

STANDARD
TECHNICAL SPECIFICATION
FOR
SUBSTATION – STRUCTURE

SUBSTATION – STRUCTURE – REV 7



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(भारत सरकार का उद्यम)

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PREFACE

Salient changes made over previous TS – 06

S No.	Ref Clause of Rev. 06	Brief Description
1	1.0	Reference to latest BIS / SFQP issued 28 days prior to actual date of bid opening shall be made.
2	1.0 Para 2	Deleted
3	2.1, 2.8 (a)	Wind load for lattice structures shall be as per IS:802 Part 4
4	2.8 (b)	Specific Requirement Rev 08 incorporated (The factor of safety for design of switchyard steel structures shall be 1.5 under normal condition and 1.2 under short-circuit condition.)
5	3.0	Heading modified as under – DESIGN, DRAWINGS AND BILL OF MATERIAL
6	3.1	New Heading (DRAWINGS UNDER POWERGRID SCOPE) Clause reframed
7	3.2	New Heading (DRAWINGS UNDER CONTRACTOR SCOPE) Clause reframed
8	3.2	Specific Requirement Rev 08 incorporated (Nuts, Bolts and washers for all structures shall be payable as per BPS.)
9	3.3	Certified shop floor drawings (pdf & dwg files) of the structures shall be submitted to POWERGRID for information and record only.
10	10.0	Typographical error IS 4579 modified to IS 4759

SECTION: STRUCTURE

1.0 GENERAL

The scope of specification covers fabrication, proto-assembly, supply and erection of galvanized steel structures for towers, beams, lightning masts and equipment support structures. If specified in section – Project, design of steel structure shall be in the scope of contractor. The structures shall be of pipe type or lattice type as per Bid Proposal Sheet. Lattice structures shall be fabricated from structural steel conforming to IS: 2062. All pipe structures shall be fabricated from GI pipe conforming to YST 22 or of higher grade as per IS 806. Wherever reference to BIS/ Standard Field Quality Plan (SFQP) is made, it shall be to the latest edition/revision of the same, issued/uploaded up to 28 days prior to the actual date of bid opening for instant package.

Support structure for circuit breaker shall be designed by the Manufacturer. If the provision of stool to facilitate interchangeability of equipment at a later stage is shown in the equipment support structure drawing then the stool shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the base support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m. Zinc coating for coastal areas, if defined in section – Project, shall not be less than 900gm/sq.m.

Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the structure fabrication drawings. Nothing extra shall be payable or recoverable from the contractor on account of modification in support structures.

2.0 DESIGN REQUIREMENTS FOR STRUCTURES (To be referred only for structures to be designed by the Contractor)

- 2.1 For design of steel structures dead loads, live loads, etc. shall be based on IS:875 Parts I to V. Wind load for lattice structures shall be as per IS:802 Part 4. Wind load for pipe structures shall be as per IS 875 Part 3.
- 2.2 For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall also be considered.
- 2.3 Minimum thickness of galvanized tower member shall be as follows:

Member	Minimum thickness (mm)
Leg members, Ground wire Peak members/Main members	5
Other members	4
Redundant members	4

Size and thickness of gusset plate, pack washer and pack plate shall be as per requirement.

- 2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.
- 2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.
- 2.6 All bolts shall be M16 or higher as per design requirement.

2.7 STEP BOLTS

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to IS: 10238.

2.8 DESIGN CRITERIA

- a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:802 Part 4 (lattice structures) and IS 875 Part 3 (Pipe structures), seismic forces as per code IS:1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including “snatch” in the case of bundled

conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA, 50kA, 63kA or as applicable. IEC-60865 may be followed for evaluation of short circuit forces.

- b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side. The factor of safety for design of lattice switchyard steel structures shall be 1.5 under normal condition and 1.2 under short-circuit condition.
- c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kg for the design of structures.
- d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 9MT per phase for 765kV, 4MT per phase for 400kV, 2MT per phase for 220kV and 1MT per phase for 132kV or as per requirements whichever is higher. The distance between terminal gantry and dead-end tower shall be taken as 200m for 765/400/220kV and 100m for 132kV. The design of these terminal gantries shall also be checked considering ± 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.
- e) The beam shall be connected with towers/columns by bolted joints.
- f) All Pipe support structures used for supporting equipment's shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS:1161 read in conjunction with IS: 806.
- g) If luminaries are proposed to be fixed in gantries, then the proper loading for the same shall be considered while designing. Also, holes for fixing the brackets for luminaries should be provided wherever required.
- h) Foundation bolts shall be designed for the loads for which the structures are designed.
- i) Height of lightning masts shall be as per approved structure layout and designed for diagonal wind condition. Lightning masts shall be provided with platforms for mounting lighting fixtures and a structural steel ladder within its base up to the level of platform. The ladder shall be provided with

protection rings. The platforms shall also have protection railings. The details of lighting fixtures would be as per the approved drawings.

3.0 DESIGN, DRAWINGS AND BILL OF MATERIAL

3.1 DRAWINGS UNDER POWERGRID SCOPE

POWERGRID shall provide the fabrication drawings to the contractor. Bill of material based on these fabrication drawing shall be developed by contractor and submitted to the employer for approval.

However, in case only line diagram of the structure is provided to the contractor, based on line diagram, the fabrication drawings and bill of material shall be prepared by the contractor and submitted for approval.

Replacing MS section with higher section or replacing MS section with HT section of same size due to non-availability of particular section shall not require employer's approval and this can be done without any additional financial implication to the employer.

3.2 DRAWINGS UNDER CONTRACTOR SCOPE

The contractor shall submit design along with line diagram for approval and based on approved line diagram, fabrication drawing shall be prepared and submitted for employer approval. The line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.

These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths, bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the employer. The fabrication drawings and bill of material based on fabrication drawing shall be submitted to the employer for approval. Approved bill of material prepared based on fabrication drawing shall be the basis for payment.

Any other structure necessary to suit the layout for a particular substation to complete the work in all respect shall be designed by the contractor at detailed Engineering stage.

- 3.3 The contractor shall do the proto assembly of the structures as per the issued/approved fabrication drawings. Employer may opt to witness such proto assembly. The contractor shall follow the fabrication drawing for preparing the proto assembly and do the minor adjustments, if necessary, without affecting

the strength of the structure. In case of equipment support structure, the attachment of stool and fixing of MOM box etc. shall be taken care by the contractor as per the requirement of the equipment. The proto to be witnessed and proto corrected drawings along with BOM shall be certified by the contractor. Certified drawings (pdf and dwg files) and BOM (pdf & editable soft copies) shall be submitted to POWERGRID for information and record only. Also certified shop floor drawings (pdf & dwg files) of the structures shall be submitted to POWERGRID for information and record only. The arrangement shall however, not absolve the contractor from the responsibility of supply and erection of safe, sound and durable structure.

- 3.4 Nuts, Bolts and washers for all structures shall be payable as per BPS.
- 3.5 Any aforesaid approval shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

4.0 FABRICATION AND ERECTION

- 4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference, however, may be made to IS 800 in case of non-stipulation of some particular provisions in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.
- 4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.
- 4.3 Sample towers, beams, lightning masts and equipment support structures may be trial assembled in fabrication shop in order to ensure fitment of various members and to avoid problems during erection.
- 4.4 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipment's and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor

modification, if any, required during erection shall be done at site with the approval of Engineer – in- charge.

5.0 BOLTING

- a) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- b) In case of fasteners, the galvanizing shall conform to IS-1367(Part 13). The spring washer shall be electro galvanized as per Grade IV of IS-1573.

6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, symbols for welding on erection and shop drawings shall be according to IS:813. Welding shall be carried out in accordance with IS:816.

7.0 FOUNDATION BOLTS

- 7.1** Foundation bolts for the towers and equipment supporting structures shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.
- 7.2** The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.
- 7.3** All foundation bolts for lattice and pipe structure are to be supplied by the Contractor.
- 7.4** All foundation bolts shall be provided with two no. standard nuts of class 5 confirming to IS:1363/1367/6639, one check nut of class 4 confirming to IS:1364, one anchor plate at the bottom of foundation bolt and one plain washer.
- 7.5** All foundation bolts shall conform to IS 5624, however, the material, shall be MS conforming to IS:2062/ SAE:1018.

8.0 STABILITY OF STRUCTURE

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

9.0 GROUTING

The method of grouting the column bases shall be subject to approval of employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base plate. No additional payment for grouting shall be admissible.

10.0 GALVANISING

All structural steel works, equipment support structures and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement of IS 4759. Purity of zinc to be used shall be 99.95% as per IS:209.

11.0 TOUCH-UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of the employer before erection.

12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the employer or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

13.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted during inspection.

14.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work - IS:7205.

15.0 STANDARD FIELD QUALITY PLANS

All tests mentioned in standard field quality plans shall have to be carried out and conformity of materials and workmanship shall be ascertained.

16.0 COPYRIGHT

- a) The copyright in all drawings, documents and other materials containing data and information for such design(s) to be developed by the Contractor or through any third party under this Contract shall remain vested in the Employer for a period of 5 years from the date of Completion of the Contract. In case the Contractor intends to use these design(s) for any purpose other than for project(s) to be executed by POWERGRID prior to the period of 5 years as above, the Contractor shall obtain a written permission from POWERGRID to this effect. The permission shall be granted or otherwise by POWERGRID keeping in view the specifics of the case and POWERGRID shall be sole judge in this regard.

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

- b) The Contractor may also use previous structure designs and associated foundation designs meeting specification requirements, which have been designed by them for any other project of POWERGRID, having copyright

retained thereof with POWERGRID, without any financial implication and without any written permission from POWERGRID as per para (a) above.

- c) In case the Contractor uses previously designed structure and associated foundation designs meeting specification requirements, developed by the Contractor for any other utility/developer, POWERGRID shall be free to use designs and reproduce all drawings, documents and other material for the purpose of the Contract including, if required, in its any other project and for operation and maintenance, without any financial implication. The contractor shall ensure to submit only those documents for which they hold copyright.
- d) Also, all the drawings indicated at (a) & (b) above shall carry the following statement and shall be displayed conspicuously on the drawing:

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