TECHNICAL SPECIFICATIONS

SECTION-IV

1.0 Transmission tower

1.1 General description of the tower

1.1.1 The towers shall be of the following types:

(a) Double circuit (DA, DB, DC, DD & DE)

(b) Multi circuit (MA, MB, MC, MD & ME)

1.1.2 The towers should be self supporting hot dip galvanised lattice steel type designed to carry the line conductors with necessary insulators, earthwire and all fittings under all loading conditions. Outline diagram of single circuit tower is enclosed with the specification.

1.1.3 The tower shall be fully galvanised using mild steel or/and high tensile steel sections as specified in clause no. 1.6. Bolts and nuts with spring washer are to be used for connections.

1.2 Type of towers

1.2.1 The towers for the lines are classified as given below:

Type of tower	Deviation limit	Typical use
DA/MA	0^0	To be used as tangent tower.
DB/MB	0^0 - 15^0	a)Angle towers with tension insulator string. b)Also to be used for uplift force resulting from an uplift span upto 200 m under broken wire condition. c)Also to be used for anti cascading condition.
DB/MB	0^0	To be used as section tower.
DC/MC	15^0-30^0	a)Angle tower with tension insulator string. b)Also to be used for uplift forces resulting from an uplift span c)Also to be used for anti cascading condition.
DC/MC	0^0	To be used as section tower.
DD/MD	30^0-60^0	a)Angle tower with tension insulator string. b)Also to be used for uplift forces resulting from an uplift span c)Dead end with 0^0 to 15^0 deviation both on line side and sub-station side (slack span)
DE/ME	0^0 to 60^0	a)Angle tower with tension insulator string. b)To be used for long valley crossing.

Note: the above towers shall be designed in such a manner so that it can be used for longer span with smaller angle of deviations.

1.2.2 Extensions

1.2.2.1 The single/double/multi circuit towers shall be designed so as to be suitable for adding 3m, 6m and 9m body extensions/leg extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.

1.2.2.2 The provision for addition 18/25m body extension to tower types DA/MA and DD/MD shall also be kept. For power line crossing or any other obstacle, tower types DA/MA or DD/MD shall be used with 18/25m extensions depending, upon the merit of the prevailing site condition. The maximum reduced spans for DA/MA and DD/MD type towers shall be mentioned in the tower spotting data.

1.2.2.3 Provision for use of unequal leg extensions (upto max. 3m difference) shall also be kept. The details of unequal leg extensions provided in the design shall be indicated to the contractor during execution stage, so that proper optimisation of benching/revetment requirement can be done accordingly by the contractor.

1.2.2.4 All above extensions provisions to towers shall be treated as part of normal tower only.

1.3 Span and clearances

1.3.1 Normal span

The normal ruling span of the line is 300 m for tower type DA/MA, DB/MB, DC/MC & DD/MD and 800 m for tower type DE/ME.

1.3.2 Wind span

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

1.3.3 Weight span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower. For spotting of structures, the span limits given in Table 1.1 shall prevail.

TABLE 1.1

Sl. no.	Tower type	Normal condition		Broken wire condition	
		Maximum	Minimum	Maximum	Minimum
1	DA/MA	500	200	315	100
2	DB/MB	1000	-1000	600	-600
3	DC/MC	1000	-1000	600	-600
4	DD/MD	1000	-1000	600	-600
5	DE/ME	2000	-2000	1500	-1500

1.3.4 In case at certain locations where actual spotting spans exceed the design spans then cross-arms and certain members of towers required to be modified/reinforced, in that case drawings of the modified/reinforced tower shall be supplied by the contractor as per requirement.

1.4 Electrical clearances

Ground clearance

The minimum ground clearance from the bottom conductor shall not be less than 6100 mm for 132kV at the maximum sag conditions i.e. 75°C and still air.

(a) An allowance of 150mm shall be provided to account for errors in stringing.

(b) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26°C, lower than the stringing temperature for ACSR PANTHER for 132kV transmission lines.

1.5 Design and drawings

1.5.1 The relevant drawings for all the 132kV, 4-circuit towers and their extension(suitable for seismic zone -5 & wind zone-5) required for the work shall be furnished to the owner by the contractor for approval and shall include structural/erection drawings, single line design drawings/diagrams, foundation working drawings.

1.5.2 However, before taking up the mass fabrication, the contractor shall arrange for proto-test for each type of towers in the presence of the authorised representative of the owner. The rates for proto-test of towers are to be quoted separately in the appropriate schedules of BPS. After successful test/inspection the contractor shall incorporate changes, if required to be made in design. The revised drawing/documents (including structural drawings, BOM etc.) shall be submitted in four copies and will be finally approved by the owner.

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

1.5.3 Some drawings & documents such as BOM, shop drawings, structural drawings for some towers/extensions based on single line design diagrams etc.; if any, required for proper and effective execution of the project may also be required to be developed by the contractor. However, no extra cost for the same shall be payable to the contractor.

1.5.4 The drawings submitted by the contractor shall be approved/commented by the owner as the case may be within 30(thirty) days of receipt of drawings in owner's office. If the designs/drawings are commented by the owner, the contractor shall submit revised design/drawings duly incorporating all comments within 15(fifteen) days of date of issue of comments.

1.5.5 The tower accessories drawings like number plate, circuit plate, danger plate, phase plate, anti-climbing device, step bolt, D-shackle, Hanger etc. including earthing drawings shall also be prepared by the contractor and shall be submitted to the owner, in three copies, along with one reproducible, for record.

1.5.6 All the drawings shall have a proper name plate clearly displaying the name of MeECL on right hand bottom corner. The exact format of the name plate shall be handed over to the successful bidder for incorporation of the same on all the drawings. Also all the drawings shall carry the following statement and shall be displayed conspicuously on the drawing:

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

1.5.7 While submitting the structural drawings, bill of materials and any other drawings pertaining to the subject transmission line, the contractor shall clearly indicate on each drawing MeECL specification no., name of the transmission line and project, letter reference no. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies. The contractor shall be required to submit 15(fifteen) copies of all relevant drawings for necessary distribution.

1.6 Materials

1.6.1 Tower steel sections

IS steel sections of tested quality of conformity with IS:2062 (designated Y.S. 250 MPa) or/and IS:8500 grade 490 (designated Y.S. 350 MPa) as per the tower designs are to be used in towers, extensions and stub setting templates. The contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International standards. However, use of steel grade having designated yield strength more than of EN 10025-S355JR/JO (designated Y.S. 355 MPa) is not permissible.

Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS:1079 -1994 (grade -0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz. gusset plates, joint splices etc. the same shall conform to IS:2062 / IS:8500 or equivalent standard meeting mechanical strength/ metallurgical properties corresponding to Fe-410 or above grade (designated yield strength not more than 355MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength and metallurgical properties may also be used in place of plates for packing plates/packing washers. The chequered plates shall conform to IS : 3502 - 1994.

For designing of towers, preferably rationalised steel sections have been used. During execution of the project, if any particular section is not available, the same

shall be substituted by higher section at no extra cost to owner and the same shall be borne by the contractor. However, design approval for such substitution shall be obtained from the owner before any substitution.

1.6.2 Fasteners: bolts, nuts and washers

1.6.2.1 All tower members shall be joined together with bolts and nuts. The redundant of first 2(two) panels from ground level shall be connected with anti-theft bolts and nuts along with spring washers whereas the balance joints shall be connected with hexagonal bolts & nuts. All hexagonal bolts and nuts shall conform to IS-12427. They shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.

Anti-theft bolts and nuts shall have round tapered heads with hexagonal shear nuts. They shall conform to IS : 12427 and IS : 1367 for property class 5.6/5 .

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

1.6.2.2 The bolt shall be of 16/24 mm diameter and of property class 5.6 as specified in IS:1367 (part-III) and matching nut of property class 5.0 as specified in IS:1367 (part-VI).

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

1.6.2.4 Nuts for hexagonal bolts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be overlapped beyond 0.4mm oversize on effective diameter for size upto M16.

Nuts for anti-theft bolts should be round tapered with hexagonal shear nuts. The hexagonal portion of shear nuts shall break away at specified torque recommended by the supplier to ensure proper tightening of members and the fasteners shall not be opened subsequently with tools. The tightening torque and shearing of anti-theft nuts shall be verified during proto-assembly.

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

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

1.6.2.7 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro-

galvanised, positive lock type and 3.5mm in thickness for 16mm dia bolt and 4.5mm for 24mm bolt.

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

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

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

1.6.2.11 To ensure effective in-process quality control it is essential that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper quality assurance system which should be in line with the requirement of this specification and IS:14000 series quality system standard.

1.7 Tower accessories

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

1.7.1 Step bolts & ladders

Each tower shall be provided with step bolts conforming to IS:10238 of not less than 16mm diameter and 175mm long, spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top of the tower. For double circuit/multi circuit tower the step bolt shall be fixed on two diagonally opposite legs upto top of the towers. For single circuit tower the step bolt shall be fixed on one leg upto waist level and on two diagonally opposite legs above waist level upto top of the towers. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5kN. For special towers, where the height of the super structure exceeds 50 meters, ladders along with protection rings as per the owner approved design shall be provided in continuation of the step bolts on one face of the tower from 30 metres above ground level to the top of the special structure. From 3.5m to 30m height of super structure step bolts shall be provided. Suitable platform using 6mm thick perforated chequered plates alongwith suitable railing for access from step bolts to the ladder and from the ladder to each cross-arm tip and the groundwire support shall also to be provided. The platform shall be fixed on tower by using counter-sunk bolts.

1.7.2 Insulator strings attachments

(a) For the attachment of suspension insulator string, 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 and considered in the design of the tower shall have similar tensile strength as that of single/double/multi

suspension string. The design and supply of hanger, D-shackles, strain plate, extension links etc. are also in the scope of contractor.

(b) At tension towers strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. 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.

1.7.3 Earthwire clamps attachment

(a) Suspension clamp:

Earthwire suspension clamps will be supplied by the contractor. The drawing shall be submitted by the contractor for owner's approval. The contractor shall also supply U- bolts/D-shackles, wherever required.

(b) Tension clamps:

Earthwire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The contractor shall also supply the U-bolts wherever required and take owner’s approval for details of the attachment before the mass fabrication.

1.7.4 Anti-climbing device

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

1.7.5 Danger, number, circuit and phase plate

Danger plates, number plates, circuit plates and phase plates shall be provided and installed by the contractor.

(a) Each tower shall be fitted with a danger plate , number plate and a set of phase plates for each circuit in the multi/double circuit tower. The transposition towers should have provision of fixing phase plates on both the transverse phase. Circuit plates shall be provided on all the double/multi circuit towers.

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

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

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

1.7.6 Bird guards

To prevent birds perching immediately above the suspension insulator string and fouling the same with droppings, bird guard arrangement as per IS : 5613 shall be provided at cross-arms tips of suspension towers. The bird guard arrangement shall be such that it shall either prevent birds from perching in position where they are liable to cause the damages or ensure that if birds do perch, droppings will fall clear of the insulator string.

1.7.7 Aviation requirements

Aviation requirements, if indicated separately in BPS shall be in the scope of the contractor and the same shall conform to IS: 5613 (part-2, section-I).

1.8 Tower fabrication

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

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

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

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

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

1.8.5 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.

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

1.8.7 Drilling and punching

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

1.8.7.2 Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The punching may be adopted for thickness upto 16mm. Tolerances regarding punch holes are as follows:-

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

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

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

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

1.8.8 Erection mark

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

1.8.8.2 Erection Mark shall be

A-BB-CC-DDD

A = Owner's code assigned to the contractors – alphabet.

BB = Contractor's mark-numerical.

CC = Tower type alphabet.

DDD = Number mark to be assigned by contractor - numerical.

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

1.9 Quantities and weights

1.9.1 The quantities of the following items have to be provided in metric tonne (MT) in the relevant price schedules for various types of 132kV, 4- circuit towers(suitable for 3- circuit stringing)by the bidder:-

(i) Basic body.

(ii) Body extensions.

(iii) Leg extension.

(iv) Stubs & cleats.

(v) Bolts & nuts including spring washers and step bolts etc.

During detail engineering, proto assembly of each of the above items shall be inspected and approved by MeECL and subsequently shall be released for fabrication and manufacturing as per the technical specification by the contractor. The manufacturing of the above items shall be taken up in such a manner that the equipment/material offered for inspection to MeECL 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 MeECL representative(s), CIP shall be issued by MeECL for the material meeting the technical specification. However, MICC shall be issued only on completed tower basis for each type of tower (comprising the required basic body, body extensions wherever required, 4(four) equal or defined unequal leg extension, bolts & nuts alongwith 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 alongwith spring washers).

Accordingly, the payment shall be released or 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 alongwith spring washers) based on the weight of the tower parts as calculated as per clause 3.9.3 and bolts & nuts based on the unit rates incorporated in the contract.

1.9.2 The tower quantities for various types of 132kV, 4- circuit towers(suitable for 3-circuit stringing) provided by the bidder in the respective price schedules shall correspond to the guaranteed tower weights of the towers. The final quantities shall be taken as per the guaranteed tower weight or actual tower weight used, whichever is lower. The final quantities of excavation and concreting shall also be guaranteed by the bidder and the final quantities shall be limited to the guaranteed volume or may be as per actual whichever is lower. It will be responsibility of the contractor to intimate the exact requirement of all towers and various line materials required for line immediately after the check survey. The owner reserves the right to order the final quantities including reasonable quantities of spares for which the rates quoted in the bid shall be valid. Regarding quantity variation the provisions of relevant clauses of SCC shall apply.

1.9.3 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 level cuts etc. but taking into consideration the weight of the D-shackles, hangers, strain plates, pack plates, gusset plates and pack washers etc. The weight of stub and cleats also shall be calculated in similar manner. 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 owner. The rate quoted by the bidder for tower/tower parts supply is deemed to be inclusive of galvanising charges including the cost of zinc.

1.9.4 The contractor is permitted to get inspected and supply upto 2.5% extra fasteners to take care of losses during erection.

No payment shall be admissible for these extra supplies.

1.10 Galvanising

Fully galvanised towers and stub shall be used for the lines. Galvanising of the member of the towers shall conform to IS:2629 and IS:4759. Post treatment (chromating) recommended as per IS:2629 shall also be carried out after

galvanising. All galvanised members shall withstand tests as per IS:2633. For fasteners the galvanising shall conform to IS:1367 (Part-13). The galvanising shall be done after all fabrication work is completed, except that the nuts may be taped or re-run after galvanising. Threads of bolts and 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 the bolts. Spring washers shall be electro-galvanised as per clause 4 of IS:1573.

1.11 Earthing

The contractor shall measure the tower footing resistance (TFR) of each tower after it has been erected and before the stringing of the earthwire during dry weather. Each tower shall be earthed the tower footing resistance shall not exceed 10 ohms. Pipe type earthing and counter poise type earthing wherein required shall be done in accordance with the latest additions and revisions of:

IS: 3043 code of practice for earthing.

IS:5613 code of practice for design, installation and maintenance (part-II/section-2) of overhead power lines.

1.11.1 The details for pipe & counterpoise type earthing are given in the drawings enclosed with these specifications.

1.11.2. The earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohm-metre, earthing shall be established by providing 4 length of 30 metre counterpoise wire (total 120m length wire) otherwise for soil resistivity greater than 1500 ohm-metre, earthing shall be established by providing 4 length of 70 m counterpoise wire (total 280 m length wire)

1.11.3 The provisional quantities for pipe type earthings and counterpoise earthing are furnished in the price schedule. The bidders are required to quote unit rates for the same in appropriate schedule of BPS. The quoted price shall include fabrication, supply and installation of earthing material including supply of coke, salt etc.

1.12 Inspection and Tests

1.12.1 General

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

1.12.2 Inspection

In addition to the provision of GCC, the following shall also apply:

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

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

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

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

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

1.12.2.5 Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the contractor and approved by the owner.

1.12.2.6 All gauges and templates necessary to satisfy the owner shall be supplied by the contractor.

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

1.13 Packing

1.13.1 Angle section shall be wire bundled.

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

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

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

1.14 Standards

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

1.14.2 The material and services covered under these specifications shall be performed as per requirements of the relevant standard code 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.	Indian standard	Title	International standard
1	IS: 209-1992	Specification for zinc	ISO/R/752 ASTM B6
2	IS 278-1991	Galvanised steel barbed wire	ASTM A131
3	IS 800-1991	Code of practice for general building construction in steel	CSA 6.1
4	(a) IS:802(part1) sec. 1-1995 Sec. 2-1992	Code of practice for general building construction in steel in overhead transmission line towers materials, loads and permissible stresses section-I: materials and loads section-II: permissible stresses.	ASCE 52 IEC 826 BS 8100
	(b) IS:802 (part2)	Code of practice for general building construction in steel in overhead transmission line towers fabrication, galvanising, inspection and packing	ASCE 52
	(c) IS:802 (part3)	Code of practice for general building construction in steel in overhead transmission line towers testing	ASCE 52 IEC 652
5	IS:808-1991	Dimensions for hot rolled steel beam, column, channel and angle sections.	
6	IS:875-1992	Code of practice for design loads (other than earthquakes)for buildings and structures.	
7	IS:1363-1990	Hexagon nuts (size range M5 to M36)	
8	IS:1367-1992	Technical supply conditions for threaded steel/fasteners	
9	IS:1477-1990	Code of practice for painting of ferrous metals in buildings: part-I, pre-treatment: part-II painting.	
10	IS:1573-1991	Electro-plated coatings of zinc on iron and steel	
11	IS:1852-1993	Rolling and cutting tolerances of hot rolled steel products	
12	IS-1893-1991	Criteria for earthquake resistant design of structures resistant design of structures	IEEE 693
13	IS:2016-1992	Plain washers	ISO/R887 ANSIB18-22.1
14	IS:2062-1992	Steel for general structural purposes	

15	IS:2074-1992	Ready mixed paint, air drying, red oxide, zinc chrome, priming specification.	
16	IS:2551-1990	Danger notice plates	
17	IS:2629-1990	Recommended practice for hot dip galvanising of iron and steel.	
18	IS:2633-1992	Method of testing uniformity of coating of zinc coated articles	ASTM A123 CSA G164
19	IS:3043-1991	Code of practice for earthing	
20	IS:3063-1994	Single coil rectangular section Spring washers for bolts, nuts, screws	DIN-127
21	IS:3757-1992	High strength structural bolts	
22	IS:4759-1990	Specification for hot zinc coatings on structural steel and other allied products	
23	IS:5369-1991	General requirements for plain washers	
24	IS:5613-1993	Code of practice for design installation and maintenance of overhead power lines section-1, design part- 2, section- 2, installation and maintenance	
25	IS:6610-1991	Specification for heavy washers for steel structures.	
26	IS:6623-1992	High strength structural nuts	
27	IS:6639-1990	Hexagon bolts for steel structure	ASTM A394 CSA B334
	IS:6745-1990	Method for determination of weight of zinc coated iron and steel articles.	ASTM A90
	IS:8500-1992	Specification for weldable structural steel (medium & high strength qualities)	
	IS:10238-1989	Step bolts for steel structures	
	IS:12427-1988	Bolts for transmission line towers	
		Indian electricity rules.	
	Publication no. 19(N)/700	Regulation for electrical crossing of railway tracks	

The standards mentioned above are available from

Reference abbreviation	Name and address
BIS/IS	Beureau of Indian standards. Manak bhavan, 9, Bahadur shah zafar marg, New Delhi – 110001, India.
ISO	International organisation for standardization. Danish board of standardization Danish standardizing sraat, Aurehoegvej-12 DK-2900, Heeleprup, Denmark.
CSA	Canadian standard association, 178, Rexadale boulevard, Rexdale (Ontario)

	Canada, M9W 1 R3.
DIN	Deutsches intitute fiir normung, Burggrafenstrassee 4-10 Post ffach 1107 D-1000, Berlin-30, Germany.
ASTM	American society for testing and material 1916, race street, Philadelphia. PA, 19103-1187, USA.
Indian electricity rules & regulations for crossing of railway tracks	Kitab mahal, Baba kharaak singh marg, New Delhi – 110 001, India
ASCE	American society of civil engineers, 345 east, 45th street, New York, NY 10017-2398, USA
IEEE	Institute of electrical and electronics Engineer, 445, hoes lane, Piscataway, NJ 0085-1331, USA
IEC/CISPR	International electro technical commission, Bureau central de la commission, electro tyechnique international, 1 Rue de verembe, Geneva, Switzerland.

2.0 Foundations

2.1 Foundation includes supply of materials such as cement, sand, coarse aggregates and reinforcement steel etc.

2.2 Foundations designs for 132kV, 4 – circuit towers types & their extensions and for all foundation classification as described in clause 1.2 shall be provided by the bidder. Foundation designs for 132kV D/C towers types & their extensions and for all foundation classification as described in clause 1.2 shall be provided by the owner during execution stage based on site requirement.

2.3 Classifications of foundations

The foundation designs shall depend upon the type of soil, sub-soil water level and the presence of surface water which have been classified as follows : -

2.3.1 Normal dry

To be used for locations where normal dry cohesive or no-cohesive soils are met.

2.3.2 Sandy dry soil

To be used for locations where cohesionless pure sand or negligible cohesion sand mixed with soil are met in dry condition.

2.3.3 Wet

To be used for locations:

(a) Where sub-soil water is met at 1.5 metres or more below the ground level.

(b) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.

2.3.4 Partially submerged

To be used at locations where sub-soil water table is met between 0.75 metre to 1.5 metre below the ground level.

2.3.5 Fully submerged

To be used at locations where sub-soil water table is met at less than 0.75 metre below the ground level.

2.3.6 Black cotton soil

To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is to be considered submerged in nature.

2.3.7 Fissured rock

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

2.3.8 Hard rock

The locations where chiselling, drilling and blasting is required for excavation, hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.

2.3.9 In addition to the above, depending on the site conditions other types of foundations shall also be designed and provided to the owner suitable for intermediate conditions under the above classifications to effect more economy.

2.3.10 The proposal for these types of foundations shall be submitted by the contractor based on the detailed soil investigation and approval for the same shall be obtained from the owner.

2.4 Type of foundations

Plain cement concrete/reinforced cement concrete footing shall be used for all type of normal towers. All the four footings of the tower and their extension shall be similar. The total depth of foundation except hard rock type below the ground level shall not be more than 3.0 meters. The working drawing for all types of foundations for 132KV, 4 – circuit towers types & their extensions shall be provided by the bidder. The working drawing for all types of foundations for 132kV D/C towers types & their extensions shall be provided by the owner during execution stage based on site requirement.

2.5 Soil investigation

The contractor shall undertake soil investigation at tower locations as approved by the owner. The provisional numbers of testing locations are furnished in schedule of prices. Unit rates for the same are to be furnished by the bidder in appropriate schedules of price, for adjustment purpose with actual quantities required for soil testing.

2.6 Properties of concrete

2.6.1 For open cast type foundation

The cement concrete used for the foundations shall be nominal mix concrete of grade M-20 having 1:1.5:3 nominal mix ratio with 20mm. coarse aggregate for chimney portion and 40 mm aggregates for pyramid or slab portion. The quantity of cement to be used per cubic meter shall be as per CPWD specification (DSR). All the properties of concrete regarding its strength under compression, tension, shear, punching and benching etc. as well as workmanship will conform to IS : 456.

2.6.2 (a) The portland cement used in concrete shall conform to 33 grade (IS: 269) or 43 grade (IS: 8112) or 53 grade (IS : 12269).

(b) The Pozzolena used in concrete shall confirm to IS: 1489. The curing time of pozzolena cement will be decided at the time of execution of the work under the contract based on the certificate form a reputed laboratory which will be obtained and submitted by the contractor.

2.6.3 Concrete aggregates shall confirm to IS:383.

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

2.6.5 Reinforcement shall confirm to IS:432 for MS bars and hard drawn steel wires and to IS:1139 and IS:1786 for deform and cold twisted bars respectively. Thermo mechanically treated (TMT) bars (equivalent grade) in place of cold twisted bars are also accepted. 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. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications.

2.7 Design of foundations

The working drawing of all type of foundations for all towers shall be furnished to the owner by the contractor for approval

The provisional quantities of excavation, concreting and reinforcement steel required for the project are furnished in the schedule of prices in BPS.

2.8 Unit rates and measurement for foundation

2.8.1 The bidder is required to quote the unit rates for different foundation activity namely, excavation for different types of soil, concreting, supply and placement of reinforcement and stub setting in the relevant price schedule.

2.8.2 The unit rates of excavation for each type of soil shall include excavation along with all associated activities like shoring, shuttering, dewatering till completion of foundation work stock piling, dressing, back filling of foundations after concreting with excavated/borrowed earth (irrespective of lead) and consolidation of earth, carriage of surplus earth to the suitable point of disposal as required by the owner or any other activity related to completion foundation work.

The payment for this item shall be made on the basis of design excavation volume arrived at considering dimension of pit leading 150mm gap around (except for under cut foundations) the base pad or actually excavated whichever is less and the unit rate of this item is indicated in letter of award. However, where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the footing. The payment for excavation shall be made as per actual type of soil pre-dominant in the footing. The payment for excavation shall be made as per actual type of soil encountered at the time of excavation, but the total payment for excavation portion shall not exceed the

amount as payable for excavation considering the soil type same as that of foundation classification. The decision of the owner shall be final and binding with respect to classification of soil and foundations.

2.8.3 Form boxes shall be used for casting of foundations. The unit rate of concreting shall include the cost of supply, fabrication and placement of form boxes, cement, water, coarse and fine aggregates mixing and placing of concrete, curing of concrete and any other activities related to completion of concreting works of foundation. The payment for this item shall be made as per the actual volumes of concreting but limited to design volume based on unit rates for these items indicated in letter of award.

2.8.4 The unit rate of 'reinforcement steel placement' shall include supply and placement of steel reinforcement steel, stirrups, wire for binding the reinforcement chairs, bolsters and spacers etc. as required to complete the foundation work. The measurement of steel for payments shall be made based on the calculated weight of reinforcement steel as per relevant Indian standard actually used in tonnes corrected to third place of decimal as calculated weight of steel as per design/working drawing whichever is less. No allowance will be made for wastage.

2.9 Construction of tower foundation, stub setting and earthing

2.9.1 General

The contractor shall furnish soil resistivity values to the owner along with the line alignment.

2.9.2 Excavation

2.9.2.1 Excavation work in a section must not be started until the tower schedule and profile of that section has been approved by the owner.

2.9.2.2 Except as specifically otherwise provide, all excavation for footings shall be made to the lines and grades of the foundations. For estimation purposes, the excavation wall shall be vertical and the pit dimensions shall be based on an assumed clearance of 150mm on all sides of the foundation pad. For footings without undercut, this clearance will actually be established in practice for facilitating work. For footings with undercut, no such clearance will be allowed. All excavation shall be protected so as to maintain a clean sub-grade and provide worker safety until the footing is placed, using timbering, shoring, dewatering etc. as approved by the owner. Contractor shall especially avoid disturbing the bearing surface of the pad.

2.9.2.3 The soil to be excavated for tower foundations shall be classified as follows

(a) Dry soil

Soil removable by means of a spade and shovel. This type of excavation will also include excavation for dry soil in case of wet, partially submerged, fully submerged and wet black cotton type of foundations.

(b) Wet soil

Where the subsoil water table is encountered within the range of foundation depth or land where pumping or bailing out of water is required due to presence of surface water shall be treated as wet soil. This type of excavation will also include excavation for wet soil in case of wet, partially submerged, fully submerged and wet black cotton type of foundations.

(c) Dry fissured rock

Limestone, laterite, hard conglomerate or other soft or fissured rock in dry condition which can be quarried or split with crow bars, wedges or pickaxes. However, if required, light blasting may be resorted to for loosening the material but this will not in any way entitle the material to be classified as hard rock.

(d) Wet fissured rock

Above fissured rock, when encountered with subsoil water within the range of foundation depth or land where pumping or bailing out of water is required, shall be treated as wet fissured rock.

(e) Hard rock

Any rock excavation, other than specified under fissured rock above, for which blasting, drilling, chiselling are required. The unit rate quoted for hard rock excavation shall be inclusive of all costs for such drilling (including drilling required for anchoring), chiselling and blasting, etc.

2.9.2.4 No extra charge shall be admitted for the removal of fallen earth into a pit once excavated. Shoring and shuttering/timbering as approved by owner shall be provided by the contractor when the soil condition is so bad and that there is likelihood of accident due to the falling of earth.

2.9.2.5 Where rock is encountered, the holes for tower footings shall preferably be drilled. Blasting where resorted to as an economy measure, shall be done with utmost care to minimise fracturing rock and using extra concrete for filling the blasted area. All necessary precautions for handling and use of blasting materials shall be taken. In cases where unnecessarily large quantities are excavated/ blasted, resulting in placement of large volumes of concrete, payment of concrete shall be limited to design volumes of excavation, concreting, reinforcement etc. In case where drilling is done, the stubs may be shortened suitably with the approval of the owner.

2.9.2.6 The contractor shall supply requisite blasting material and be responsible for its storage and use.

2.9.2.7 Indian standard IS:3764 shall be followed regarding safety of excavation work.

2.10 Setting of stubs

2.10.1 For all towers the contractor shall submit for approval the proposed method for setting of stubs.

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

2.10.3 Setting of stub at each location shall be approved by owner.

2.10.4 However, in hilly region for towers with unequal leg extensions and for river crossing towers, props may be used with complete accuracy and high skilled supervision, subject to prior approval from owner.

2.10.5 Stub setting templates

2.10.5.1 Stub setting templates will be provided by the owner.

2.10.5.2 The contractor shall deploy sufficient number of templates for timely completion of the line.

2.10.5.3 The stub setting templates shall be returned to the owner, on completion of the project.

2.11 Mixing, placing and compacting of concrete

2.11.1 The concrete shall be mixed in the mechanical mixer. However, in case of difficult terrain, hand mixing may be permitted at the discretion of owner. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalis. Saltish or brackish water shall not be used.

2.11.2 Mixing shall be continued until there is uniform distribution of material and mix is uniform in colour and consistency, but in no case the mixing be carried out for less than two minutes. Normal mixing shall be done close to the foundation but exceptionally 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.

2.11.3 To avoid the possibility of reinforcement rods being exposed due to unevenness of the bottom of the excavated pit, a pad of lean concrete 50mm thick and corresponding to a 1:3:6 nominal mix shall be provided at the bottom of the pad.

2.11.4 Form boxes shall be used for casting all types of foundations except at an undercut interface for which the adjoining subsurface material shall provide adequate support.

2.11.5 The concrete shall be laid down in 150mm layers and consolidated well, so that the cement cream works, up to the top and no honey-combing occurs in the concrete. A mechanical vibrator shall be employed for compacting the concrete. However, in case of difficult, terrain, manual compaction may permitted at the

discretion of the owner. Monolithic casting of foundations must be carried out. However, in case of unavoidable circumstances, a key construction joint can be provided at the chimney-pad interface subject to approval of the owner. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge for draining rain water. However nothing extra shall be paid to the contractor for providing such construction joints.

2.11.6 Wet locations shall be kept completely dewatered, both during and 24 hours after placing the concrete, without disturbance of the concrete.

2.11.7 If the concrete surface is found to be defective after the form work has been removed, the damage shall be repaired with a rich cement sand mortar to the satisfaction of the owner before the foundation is back filled.

2.12 Backfilling and removal of stub templates

2.12.1 After opening of form work and removal of shoring, timbering, etc., backfilling shall be started after repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless it is a clay type or it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At locations where borrowed earth is required for backfilling, contractor shall bear the cost irrespective of lead & lift.

2.12.2 The backfilling materials shall be clean and free from organic or other foreign materials. A clay type soil with a grain size distribution of 50% or more passing the # 200 sieve as well as a black cotton soil are unacceptable for backfilling. The earth shall be deposited in maximum 200mm layers, levelled, wetted if necessary and compacted properly before another layer is deposited.

2.12.3 The backfilling and grading shall be carried to an elevation of about 75mm above the finished ground level to drain out water. After backfilling 50mm high, earthen embankment (band) will be made along the sides of excavation pits and sufficient water will be poured in the backfilling earth for at least 24 hours. After the pits have been backfilled to full depth the stub template can be removed.

2.13 Curing

The concrete shall be cured by maintaining the concrete wet for a period of at least 10 days after placing. Once the concrete has set for 24 hours the pit may be backfilled with selected moistened soil and well consolidated in layers not exceeding 200mm thickness and thereafter both the backfill earth and exposed chimney shall be kept wet for the remainder of the prescribed 10 days. The exposed concrete chimney shall also be kept wet by wrapping empty cement bags around it and wetting the bags continuously during the critical 10 days period.

2.14 Benching

When the line passed through hilly/undulated terrain, levelling the ground may be required for casting of tower footings. All such activities shall be termed benching

and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by owner. Benching shall be resorted to only after approval from owner. Volume of the earth to be cut shall be measured before cutting and approved by owner for payment purposes. Further, to minimise benching, unequal leg extensions shall be considered and provided if found economical. The proposal shall be submitted by the contractor with detailed justification to the owner.

2.15 Protection of tower footing

2.15.1 Tower spotting shall endeavour to minimise the quantity of revetment required.

2.15.2 The work shall include all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in nalas, river bed undulated terrain, etc., including suitable revetment or galvanised wire netting and meshing packed with boulders. The top cover of stone revetment shall be sealed with M-15 concrete (1:2:4 mix). Contractor shall recommend protection at such locations wherever required. Details of protection of tower footing are given in drawing enclosed with these specifications for reference purpose only.

2.15.3 Tower footings shall generally be backfilled using soil excavated at site unless deemed unsuitable for backfilling. In the latter case, backfilling shall be done with borrowed earth of suitable quality irrespective of lead. The unit rate for backfilling quoted in BPS shall include the required lead and consolidation and levelling of earth after backfilling.

2.15.4 The provisional quantities for protection work of foundations are furnished in schedule of quantities as well as in price schedule. The unit rates shall also be applicable for adjusting with the actual quantities of protection works done. These unit rates shall hold good for protection work carried out on down hills or up hills slopes applicable for the tower locations.

2.15.5 The unit rates for random rubble masonry revetment quoted in price schedule shall also include excavation & (1:5) random masonry and unit rate for top sealing with M-15 concrete. For payment purposes the volume of random rubble masonry revetment shall be measured from bottom to top sealing coat and paid at the quoted rates indicated in price schedule.

No extra rates shall be paid for allied work such as excavation, for revetment, packed stone at head of weep holes etc. However, no deduction shall be made for the volume enclosed by weep holes. The locations where both benching and protection of tower footing are envisaged, an economy got to be established against providing unequal leg extension.

2.15.6 For some of the locations in nalas, river bed or undulated terrain etc., maximum size boulders of min. 150mm dimension bounded and packed in galvanised wire net/mesh of 8 SWG wire 152 square mesh are to be provided. These stones shall

be provided in crates size of 2.0mx2.0m or as deemed suitable for a particular location. Measurement shall be taken in cubic metres and 15% deduction will be made for void from cage/stack measurements.

3.0 Tower erection, stringing and installation of line materials

3.1 General

3.1.1 The scope of erection work shall include the cost of all labour, tools and plant and all other incidental expenses in connection with erection and stringing work. The bidders shall indicate in the offer the sets of stringing equipment he would deploy for the construction of the transmission line, sets which shall be of sufficient capacity to string single ACSR PANTHER conductor.

3.1.2 The contractor shall be responsible for transportation to site of all the materials to be provided by the contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the owner. Similarly, the contractor shall be responsible for transportation, proper storage, safe custody, and loss or damage of all materials supplied by the owner for incorporation in the lines and shall maintain and render proper account of all such materials at all times, till such time the erected line is taken over by the owner.

3.1.3 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the owner.

3.1.4 Payment for stringing shall be done on the basis of per kilometer and irrespective of number of tension/suspension towers.

3.2 Treatment of minor galvanisation damage

Minor defects in hot-dip galvanised members shall be repaired by applying at least two coats of zinc rich primer (having approx. 90% zinc content) and two coats of enamel paint to the satisfaction of the owner before erection.

3.3 Assembly

The contractor shall give complete details of the erection procedures he proposes to follow

3.3.1 The method for the erection of towers shall ensure the following

(a) Straining of the members shall not be permitted for positioning. It may, however, be necessary to match hole positions at joints using tommy bars not more than 450mm in length;

(b) Prior to erection of an upper section, the tower section shall be completely braced, and all bolts provided tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.

(c) All plan diagonals relevant section of tower shall be in place prior to assembly of an upper section;

(d) The bolt positions in assembled towers shall be as per IS-5613 (part -II/section- 2);

(e) Tower shall be fitted with number, danger and phase plates as well as anti-climbing device, as described;

(f) After complete erection of the tower, all blank holes, if any, are to be filled by bolts and nuts of correct size.

3.4 Tightening of bolts and nuts

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

3.4.2 The threads of all the bolts except for anti-theft bolts projected outside the nuts shall be welded at two diametrically opposite places, the circular length of each welding shall be at least 10mm. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm for double/multi circuit towers. After welding zinc-rich primer having approximately 90% zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The surface coated with zinc rich primer shall be further applied with two finish coats of high build enamel of the grade recommended by the manufacturer of the zinc rich primer. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.

3.4.3 Alternatives to the tack welding of nuts with bolts, as described above the contractor can also propose some other arrangements, like use of epoxy resin adhesive which can serve the purpose of locking the nuts permanently with the bolt and thus preventing pilferage of the tower members.

3.5 Insulator hoisting

Single suspension insulator strings shall be used for suspension towers and single tension insulator strings on tension towers. Damaged insulators and strings, if any, shall not be employed in the assemblies. Prior to hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for that purpose. For checking the soundness of insulators, IR measurement using 5 kV (DC) Megger shall be carried out on insulators. Corona control rings/arcing horn shall be fitted in an approved manner. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor and earthwire etc., whenever recommended by the manufacturer of the same.

3.6 Handling of conductor and earthwire

3.6.1 Running out of the conductors

3.6.1.1 The conductors shall be run out of the drums from the top in order to avoid damage. The contractor shall be entirely responsible for any damage to tower or conductors during stringing.

3.6.1.2 A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken that the conductors do not touch and rub against the ground or objects which could scratch or damage the strands.

3.6.1.3 The sequence of running out shall be from the top down i.e. the earthwire shall be run out first followed in succession by the conductors. Unbalanced loads on towers shall be avoided as far as possible. Inner phase of line conductors shall be strung before the stringing of the outer phases is taken up.

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

3.6.1.5 When the 132 kV transmission line runs parallel to existing energised power lines, the contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage built up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwire during stringing operations.

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

3.6.2 Running blocks

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

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

3.6.3 Repairs to conductors

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

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

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

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

3.6.4 Crossings

Derricks or other equivalent methods ensuring that normal services need not be interrupted nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication lines, power lines and railway lines have to be crossed. However, shut down shall be obtained when working at crossings of overhead power lines. The contractor shall be entirely responsible for the proper handling of the conductor, earthwire and accessories in the field.

3.7 Stringing of conductor and earthwire

3.7.1 The stringing of the conductor for 132 kV shall be done by the controlled tension method. The equipment shall be capable of maintaining a continuous tension that the sag for the conductor is about twenty percent greater than the sags specified in the stringing sag table.

3.7.2 The bidder shall give complete details of the stringing methods he proposes to follow. Prior to stringing the contractor shall submit the stringing charts for the conductor and earthwire showing the initial and final sags and tension for various temperatures and spans alongwith equivalent spans in the lines for the approval of the owner.

3.7.3 Conductors or earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

Conductor creep are to be compensated by over tensioning the conductor at a temperature of 26^0C lower than the ambient temperature or by using the initial sag and tensions indicated in the tables.

3.8 Jointing

3.8.1 When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the accessories manufacturer.

3.8.2 Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

3.8.3 All the joints on the conductor and earthwire shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the

contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc., and be properly greased with anti-corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors.

3.8.4 All the joints of splices shall be made at least 30 metres away from the tower structures. No joints or splices shall be made in spans crossing over main roads, railways and small river tension spans. The compression type fittings shall be of the self centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

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

3.9 Tensioning and sagging operations

3.9.1 The tensioning the sagging shall be done in accordance with the approved stringing charts or sag tables. The 'initial' stringing chart shall be used for the conductor and final stringing chart for the earthwire. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductor shall be clamped within 96 hours of sagging in.

3.9.2 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

3.9.3 The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

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

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

3.10 Clipping in

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

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

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

3.11 Fixing of conductors and earthwire accessories

Conductor and earthwire accessories including vibration dampers shall be installed by the contractor as per the design requirements and manufacturer's instruction 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 that no damage occurs to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the dampers, suspension clamps etc. and torque recommended by the manufacturer of the same shall be applied.

3.12 Replacement

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

3.13 Permitted extra consumption of line materials

3.13.1 The quality of conductor and earthwire to be incorporated in the line shall be worked as per the following norms.

Quantity of conductor = Line length as per detailed survey x 3 phases x no. of circuit

Quantity of earthwire = Line length as per detailed survey

3.13.2 The contractor shall make every effort to minimise breakage, losses and wastage of the line materials during erection. However, the contractor shall be permitted an extra consumption of following line materials up to the limits specified in Table- 6 and shall be permitted to dispose of the scrap, if any at the end.

Table- 6 : Permitted extra consumption of line materials

Item	% of permitted extra consumption
Conductor and earthwire	1

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

3.13.4 However, for hilly terrain, where level difference between two locations is there, consumption shall be allowed equal to the increase in conductor length due to slope effect. Contractor shall prepared detailed consumption statement for such locations for approval of the engineer-in-charge.

3.13.5 The contractor shall not be required to return to the owner empty conductor and earthwire drums and shall be disposed off the same at his cost.

3.14 Final checking, testing and commissioning

After completion of the works, final checking of the line shall be carried out by the contractor to ensure that all foundation works, tower erection and stringing have been done strictly according to the specifications and as approved by the owner. All the works shall be thoroughly inspected in order to ensure that:

(a) Sufficient backfilled earth covers each foundation pit and is adequately compacted;

(b) Concrete chimneys and their copings are in good condition and finely shaped.

(c) All tower members are used strictly according to final approved drawing and are free of any defect or damage whatsoever.

(d) All bolts are properly tightened, punched, tack welded and painted with zinc rich paint;

(e) The stringing of the conductors and earthwire has been done as per the approved sag and tension charts and desired clearances are clearly available;

(f) All conductor and earthwire accessories are properly installed;

(g) All other requirements for completion of works such as fixing of danger plate, phase plate, number plate, bird guard, anti-climbing device, aviation signal have been fulfilled.

(h) Wherever required, that proper revetment (erosion protection) is provided;

(i) The original tracings of profile and route alignment as well as tower design, structural drawings and bill of material of all towers are returned to the owner.

(j) The insulation of the line as a whole is tested by the contractor through provision of his own equipment, labour etc., to the satisfaction of the owner.

(k) All towers are properly grounded.

(l) The line is tested satisfactorily for commissioning purpose.

4.0 Field quality plan

All field activity shall be carried out in accordance with standard field quality plan given in the specification.