shear stress of 310M pa.

3) **Grade:-** The bolts shall be of product grade C as specified in IS.1367 (Part–2) – 1979; Technical supply conditions for threaded steel fasteners; Part –2-product grade and tolerance.

4) **Dimensions**:- Dimensions shall comply in all respects with IS.6639 – 1972 with latest amendment and latest version of IS.1363 – 1967.

5) **Weight**:- The approximate weight of bolts with nuts shall be as per IS.6639 – 1972 i.e., given in table –2.

6) **Galvanising**:- All bolts and nuts shall be hot dip galvanized as in IS.5358 – 1969.

7) **Mode of delivery**:- Shall be in accordance with IS.1367 (Part–18)–1979– Technical supply conditions for threaded steel fasteners: Part 18 marking and mode of delivery. All bolts and nuts shall be packed in double gunny bags and weight of the contents of the individual bags being approximately 50Kg.

8) **Tests for mechanical properties of bolts**:- Suitable number of samples from each consignment shall be selected as specified in IS.2614 – 1969 and the tests done must include the following as specified in the IS.1367 (Part -3) – 1991.

a) Rockwell hardness test

b) Proof load test

c) Test for strength under wedge loading

d) Head soundness test

9) **Tests for mechanical properties of nuts**:- The nuts shall be tested in accordance with the test methods described in IS.1367 (Part-6) – 1980.

a) Proof load test

b) Hardness test

TABLE – I

Dimensions for hexagon bolt for steel structures

IS.6639 – 1972

	All dimensions in mm	
Size	M16	M20
Diameter	16	20
Maximum	16.70	20.84
Minimum	15.30	19.16

Table –II

Approximate weight of Hexagon Bolts with Nuts (For 1000 pieces in Kg)

IS.6639 – 72

Sl. No.	Item	Weight(Kg)
1)	16 x 35 mm	124
2)	16 x 40mm	132
3)	16 x 45 mm	140
4)	16 x 50 mm	148
5)	16 x 55 mm	156
6)	16 x 70 mm	164
7)	16 x 75 mm	172
8)	20 x 50 mm	247
9)	20 x 55 mm	259
10)	20 x 60 mm	271
11)	20 x 70 mm	283

Technical Specification for Earthing set, U Bolt and D Shackle for 220kV & 110kV Overhead Transmission Line Steel Towers

Scope:- This specification covers manufacture, testing at manufacturers works, supply and delivery of earthing set for 220kV overhead transmission line steel towers.

I) **Earthing Set:-**

1) **Standards**:- All materials to be supplied shall comply in all respects with relevant Indian Standard Specification. IS-1239 (1979), IS-5358 (1969), IS-2633/64, IS-3043/87 with latest amendments or any other equivalent authoritative standard.

2) **Materials**:- The materials supplied shall be of best quality and workmanship.

3) **Galvanising Test**:- Galvanised parts shall be tested in accordance with IS-2633-1972 & IS-5358-1968 or any equivalent authoritative standard.

Each earth set should consist of 50mm bore 3.65mm thickness galvanized iron pipe 2.850m in length and G.I.strip of size 50 x6 mm and length 4850mm with two holes each at both ends of the strip to receive 16mm x 45mm size bolts (Drawing No.1/94 attached). The centre line of the holes should be 50mm apart at one end of the strip (the tower end) and 80mm apart on the other end of the strip as shown in the drawing. 35mm end clearance should be given at both ends of the strip.

Staggered holes of size 12mm at 150mm center to center should be provided in the G.I.Pipe. One end of the G.I.Pipe electrode should be flattened upto a length of 150mm to fasten the earthing strip. Two suitable holes to receive 16mm x 45mm bolts should be provided on the flattened surface of the G.I electrode pipe 80mm apart. One end of the electrode pipe should be wedged.

4Nos. 16mm x 45mm G.I bolts and nuts with G.I spring washers of 3mm thickness should also be supplied.

4) **Galvanising**:- Bolts and Nuts shall be hot dip galvanized except spring washers, which shall be electro- galvanised. Galvanising shall be done after fabrication is completed but the nuts may be tapped or re-run after galvanizing. Thread of the bolts may be under cut to provide for increase in diameter because of galvanizing. Rerunning of the bolt threads is not permitted.

Before galvanizing, the section shall be thoroughly cleaned of any paint, grease, scale acid or alkali or such other foreign matters as are likely to interfere with the galvanizing process or with the quality or durability of the zinc coating. Galvanising of

each member shall be carried out in one complete immersion. The galvanizing bath shall contain only the approved standard spelter.

The galvanizing bath shall be reasonably free from dross, and the steel shall be dipped in the molten zinc in such a manner that it does not come in contact with the dross which might have collected at the bottom of bath. On removal from the kettle the galvanized materials may have the excess spelter removed from the surface by "bumping". The process known as 'wipping' or "scrapping" shall not be used for this purpose. The temperature of the spelter in the kettle shall be controlled by means of accurate pyrometers within close limits.

The galvanized surface shall consist of a continuous and uniformly thick bright coating of zinc, firmly adhereing to the surface. The galvanizing shall be free from any defect, which may affect or tend to affect its anti-corrosive properties. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bad spots, uneven coating, zinc which is loosely attached to the steel, globules of zinc, spiky deposits of zinc, blistered surface, flaking or peeled off zinc, etc. The presence of any of the above defects or deformation noticed on visual inspection even without carrying out any test shall render the material liable for rejection.

Galvanised articles, zinc to be used for galvanizing, method of testing, etc shall conform to the relevant standards.

II) **U Bolt of 16 mm and 20 mm:-** U Bolt shall be Galvanised after manufacture as per IS 1367 Part XIII-1983.The material shall be mild steel as per IS 2062 –1992 Grade A Nuts shall be as per IS 1363 Part III 1992.The materials shall be supplied as per attached drawings.

III) **D Shackle of 16 mm and 20 mm:-** D Shackle shall be Galvanized after manufacture. The material shall be as per IS 2004 Class IV.

Sd/-

Chief Engineer (SCM)

ANNEXURE II

GUARANTEED TECHNICAL PARTICULARS OF STEEL FOR 220 kV & 110kV TOWERS)

Sl. No.	Description	
1)	Ultimate Tensile strength	
2)	Yield stress	
3)	Percentage elongation	
4)	Bend	
5)	Impact for grade C steel	
6)	Tolerance for leg length of Angles	
7)	Out of squares ness of Angles	
8)	Weight tolerance of Angle sections	
9)	Weight tolerance of plates	
10)	Thickness tolerance of plates	

Guaranteed Technical Particulars of Bolts & Nuts

1.	Maker's Name & Address	
2.	Reference Standard Specification	
3.	Type	
4.	Material	
5.	Weight	
6	Diameter	

Guaranteed Technical Particulars Earthing set, U Bolt and D Shackle for 220kV & 110kV Overhead Transmission Line Steel Towers

I)	**Earthing Set**	
1)	Type of Earth Electrode	
2)	Length of Flatted portion at one end of the G.I. pipe	
3)	Distance between centre bolts of G.I.pipe	
4)	Type of earthing strip	
5)	Distance between centre of holes at one end of the strip	
6)	Distance between centre of holes at other end of the strip	
II)	**D Shackle (16mm/20mm)**	
1)	Ultimate Load	
2)	Factor of Safety	
3)	Minimum Breaking Strength	
4)	Tolerance	
5)	Weight per piece	
III)	**U Bolt (16mm/20mm)**	
1)	Maximum working load	
2)	Factor of safety	

3)	Minimum Breaking Strength	
4)	Tolerance	
5)	Weight per piece	

Name and Address of Bidder