

## **SECTION-VIII**

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# TECHNICAL SPECIFICATION

## SECTION - VIII

### 1. General information and Scope

#### 1.1 Scope

1.1.1 This Specification covers proto type testing of 400 kV DC towers as per Owner's design as indicated in the Bid Proposal Sheets (BPS) for transmission lines associated with the Project as described hereunder. The testing of the towers shall be carried out at Bidder's own test bed or a suitable test bed where adequate facilities are available.

The Owner shall provide designs of the towers required for carrying out type testing, to the successful Bidders within 15 days of placement of award and acceptance of award by the Bidder. The scope of this specification also provides for development of structural drawings and fabrication shop drawings, Bill of Materials including bolts/nuts and spring washers, section wise steel requirement chart, fabrication and supply of prototype tower and its assembly, inspection, transportation of prototype tower material to the test bed along with bolts/nuts & spring washer and necessary tower accessories required for tower testing, erection of the tower at the test bed and testing the same to the full design load and additional loads as specified for verification of overall capacity of the tower.

1.1.2 The schedule of testing of towers are indicated at Annexure-I. The entire tower testing work covered hereunder shall be completed as per the completion schedule specified in the above mentioned annexure.

1.1.3 Above towers shall be tested with **+9m** body extension. For all other body/leg extensions, the Contractor shall prepare structural drawings, shop drawings, Bill of Materials based on single line diagram supplied by the Owner. Contractor shall also arrange proto-assembly of test tower with **+9 M** body extension. At the time of proto-assembly, if any modification is required to be carried out on the fabrication shop drawings or on the structural drawings, the same shall be properly incorporated and fresh drawings submitted by the Contractor.

1.1.4 The Contractor shall also be required to develop stub and stub setting template drawings for all body extensions based on the design inputs provided by the Owner.

1.1.5 a) The provisional quantities are given in Bid Proposal Sheets (BPS).  
b) The items of work are described very briefly in the BPS. The various items in the BPS shall be read in conjunction with the corresponding sections in the Technical Specification including amendments and additions, if any. The unit rates and price quoted by the Contractor shall be based on the description of items in the BPS and also detailed in these technical specifications.

c) The unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been explicitly described in these documents but are essential for the satisfactory completion of the various works.

d) The unit rates quoted shall be inclusive of all plant, equipment, men, material, skilled & unskilled labour.

e) All measurements for payment shall be in S.I units. Lengths shall be measured in metres corrected to two decimal places. Areas shall be computed in square metres & volume in cubic metres, rounded off to two decimals.

1.1.6 The design rights of tower designs furnished by the OWNER will be strictly reserved with the OWNER. Accordingly the following endorsement shall be incorporated on all drawings and documents by the Contractor:

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

1.1.7 The Bidder shall quote for items/ activities on unit rate basis in the appropriate schedule of BPS for the following towers:-

**400 kV DC TOWERS WITH QUAD "MOOSE" CONDUCTOR: -**

Tower type	Wind Zone	No. of towers.
DB	4 (47 m/sec)	1
DC	4 (47 m/sec)	1
DD	4(47 m/sec)	1
Total No. of towers		3

**1.2 Quality Assurance, Inspection and Testing**

**1.2.1 Quality Assurance**

To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub-Contractor's premises or at Site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programme of the Contractor shall generally cover but not limited to the following:

a) His organisation structure for the management and implementation of the proposed quality assurance programme.

- b) Documentation control system.
- c) Qualification data for Contractor's key personnel
- d) The procedure for purchases of materials, parts/components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e) System for shop manufacturing including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective action.
- g) Control of calibration and testing of measuring and testing equipment's.
- h) Inspection and test procedure for manufacture.
- i) System for indication and appraisal of inspection status.
- j) System for quality audits.
- k) System for authorising release of manufactured product to the Owner.
- l) System for maintenance of records.
- m) System for handling storage and delivery and
- n) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of supply.

The Quality Plan shall be mutually discussed and approved by the Owner's after incorporating necessary corrections by the Contractor as may be required.

#### **1.2.1.1 Quality Assurance Documents.**

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Owner's inspection of material.

- 1.2.1.2 The Owner through his duly authorised representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor's/his subcontractors Quality Management and Control Activities.

#### **1.2.2 Inspection, Testing and Inspection Certificates**

The provisions of the clause regarding inspection, Testing and Inspection Certificates as described in GCC & SCC shall be applicable to the supply and

erection portion of the Works. The Owner shall have the right to re-inspect at his expenses any material though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If following the latter, material is found defective, then the Contractor shall bear the cost of this inspection and reinstatement according to specification.

## **2.0 Design Drawings**

Owner shall develop the tower designs and the single line drawings of tower shall be handed over to the contractor after award of contract. The contractor will develop computer aided structural drawings, bills of materials and shop drawings of each type of tower. After completion of testing the revised structural drawings, bills of materials and shop drawings to be corrected based proto corrections and testing and shall be submitted to the Owner within 15 days of completion of testing of towers for their approval. After approval Contractor has to submit 6 copies of drawings/BOMs and 2 sets of shop drawings along with one set of RTF. Soft copies of Structural & Shop drawings and BOM's shall also be submitted in Compact Disk (CD) for computer use.

- 2.1 The Contractor shall develop the structural drawings including all the details of the joints and attachments based on Owner's supplied line diagrams and furnish four copies of the drawings within 4(four) weeks (for DB type), 6(six) weeks for DC type & 8 (eight) weeks (DD type) after the receipt of the single line drawing for scrutiny at Owner's end. After thorough scrutiny and upon satisfaction about the soundness/correctness of joints and the drawing as a whole, the Owner shall convey their acceptance to contractor.
- 2.2 The drawings prepared by Contractor shall be approved/commented by the Owner as the case may be with 15 (fifteen) days of receipt of drawings in Owner's office. If the drawings are commented by the Owner's the Contractor shall submit revised drawings duly incorporating all comments within 7 (seven) days of date of issue of comments.
- 2.3 Upon receiving the acceptance of structural drawing from the owner, the contractor shall develop shop drawings for all the tower members and fabricate them as per the drawings for the purpose of proto assembly and inspection. During proto assembly inspection, the Owner may depute their Engineer for checking the conformity, however, the overall responsibility of ensuring the correctness of the shop & structural drawings and the proto assembly lies with the contractor. At this stage if any modification is required to be carried out on the fabrication shop drawings or on the structural drawings, the same shall be properly incorporated with prior intimation to the Owner.
- 2.4 Subsequent to the successful proto assembly of the tower, the fabricated member shall be galvanised in accordance with the relevant standards and tower shall be transported to and erected on the test bed along with bolts/nuts and spring washer and necessary tower accessories. Thereafter the tower shall

be tested as per IS-802 (Part 3) 1978 and as described by the Owner. The test shall be carried out only in presence of Owner's representatives.

- 2.5 The Bill of Materials of tower shall be prepared and submitted in the standard format to be issued by the owner to the contractor.

### **3.0 Materials**

#### **3.1 Tower Steel Sections**

IS steel sections of tested quality of conformity with IS:2062:1992 (Designated yield strength 250 Mpa) and/or IS:8500:1991 Grade 490 (Designated yield strength 350 Mpa) for HT steel are to be used in towers, leg extensions, stub and stub setting templates. However, use of steel grade having designated yield strength more than that of EN 10025-S355 Jr/Jo (designated yield strength 355 mpa) is not permitted. Preferably no individual member shall be longer than 6000mm.

Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS-1079-1994 (Grade O) are also acceptable. However, if below 6mm size plates 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 355 Mpa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength/metallurgical properties may also be used in place of plates for packing plates/packing washers. The chequered plates shall conform to IS-3502-1994.

#### **3.2 Fasteners: Bolts, Nuts and Washers**

- 3.2.1 All bolts and nuts shall conform to IS:6639:1972. All bolts and nuts shall be galvanised as per IS:1367 (Part-13)/ IS:2629 and 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.
- 3.2.2 The bolt shall be of 16 / 24 mm diameter and of property class 5.6 as specified in IS:1367 (Part-III)-1979 and matching nut of property class 5.0 as specified in IS:1367 (Part-VI)-1980.
- 3.2.3 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MPa minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 (Part-1) to ensure proper bearing.
- 3.2.4 Nuts should be double chamfered as per the requirement of IS:1363 Part-III, 1984. It should be ensured by the manufacturer that nuts should not be overlapped beyond 0.4mm oversize on effective diameter for size up to M16.

- 3.2.5 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.
- 3.2.6 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.
- 3.2.7 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of steel electro-galvanised, positive lock type and 3.5mm in thickness for 16mm diameter bolt and 4.5mm for 24mm bolt.
- 3.2.8 The Contractor shall furnish bolt schedules giving thickness of members connected, the washer and the length of shank and the threaded portion of bolts and sizes of holes and any other special details of this nature.
- 3.2.9 To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.
- 3.2.10 The bolt positions in assembled towers shall be as per IS:5613 (Part-3 / Section 2):1989.
- 3.2.11 Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.
- 3.2.12 Tower shall be provided with 16 mm diameter 175 mm long step bolts spaced not more than 450mm apart and extending from above 3.5 meters above the ground level to the top of the tower. For these DC towers the step bolts shall be fixed on two diagonally opposite legs of towers up to the top of tower. Each step bolts 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 feet slipping away. The step bolts shall be capable of withstanding a vertical load not less than 15 KN.
- 3.2.13 During installation of towers at site for transmission line projects, redundants of first two (2) panels from ground level shall be connected using anti-theft bolts. As such, while preparing structural drawing it shall be ensured that different symbols are used for hexagonal bolts and anti theft bolts. Also quantities of hexagonal bolts / antitheft bolts are to be indicated separately in structural drawing / BOMs.  
However, for tower testing purpose only hexagonal bolts shall be used in the entire tower. The payment for tower testing shall be made as per Bill of materials with hexagonal bolt.
- 3.2.14 To ensure effective in process Quality control it is desirable that the manufacturer should have in-house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also



have proper Quality Assurance System which should be in line with the requirement of this specification and IS 14000 series Quality System Standard.

### **3.3 Tower Fabrication**

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

- 3.3.1 Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) 1978 or the relevant international standards.
- 3.3.2 For splicing of the members Butt splice shall be used and the inside Angle and outside plates shall be designed to transmit the load. 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 heel 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. Pack plate of 2mm and 4mm thickness can be used conforming to IS:1079-1994 (grade O).
- 3.3.3 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. The thickness of the gusset plates, required to transmit stress shall not be less than that of members connected.
- 3.3.4 The use of filler in connections 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.
- 3.3.5 The tower structures shall be accurately fabricated to connect together easily at Site without any undue strain on the bolts.
- 3.3.6 No angle member shall have the two leg flanges brought together by closing the angle.
- 3.3.7 The diameter of the hole shall be equal to the diameter of bolt plus 1.5 mm
- 3.3.8 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.

All similar parts shall be made strictly inter-changeable. All steels sections before any work is done on them, shall be carefully 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.

### **3.3.10 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.

3.3.10.2 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 tolerance in this respect is permissible.

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

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

3.3.10.3 All burrs 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.

### **3.3.11 Erection mark**

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

3.3.11.2 Erection Mark shall be

T-BB-CC-DDD

T = 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.

### **3.4 Galvanising**

Fully galvanised towers shall be tested. Galvanising of the member of the towers shall conform to IS:2629-1985 and IS:4759-1968. All galvanised members shall withstand tests as per IS:2633-1986. 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 tapped 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:1573-1970.

### **3.5 Inspection and Tests**

#### **3.5.1 General**

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

#### **3.5.2 Inspection**

In addition to the provision of Clause 20 of GCC, the following shall also apply:

3.5.2.1 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.

3.5.2.2 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 specifications.

3.5.2.3 Should any member of the structure be found not to comply with the approved design, it shall be liable to rejection. Member(s) once rejected shall not be resubmitted for inspection, except in cases where the Owner or his authorised representative considers that the defects can be rectified.

3.5.2.4 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.

3.5.2.5 All gauges and templates necessary to satisfy the Owner shall be supplied by the Contractor.

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

### **3.6 Tower Load Tests**

#### **3.6.1 Testing of Tower**

Towers as mentioned in CL. 1.1.1 shall be tested by Contractor at his own test bed or a suitable test bed where adequate facilities are available. Tower testing shall generally conform to IS:802 (Part-3):1978. A galvanised tower with +9m extension shall be subjected to design loads by applying test loads applied in a manner approved by the Owner. The tower shall withstand these tests without showing any sign of failure or permanent distortion in any part. Thereafter the tower shall be subjected to additional loads beyond design loads to verify overall capacity of the tower by increasing the loads further in an approved manner. The tower shall be tested for specified loading conditions. The Contractor shall submit within 7 days from the receipt of Design drawings from the Owner, the detailed programme and proposal for testing the towers showing the methods of carrying out the tests and manner of applying the loads to the Owner for approval. After the owner has approved the test procedures and programmes the Contractor will intimate the Owner about carrying out the tests at least 15 days in advance of the scheduled date of tests during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests. The Contractor shall submit one set of shop drawings along with the bill of materials and structural drawings at the time of prototype tower testing for checking the tower material. The number of tests to be carried out for each type of tower is indicated in the BPS.

3.6.1.1 After successful testing of the towers, the Contractor shall prepare a detailed test report of the same and submit in six copies to the Owner for their formal approval.

Further at the time of submitting test report, the Contractor has to submit the final tracings of shop drawings, structural drawings and Bill of materials as well as their soft copies in Compact Disk (CD) compatible to Autocad software for Owner's reference and record.

3.6.1.2 In case of any premature failure even during the waiting period, the tower is to be retested after rectification. Failure shall be considered minor in case retesting can be resumed after replacing few members of the tower and major in case whole tower is to be re-fabricated and replaced. Owner's decision regarding minor or major failure shall be final and binding on Contractor.

3.6.1.3 In case of minor premature failures, failed members of towers shall be replaced with modifications suggested by the Owner's and testing shall be resumed further from the test in which the failure was observed.

3.6.1.4 In case of major premature failure, the whole tower is to be re-fabricated as per the modification suggested by the Owner. In such cases all the tests to be carried out thereafter shall be decided by the owner at the time of retesting.

3.6.1.5 The Contractor shall provide facilities to the Owner or their representatives for inspection of materials during testing of the same.

- 3.6.1.6 The Contractor shall ensure that the specification of material and section sizes of the tower to be tested, conform strictly as per design supplied by Owner.
- 3.6.1.7 Each type of tower to be tested shall be a full scale prototype galvanised tower and shall be erected vertically on rigid foundation of the stub protruding above ground level as provided in the design/drawing between ground level and concrete level. This portion of the stub shall be kept unbraced with a cleat inside as per the drawings while testing. The tower erected on test bed shall not be out of plumb by more than 1 in 360.
- 3.6.1.8 All the measuring instruments shall be calibrated in systematic/approved manner with the help of standard weight/device. Calibration shall be done before commencing the test of each tower upto the maximum anticipated loads to be applied during testing.
- 3.6.1.9 The tower shall be tested along with actual components like hangers, D-shackles, strain plates etc. as considered in design for fixing of insulator strings. The tension tower is to be tested with strain plate as per approved design/drawings.
- 3.6.1.10 The sequence of testing shall be decided by the Owner at the time of approving the rigging chart/test data sheet.
- 3.6.1.11 The Owner will carry out the tensile test etc. as per relevant IS on few members of the test tower completion of the test or in case of any premature failure. The Contractor shall make suitable arrangement for the same without any extra cost to the Owner. After submission of the material test report only, testing of tower shall be treated as complete. The type testing charges shall be released only after approval of test report, shop drawings, bills of material and structural drawings of tower.
- 3.6.1.12 Prefix 'T' shall be marked on all members of test tower in addition to the mark no. already provided.
- 3.6.1.13 One type of test includes both maximum vertical load and minimum vertical load condition.
- 3.6.1.14 Before quotation, Bidders should ensure that their test bed shall be suitable for tentative base widths and leg load requirements mentioned at Annexure-II.
- 3.6.1.15 The Bidders are requested to quote the tower testing charges in the relevant Price Schedule excluding charges towards the required Tower Parts, Bolts & Nuts, Spring washer with required accessories for testing, Erection and dismantling of Tower Parts at Test bed and Freight & Insurance from manufacturer's Works to the Test bed. No. of test mentioned in the relevant price schedule are provisional, however, the payment shall be made/regulated based on actual number of test conducted till successfully completion of testing.

Regarding Tower Parts including Bolts & Nuts, Spring washers and required accessories, Freight & Insurance from manufacturer's works to Test bed irrespective of the distance between the two, deemed to be included in the price quoted for total quantity indicated in the price schedule of BPS and accordingly the payment shall be made based on the actual weight of tower parts calculated as per Clause 3.6.1.16 below. After testing of the tower, the tower materials shall be the property of the Contractor, therefore, the Contractor should give due credit for the same while quoting the Unit rate of tower materials towards the scrap value of the tower.

Erection of tower parts including bolts and nuts and its dismantling during successful completion of test shall be considered as a separate item and payment shall be made for actual quantity of tower parts (MT) erected and dismantled.

In case of premature failure during tower testing the contractor is required to dismantle the tower parts to the extent required, fabricate and supply fresh tower parts including Bolts, Nuts and accessories to substitute damaged tower members as well as for tower reinforcement/modifications and erect the same on the test bed. In such cases, payment shall be made for the extra tower material fabricated and supplied for rectification and number of tests repeated as explained in Clause 3.6.1.2. Payment shall also be made as per unit rates for dismantling and erection of undamaged tower parts carried out in connection with rectification of the test tower after premature failure.

3.6.1.16 The estimated total weight of towers / tower parts to be supplied by the contractor under the package have been furnished in the relevant Price Schedules. Though fully galvanised tower parts are to be supplied, the weight of tower and **tower parts** 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 hangers, strain plates and pack washers etc.

3.6.1.17 During the testing, depending on facilities available in the test bed, owner may decide to install strain gauges at selected structural members on test tower for monitoring loads on the members. The strain gauge readings shall be recorded and attached with the test report. In such cases, payments for use of strain gauges shall be made separately.

### **3.6.2 Method of Load Application**

3.6.2.1 Loads shall be applied according to the approved rigging arrangements through normal wire attachments angles on bent plates.

3.6.2.2 The various types of loads-transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the tower due to jerks from the winches.

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

### **3.6.3 Tower Testing Procedure**

The procedure for conducting the tower test shall be as follows:

#### **3.6.3.1 Bolt Slip Test**

In a bolt slip test, the test loads shall be gradually applied upto the 50% of design loads under normal condition, keep constant for two (2) minutes at that loads and then released gradually.

The initial and final readings on the scales (for measurement of deflection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of deflection in the bolt slip.

#### **3.6.3.2 Normal/Broken Wire Load Tests**

All the loads, for a particular load-combination test, shall be applied gradually up to the full design loads in the following steps and shall also be released in the similar manner:

50 percent,  
75 percent,  
90 percent,  
95 percent and  
100 percent.

#### **3.6.3.3 Observation Periods**

Under normal and broken wire loads tests, the tower shall be kept under observation for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading up to and including 95 percent of full design loads.

For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded up to 100 percent of full design loads.

While the loading operations are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.

The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts).

Ovalization of holes and permanent deformation of bolts shall not be considered as failure.

#### **3.6.3.4 Recording**

3.6.3.4.1 The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be long enough to measure the deflection of tower at top Cross arm level and shall have marking up to 5mm accuracy.

3.6.3.4.2 Video recording of tower testing shall be done for each test case commencing from 75% loading to final loads and the same shall be edited, compiled and submitted in Compact Disk (CD) along with the report.

#### **3.6.3.5 Destruction Test :**

After successful completion of 5 minutes waiting period at 100% loads under Reliability/Security condition as may be decided by the Owner, the loads shall be further increased in the steps of 5% till the tower fails.

#### **3.7 Standards**

The design, manufacturing, fabrication, galvanising, testing, erection procedure and materials used for manufacture and erection of towers, design 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.

3.7.2 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 which ensure equal or higher performance than those specified shall also be accepted



Sl. No.	Indian Standards (IS)	Title	Internationally recognised Standards/Guides
1.	IS:209-1992	Specification for Zinc	ISO/R/752 ASTM B6
2.	IS 800-1991	Code of practice for General Building Construction of Steel	CSA S16.1
3	(a)IS:802(Part1) Sec 1-1995 Sec 2-1992	Code of Practice for use of Structural Steel in Overhead Transmission Line Towers: Materials, loads and Permissible Stresses Section 1 Materials and loads Section 2 Permissible stresses.	ASCE 52 IEC 826 BS 8100
	b)IS:802-1978 (Part 2)	Code of practice for use of structural steel in overhead Transmission Line: Fabrication, Galvanising, Inspection and Packing	ASCE 52
	c)IS:802-1978 (Part 3)	Code of practice for use of Structural Steel in Overload Transmission Line Towers & Testing	ASCE 52 IEC 652
4.	IS:808-1989	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.	
5.	IS:875-1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.	
6.	IS:1363-1992	Hexagon Nuts (size range M5 to M36)	
7.	IS:1367-1992	Technical Supply Conditions for Threaded Steel/ Fasteners	
8.	IS:1573-1991	Electro-Plated Coatings of zinc on iron and Steel	
9.	IS:1852-1991	Rolling and Cutting Tolerances of Hot Rolled Steel Products	
10.	IS-1893-1991	Criteria for Earthquake Resistant Design of Structures	IEEE 693
11.	IS:2016-1992	Plain Washers	ISO/R887 ANSI B18-22.1
12.	IS:2062-1992	Steel for general structural purposes	
13.	IS:2629-1990	Recommended Practice for Hot Dip Galvanising of iron and steel.	ASTM A123 CSA G 164
14.	IS:2633-1992	Method of Testing Uniformity of Coating of Zinc Coated Articles	ASTM A123 CSA G164

15.	IS:3063-1994	Single coil Rectangular section Spring Washers for Bolts, Nuts Screws	DIN-127
16.	IS:3757-1992	High Strength Structural Bolts	
17.	IS:4759-1990	Specification for Hot zinc coatings on structural steel and other Allied products	
18.	IS:5369-1991	General Requirements for Plain Washers	
19.	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	
20.	IS:6610-1991	Specification for Heavy Washers for Steel structures.	
21.	IS:6623-1992	High Strength Structural Nuts	
22.	IS:6639-1990	Hexagon Bolts for Steel Structure.	ASTM A394 CSA B334
23.	IS:6745-1990	Method for Determination of weight of Zinc coated iron and Steel Articles.	ASTM A90
24.	IS:8500-1992	Specification for Weldable Structural Steel (Medium & High Strength Qualities)	
25.	IS:10238-1989	Step Bolts for Steel Structures	
26.	IS:12427-1988	Bolts for Transmission Line Towers	

3.7.3 The standards mentioned above are available from

Reference/Abbreviation	Name and address from which the Standards/guides are available
IS	Bureau of Indian Standards Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi India.
ISO	International Organisation for Standardisation, Danish Board for Standardisation, Dansk Standardising Sraat, Aurehoegvei-12 DK-2900 Hellepruip, DENMARK
CSA	Canadian Standard Association 178,Rexadale Boulevard, Rexdale(Ontario) Canada M9W 1R3
DIN	Deutsches Institute Fiir Normung Burggrafenstrasse 4-10 Post Fach 1107 D-1000, Berlin-30 GERMANY
ASTM	American Society for Testing and Material 1916 Race Street Philadelphia.PA 19103-1187 USA
Indian Electricity Rules Regulation for Electricity Crossing of Railway Tracks	Kitab Mahal Baba Kharak Singh Marg New Delhi-110001 INDIA
ASCE	American Society of Civil Engineers 345 East 47th Street New York, NY 10017-2398 USA
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane Piscataway, NJ 0085-1331 USA
IEC	International Electrotechnical Commission Bureau Central de la Commission 1 rue, de varembe Geneva Switzerland.

ANNEXURE-I

**A. TESTING SCHEDULE**

Activities	Completion schedules of tower in weeks.		
	DB Tower	DC Tower	DD Tower
1. Preparation of structural drawings	4	6	8
2. Preparation of shop drawings.	8	10	12
3. Proto-assembly	12	14	16
4. Testing of Proto-type tower.	16	20	24
5. Submission of Final drawings.	18	22	26

## ANNEXURE-II

**LEG LOADS & TENTATIVE BASE WIDTHS OF VARIOUS TOWERS**

SL. NO	TOWER TYPE	WIND ZONE	TENTATIVE BASE WIDTH (METER)	MAX.LEG LOAD (TON). (APPROX)
1	400 kV D/C "DB" type tower	4(47 m/sec)	17	185
2	400 kV D/C "DC" type tower	4(47 m/sec)	18	220
3	400 kV D/C "DD" type tower	4(47 m/sec)	19	260