



ODISHA POWER TRANSMISSION CORPORATION LTD.

PACKAGE: 25/2019-20: Enlistment of Firms in rate contract for supply of hot dip Galvanized structure materials (HT & MS) and Nut & bolts for Transmission Line towers and Substation equipment structures as per OPTCL design.

TECHNICAL SPECIFICATION

e-Tender Notice No. **CPC-25/2019-20**
Tender Specification No. **Sr. G.M-CPC- e-Tender-G.I. structure (line & S/s) R/C-25/2019-20**



TECHNICAL SPECIFICATION

PART- I

SUPPLY OF TOWER STRUCTURES FOR THE TRANSMISSION LINE OF OPTCL

1.0 SCOPE

1.1 OPTCL intends to procure hot dip Galvanized structure materials (HT & MS) and Nut & bolts for Transmission Line towers (400kv, 220kv, 132kv & Multi circuit) and Substation equipment structures as per OPTCL design.

For this purpose, OPTCL invites sealed bids under single stage two part bid system in e-tendering mode only for enlistment of reputed manufacturers for supply of hot dip Galvanized structure materials (HT & MS) and Nut & bolts in rate contract with PRICE VARIATION basis [PV shall be drawn as per WPI formula], which will remain valid for a period of 02(Two) years from the date of enlistment.

Firms shall quote their rates for their own design of towers as well as the OPTCL design towers as per the enclosed schedule. The tower design shall be for 220 Multi circuit tower, 220 KV and 132 KV towers of three version and 4 version with both MS Steel towers and towers with combination of MS and HT Steels, Special type Towers of UR and its extensions, for which OPTCL shall provide bill of materials and out line drawings.

This specification also provides relevant data for design, proto fabrication, galvanizing and delivery FOR (destination) of transmission line towers including super-structure stubs, tower extensions, stub-templates, tower accessories (Hangers, U-bolts, bird guards, anti-climbing devices), bolts and nuts, step bolts, flat and spring washers etc. for utilization in OPTCL's transmission network. OPTCL may also procure only Tower structures, Stubs and their extensions as per their requirement from time to time and the firms quoting their rates must agree to supply the same without the other accessories as above.

a) Wind effects:

Tower shall be designed for reliability Level-I, Terrain category-I & Wind Zone-V Design wind pressure on towers, conductors, earth wire and insulator string in the range of 30.45 mt. And above 45 mt. Height shall be computed as per IS-802(Part/Sec-I) 1995 Bidder shall furnish the maximum wind pressure adopted in their design against each component mentioned above.

b) Design Temperatures:

The following temperature range for the power conductor and ground wires shall be adopted for the line design:

(i)	Minimum temperature:	5 deg. C
(ii)	Everyday temperature of conductor	32 deg. C
(iii)	Maximum temperature of Conductor	
1.	75 deg. C for ACSR/Zebra/Panther	90 deg. C for AAAC Moose.
2.	Ground wire exposed to sun	53 deg. C

The above values are subject to latest revision if any made in IS-802 (part-I/Sec-I) 1995

c) Maximum Tension:

Maximum tension shall be based on either:

i)	at 5 deg. C with 2/3 rd . full wind pressure	or Conform to IS 802-1995
ii)	At 32 deg. C with full wind pressure whichever is more stringent.	Part-I/Sec-I-Clause No.10.3

d) Factors of Safety & Span details:

i)	Factor of Safety	Should conform to IS-802 Part-I-1995
ii)	Normal span:	The normal span of the line shall be 350 meters of 220KV and 320 meters for 132 KV.
iii)	Wind & Weight Span	The wind and weight span to be adopted in the design of the structures shall be as follows
iv)	Wind span:	The wind span is the sum of the two half spans adjacent to the support under consideration. In case of towers located on a perfectly horizontal terrain, this shall be the normal span. For design purpose the wind on conductor shall be calculated on a wind span of at least 1.1 times the normal span
v)	Weight Span	The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower. All C and D type towers shall be designed for uplift spans (minimum weight spans in the following table) also. These are applicable both for pointed and square cross arms.

For details of cross arms and towers, the span limits given below shall prevail.

Tower type.	220 KV				132 KV			
	Normal condition.		Broken wire condition.		Normal condition.		Broken wire condition.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
A/DA & B/DB	525	100	315	100	500	100	300	100
C/DC & D/DD	600	100	360	100	500	100	300	100

1.2 The design of towers and their extensions shall be done conforming to the design parameters specified herein, the scope of design also includes supply of design calculation for towers and extensions including detailed structural/shop drawings of towers extensions and stub setting templates. The bidder, who has already type tested the various tower viz: 0-2°, +3, +6; 0-15°, +3, +6; 0-30°, +3, +6; 0-60°, +3, +6 (220 KV) in any nationally or internationally recognized laboratories, and conforming to our specification, may also offer the same.

1.3 Standards:

Except as modified in this specification, the material and work covered under this specification shall conform to the latest revision with amendments thereof of the following of Indian Standards and equivalent International Standards whenever indicated below.

Sl No	Bureau of Indian standards (BIS)	Title	International & Internationally recognized standard
1	IS:209	Specification for Zinc	ISO/R/752

2	IS: 2062	Structural steel (Standard quality)	ISO/R/660
3	IS: 432	Mild steel and medium tensile bars and for concrete reinforcement	BS-785CSA-G-30
4	IS: 802	Code of practice for use of structural steel in overhead transmission line Part-I/Section-I & Section2: Load and permissible stresses Part-II: Fabrication Galvanizing Inspection and Packing	
		PART-III: TESTING	
5	IS: 136	Technical supply conditions for threaded fasteners	
6	IS: 1893	Criteria of Earthquake resistant design structures	
7	IS: 2016	Plain washers	ISO/R/987
8	IS: 2551	Danger Notice Plates	
9	IS: 2629	Recommended practice for hot dip galvanizing of iron and steel	
10	IS: 2633	Method of testing uniformity of casting of zinc coated articles	
11	IS: 3063	Single coil rectangular section spring washers for bolts, bolts, screws	DIN-127
12	IS: 5358	Hot dip galvanized coatings on fasteners	
13	IS:5613 Part-1 & 2 Of Section-I	Code of Practices for design installation & maintenance of, overhead power line	
14	IS: 6610	Specification for heavy washers for steel structures	
15	IS: 6745	Methods of determination of weight of zinc coating of zinc coated iron and steel articles	

1.4 The standards mentioned above are available from

Reference/ Abbreviation	Name and Address from which the Standards are available
IS	BUREAU OF INDIAN STANDARDS Manak Bhavan, 9, Bahadur Shah Zafar Marg, NEW DELHI(India)
ISO	INTERNATIONAL ORGANISATION FOR STANDARDISATION, Danish Board Standardisation, Danish Standardising Street, Aurehoegbvej-12, DK-2900, Hellestrup, DENMARK
CSA	CANADIAN STANDARD ASSOCIATION 178, Rexdale Boulevard, Rexdale, Ontario, CANADA M9W IR
BS	BRITISH STANDARDS British Standard Institution, 101, Pentonville Road, N-19-ND-UK
DIN	DEUTSCHES INSTITUT FÜR NORMUNG Gurggrafenstrasse 5-10, Post Fach 1107 D-1000, Berlin - 30

Indian Electricity Rules 1956, Regulation for Electrical crossing of Railway tracks.	KITAB MAHAL , Baba Kharak Singh Marg, NEW DELHI – 110 001(INDIA)
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2.0 PRINCIPAL PARAMETERS

2.1 Electrical System Data:

a)	System voltage (kV rms)	220	132
b)	Max. voltage (kV rms)	245	145
c)	Lightning impulse withstand voltage (dry & wet) (kVp)	1050 to 1250	650 to 750
d)	One min. Power frequency withstand voltage (wet) (KV rms)	460	275
e)	Short circuit level (KA for 1 sec.)	40	31.5

2.2 Line data

2.2.1 Conductor

a)	Name	ACSR Zebra	AAAC Moose
b)	Strength & wire dia		
i)	Aluminium	54/3.18	61/3.55
ii)	Steel	7/3.18	---
c)	Conductors per	Single	Single
d)	Spacing between the conductors of same phase (sub-conductor spacing) (mm)	----	-----
e)	Inter-phase spacing (mm)	8,400	8,400
f)	Configuration		
i)	Single circuit	Delta	Delta
ii)	Double circuit	Vertical	Vertical
g)	Nominal Aluminium area (mm ²)	420	520(Alu. Alloy)
h)	Section area of Aluminium (mm ²)	428.90	603.7 (Alu. Alloy)
i)	Total sectional area (mm ²)	484.50	603.7
j)	Calculated resistance at 200 c (Max.) ohm/km per conductor	0.06915	0.05502
k)	Approx. calculated breaking load (KN)	130.32	159.8
l)	Modulus of elasticity (GN/M ²)	69	54
m)	Co-efficient of linear exp. Per degree cent.	19.3X10	23X10
n)	Mass of zinc in gms/sqm		
o)	Overall diameter (mm)	28.62	31.95
p)	Weight (kg/km)	1621	1666
q)	Minimum ultimate tensile strength (KN)	130.32	159.8
r)	Conductor tension at 32° C without external load		
i)	Initial unloaded tension		
ii)	Final unloaded tension		

2.2.2 Galvanized Steel Ground Wire

a)	Size (no. of strands/strand dia)7/3.15.....
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b)	Overall diameter (mm)9.45.....
c)	Standard weight (Kg/km)432.....
d)	Location of ground wire	One continuous ground wire to run horizontally on the top of the towers.
e)	Tensile load in each ground wire	
i)	At min. temp. of 5° C and in still air (kgs)	
ii)	At every day temp. of 32° C and still air (kgs)	
iii)	At 5° C and 2/3 rd of full wind (kgs)	

2.2.2.1 Towers

a)	Span lengths in meters	220 KV ACSR Zebra/Moose	220 KV AAAC Zebra	132 KV ACSR Panthor	132 KV AAAC panthor
i)	Ruling design span	300,335,350,375	300,335,350	300,315,325, 335	300,315,325
b)	Wind load (kg/sqm) on conductor	52	52	52	52
c)	Shielding angle with vertical	20°	20°	20°	20°
d)	Towers to be designed for heavy wind zone				

2.2.2.2 Insulator Strings

Sl. No	Particulars	Single Suspension string/ Single Tension string/	Double suspension string/ Double Tension string	Single Suspension string/ Single Tension string	Double suspension string/ Double Tension string
1.	No. of standard Discs (Nos) (220kV)	1X14/1X15	2X14/2X15	1X10/1X11	2X10/2X11
2.	Size of Disc	280	280	305	305
3.	Electromechanical strength (kg)	90/120 KN	90/120 KN	90/160 KN	90/160 KN

The towers should be also designed for Double circuit both for ACSR and AAAC Zebra for 220 KV and Double circuit ACSR and AAAC Panther for 132KV System of OPTCL .All the towers should be suitable for Double circuit. However, the tower should be designed in such a way that in case of single Circuit stringing, there should not be any unbalance. The towers should also be designed taking into consideration of other type of earth wires, insulators of highest tensile strength.

2.0 GENERAL TECHNICAL REQUIREMENTS

2.1 Tower Design – General

The employer is looking for a structurally safe design of transmission line towers to be installed on EHV lines keeping the loadings and line parameters detailed in this specification and in compliance with IS: 802 (Part-1/Sec-1)-1995, IS: 802(Part-1/Sec-2)-1992.

The Bidder may offer economical designs with rational sections or offer towers of recent design, proven in service and accepted by other reputed Central and State Sector Utilities and by OPTCL (Previously ODISHA POWER TRANSMISSION CORPORATION) confirming to this technical specification. The Bidder in the latter case shall forward documentation

of proto type tests conducted and acceptance given by the user authorities as also performance report for such towers in service.

2.2 Transmission Towers

2.2.1 General Description: The towers shall be of the following types.

- (a) Double Circuit (A, B& C) and their extensions of +3 mtr,6 mtr,+9 mts,+15mtrs and +24mtrs
- (b) Double Circuit (A, B, C & D) and their extensions of +3 mtr,6 mtr,+9 mts,+15mtrs and +24mtrs
- (c) Special Towers (River Crossing, Railway Track Crossing, Power Line Crossing etc.)
- (d) Multi circuit Towers for 220 KV System

2.2.2 The towers shall be of the self-supporting type, built up of lattice steel sections or members and designed to carry the power conductors with necessary insulators. Ground wires and all fittings under all loading conditions. Outline diagrams of the towers required are to be furnished by the Bidder.

2.2.3 The towers shall be fully galvanized structures built up of structural mild steel sections. All members shall be connected with bolts, nuts and spring washers.

2.2.4 Stubs and Superstructures:

(i) **Stub:** shall mean a set of four stub angles fully galvanized and shall include cleats, gussets, bolts and nuts, etc. the black portion of the stub being cast in foundation footings. Stub length shall correspond to foundation depth of 3-0 metres from ground level.

(ii) **Superstructure:** shall mean the galvanized tower assembly above the stubs which includes structural members like angle sections, cross arms, ground wire peaks, accessories and fittings such as gusset plates, pack washers, spring, washers, ladders, step bolts, anti climbing devices and such other items which are required for completing the towers in all respect. Steel and zinc required for manufacturing these items will be arranged by the supplier.

(iii) **Bolts, nuts, spring washers, D shackles, U bolts:** Supply of bolts and nuts and spring washers, hangers/D-shackles for attaching suspension strings and 'U' bolts for attaching ground wire suspension assemblies are included in the supply of tower.

The Bidder shall make his own arrangement for procurement of required Bolt- Nuts, accessories, attachments like 'D' shackles. 'U' bolts, anchor bolts, step bolts etc from the following approved vendor of OPTCL well in advance and supply as per scheduled completion period along with the inspection at sub vendor's premises.

Sl No	Name of the approved vendor of OPTCL
1	NEXO/GKW / ASP / MAHESWARI(P) FASTNERS & BRIGHT PVT LTD / REMAX

The bolt nuts shall be procured from the above manufacturer's approved by OPTCL. For any other make of bolt nuts, the Bidder will have to take prior approval of the OPTCL. For such approval the Bidder has to submit the following in respect of prospective bolt-nut supplier.

- (1) Plant Capacity per annum.
- (2) Type test reports for bolt nuts to be supplied (not older than 5 years).
- (3) List of orders executed / under execution.
- (4) However, OPTCL reserves right to test the samples of Bolts & nuts of the proposed Bolt-nut supplier before approving the make. OPTCL is at liberty to have samples of steel, zinc etc. to be used, test, check in any Laboratory recognized by the Government at the cost of Bidder and reject the material if found below standard.

(5) The zinc used for galvanizing of fabricated materials shall be electrolytic high grade zinc (99.95% Purity).

(iv) **Procurement of Steel and Zinc:** The following provisions shall apply in connection with the procurement of steel and zinc by the supplier.

(a) The steel used for fabrication of tower parts extensions, templates etc. shall be of mild steel of tested quality as per IS: 2062 GRA.

(b) The Bidder shall take into account the fabrication wastage while quoting the rates. The employer will not accept any liability in connection with the wastage of steel during fabrication or otherwise.

(c) The Bidder shall indicate in his offer the sizes of steel sections which are proposed to be used by him in the design of towers.

(d) Substitutions, if any, of steel sections of the tower parts by higher sizes, due to non-availability or otherwise shall be to the supplier's account. The employer will not accept any liability on this account.

(e) The contractor shall procure all structural steel members i.e. Angles, tees, Plates, nuts & bolts etc. conforming to relevant I.S. Codes from main producers as approved by the Ministry of Steel namely SAIL, TISCO, ISCO and RINL. All MS angles, Tees and Plates shall be of grade 'A' as per IS: 2062-1999 and IS: 8500-1991. Samples shall also be taken and got tested by the Engineer-in-charge as per the provisions in this regard in the relevant I.S. Codes. In case the test results indicate that the steel arranged by the contractor does not conform to I.S. Codes, the same shall stand rejected. The proof of manufacturer of structural steel members from virgin billets purchased from main steel producers is to be furnished by him before tower member / templates are cut.

(f) Structural steel section not available from main producers can be procured from secondary producers/re-rollers subject to production of proof of manufacture of structural steel members from virgin billets produced from main steel producers before starting fabrication work. In case of sections not rolled by main producers, can be procured from re-rollers provided.

Production of proof of manufacture of structural steel members from virgin billets produced from main steel producers before starting fabrication work.

- Re-rolling of structural steel sections is done from billets/ingots of tested quality.
- Re-rolled sections are duly tested as per relevant standard.

(g) The zinc used for galvanizing fabricated material shall be of High Grade Electrolytic zinc.

2.2.5 Extensions:

a) The towers shall be designed so as to be suitable for adding 3 metres, 6 metres, 9 metres extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.

b) The Bidder shall have to design leg extensions for all types of towers ranging from minus 3 metres to plus 9 metres at intervals of 1.5 metres and such leg extensions shall be suitable for being fitted to a normal tower as well as a tower with extensions. This is to enable tower spotting in hilly terrain.

2.2.6 Stub setting Templates:

Stub templates shall be designed and supplied by the supplier as per requirement for all types of towers with or without extensions. Stub templates for standard towers and towers with extension shall be of fixed type. The stub templates shall be painted with anti-corrosive paints.

2.2.7 Fasteners: Bolts, Nuts & Washers to be used for the towers

2.2.8 All bolts shall be of property class 5.6 and nuts of property class 5.0 IS: 1367 (Part -3) 1991 and IS: 6639-1972 shall conform to IS: 12427, they shall be galvanized and shall have hexagonal heads and nuts, the heads being forged out of solid steel rods and shall be truly concentric and square with the shank. The shank shall be perfectly straight.

2.2.9 Manually threaded bolts shall not be used, the length of bolts should be such that the threaded portion shall not extend into the place of contact of the members.

2.2.10 (i) The bolts shall be threaded to take the full depth of the nut and threaded far enough to permit VARIABLE gripping of the members, but not any further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit hand tight to the point where the shank of the bolt connects to the head.

(ii) Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of electro-galvanized steel and of the positive lock type. Their thickness shall be 2.5 mm for 12 mm dia bolts, 3.5 mm for 16 mm dia bolts and 4.5 mm for 20 mm dia bolts.

(iii) The Bidder shall furnish bolt schedules giving thickness of members connected, size of bolts and nuts, the length of the shank, the length of the threaded portion of bolts, sizes of bolt holes, thickness of washers and any other special details of this nature.

(iv) To obviate bending stress in bolts or to reduce it to a minimum, no bolt shall connect aggregate thickness of more than three (3) times its dia.

(v) The bolt positions in assembled towers shall be as per IS: 5613 (Part-I/Section-I) (Part-II/Section-2)-1985.

(vi) Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

3.0 TOWER ACCESSORIES

3.1 **Step Bolt Ladders:** These bolts shall be of property class 4.6 conform to IS: 6639-1972. Each tower shall be provided with step bolts on one of the main legs, of not less than 16 mm diameter and 175 mm long, spaced not more than 400 mm apart and extending from about 2.5 metres above the ground level to the top of the tower. Each step bolt shall be provided with two nuts on one end to fasten the bolt security 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 1.5 KN and shall be used as a ladder for climbing.

3.2 **Anti-climbing devices:** This shall conform to IS: 5613 (Part-I/Sec -I), 19085. Fully galvanized barbed wire type anti-climbing device shall be provided at a height of approximately 3 metres as an anti-climbing measure. Four layers of barbed wires will be provided each inside and outside the tower in horizontal plane, spacing between the layers being 140 to 150 mm. The towers to be designed by the supplier shall have provision to fix the barbed wire as indicated above. Thus the angle pieces with notches for accommodating barbed wire shall be designed and supplied with the towers along with provision for suitable bolt holes on leg members for fitting bolt holes on leg member for fitting the angles. The scheme of the anti-climbing device shall be submitted along with the tower drawing. Barbed wire shall be included in the scope of bidder.

3.3 Insulator strings and ground wire clamp attachments: For the attachment of suspension insulator strings a suitable swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free swinging of the string. The hanger shall be designed to withstand an ultimate tensile strength of 11.500 kg.

(a) For ground wires at suspension towers suitable 'U' Bolts strong enough to withstand the full designed loads shall be provided to accommodate the hook of the ground wire suspension clamps.

(b) At tension towers, horizontal strain plates of suitable dimensions on the underside of each power cross-arm tip and at the top ground wire peak shall be provided for taking the 'D' Shackles of the tension insulator strings or ground wire tension clamps, as the case may be. Full details of the attachments shall be submitted by the supplier for the employer's approval before commencing with mass fabrication.

3.4 Phase Plate: Phase plate shall be of mild steel of 16 gauge vitreous enameled at back and front, circular in shape and diameter 75 mm. One set of phase plate shall be consisting of 3 plates red, yellow and blue coloured accordingly to indicate the phase of the conductor. There shall be one fixing bolt on the plate. This shall conform to IS: 5613 (Part-II/Section01) of latest edition.

3.5 Number Plate: The number plate shall be mild steel vitreous enameled at back and front, 200 mmx 150 mm, rectangular shape and inscribed thereon shall be the number of the tower location preceded by letter corresponding to the short name of the line and the type of towers. There shall be two fixing bolts on both end of the plates. The dimension and details of the number plate shall be as per IS: 5613 (Part-II/Section1 & Section-2), 1985.

3.6 Danger Plate: These shall be of mild steel vitreous enameled at back and front 250 x 200 mm rectangular shape and inscribed thereon shall be in signal red the work 'DANGER' with its Oriya and Hindi translation and also with the inscription of Bone and Skull and voltage of the line. There shall be two holes on the plates for fixing. This shall conform to IS: 2551 (latest edition).

4.0 DETAILS TO TOWER FABRICATION WORKMANSHIP

4.1 Except where hereinafter modified details of fabrications shall confirm to IS: 802 (Part-II)-1978.

4.2 But splices shall generally be used such that the inside cleat angle and outside plates are designed to transmit load. The inside cleat angle shall not be less than half the thickness of the connected heaviest member plus 2 mm. Lap splices may also be used for connecting members of unequal size in such a manner that the inside angle of the lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the members connected through bolts. But as well as lap splices shall be made as above and as close to and above the main panel point as far as possible.

4.3 Joints shall be so designed so as to avoid eccentricity. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where connections are such that the elimination of the gusset plates would result in eccentric joints then gussets plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plate, required to transmit stress, shall not be less than that of the thinnest of connected member but not less than 5 mm in any case.

The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate where necessary so as to avoid the use of filler and it shall be connected at the point of inter-section by one or more bolts.

4.4 The tower structures shall be accurately fabricated to bolt together easily at site without any strain on the bolts.

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

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

4.6 The structure shall be designed such that all parts are accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depressions are likely to hold water.

All similar parts shall be made strictly interchangeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which shall not injure the materials so that when assembled, the different matching surfaces are in close contact throughout. No rough edges shall be permitted anywhere in the structure.

5.0 DRILLING AND PUNCHING

(a) 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.

(b) Holes for bolts shall be drilled or punched with a jig but drilled holes are preferred. The following maximum tolerance of accuracy of punched holes is permissible.

(i) Holes must be perfectly circular and no tolerance in this respect is permissible.

(ii) 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 punched holes should not exceed 0.8 mm on diameter.

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

(c) All burrs left by drills or punches shall be removed completely when the tower members are truly opposite to each other. Drilling or reaming to enlarge defective holes is not permitted.

6.0 ERECTION MARK:

Each individual member shall have an erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be done with marking dies of 16 mm size before galvanizing and shall be legible after galvanising. The erection mark shall be A-BB-CC-DDD where:

A: Employer code assigned to the supplied (alphabet)

BB: Supplier's mark (Numerical)

CC: Tower type (Alphabet)

DDD: Number mark to be assigned by the supplier (Numerical)

7.0 GALVANIZING

The super structure of all towers and stubs upto 150 mm below plinth level (Top of concrete pedestal) shall be galvanized. Galvanizing of tower members and stub shall be in conformity with IS: 4759-1984 and shall be done after all fabrication work has been completed except that the nuts may be tapped or return after galvanizing. Threads of bolts and nuts after galvanizing shall have a neat fit and shall be such that they can be turned with fingers throughout the length of the threads of bolts and they shall be capable of developing the full strength of the bolts. Spring washers shall be electro-galvanized as per Grade – 4 of IS: 1573 – 1986. Galvanizing for fasteners shall conform to IS: 1367 (Part-XIII) – 1978.

8.0 QUANTITIES AND WEIGHTS

8.1 The quantities stated in Annexure-I are only provisional. Final quantities will be informed by the employer to the supplier on completion of detailed survey. However, bids will be evaluated based on quantities indicated in the Annexure – I.

8.2 The employer reserves the right to order for the final quantities at the rates quoted in the bid, which shall be valid throughout the pendency of the contract.

8.3 The unit weight of each type of tower stubs, super structure and extension be furnished by the Bidder. The weight of tower shall mean the weight of tower calculated by using the black section(non galvanized) weight of steel members including stubs, of the sizes indicated in the approved fabrication drawings and bills of materials, without taking into consideration the reduction in weights due to holes, notches, cuts, etc. but taking into consideration the weight of special fittings.

9.0 TOWER DESIGNS SUPERSTRUCTURE

9.1 Wind Pressure

The wind pressure on towers, power conductors and earth wire shall be as per IS: 802 (Part-I/Sec-I) – 1995. 280

9.2 Design Temperatures

The following temperature range for the power conductor and ground wires shall be adopted for the line design confirming to IS: 802 (Part –I/Sec – I) – 1995.

- i) Minimum temperature: 50°C.
- ii) Every day temperature: 32°C
- iii) Maximum temperature of Conductor: 75°C [For ACSR Zebra/Panther]
90°C [For AAAC Moose equivalent]
- iv) Ground wire- 53°C (exposed to Sun)

9.3 Factors of Safety & Span details

(a) **Factory of safety:** The factor of safety based on crippling strength of struts and elastic limit of tension members shall not be less than 2(two) under normal condition and 1.5 (one and a half) under broken wire conditions for all the members of the towers and their cross arms.

(b) **Normal Span:** The normal span of the line shall be 300metres for 220 kV and 250metres for 132 kV.

(c) **Wind and weight spans:** The wind and weight spans to be adopt in the design of the structures shall be as follows:

(i) **Wind Span:** The wind span is the sum of the two half spans adjacent to the support under consideration. In case of towers located on an perfectly horizontal terrain, this shall be the normal span. For design purposes the wind on conductor shall be calculated on at least 1.1 times the normal.

(ii) **Weight Span:** The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower. All C and D type towers shall be designed for uplift spans (minimum) weight spans in the following table also. These are applicable both for pointed and square cross arms.

For details of cross arms and towers, the span limits given below shall prevail.

WEIGHT SPANS

Tower Type	Normal Condition		Broken wire condition		Normal Condition		Broken wire condition	
	Max	Min	Max	Min	Max	Min	Max	Min
A & B	525	100	300	100	488	100	195	100
C & D	600	100	300	100	576	100	195	100

9.4 Conductor and Ground wire Configuration: For single circuit towers the three phases shall be Delta formation. One number of ACSR/AAAC conductor shall be used for each phase. One galvanized steel wire shall be used as ground wire. The ground wire shall be continuous and shall be provided above the conductors at suitable elevation to offer effective shielding and safe clearances. For double circuit towers the phases shall be in vertical formation with phase to phase horizontal spacing of not less than 8.4 meters and vertical 4.9 meters for 220 kV.

9.5 Loads on Towers

(i) **Transverse Loads:** Transverse load due to wind on towers conductors and under broken wire earth wire shall be calculated in accordance with IS: 802(Part-I/Sec-I)-1995.

(ii) **Longitudinal Loads:** Longitudinal loads due to wind on towers conductors and shield shall be calculated as per IS: 802 (Part-I/Sec-I)-1995.

(iii) **Vertical Loads:** The vertical load due to conductors and ground wire shall also include 150 kg ss weight of a Lineman with tools. These loads are in addition to the vertical loads due to insulator fittings and the dead weight of the structure. The weight of a Lineman with tool should not be considered in minimum vertical load calculation. An additional erection load of 3.5 KN shall also be considered for the design of the tower. The stringing procedure shall ensure that the above vertical loads are not exceeded. For calculating vertical loads the following insulator weights may be considered.

Type string	220 KV	132 KV
Each single suspension insulator string	160 kg	120 Kg
Each double suspension insulator string	320 kg	240 Kg
Each double tension insulator string	420 kg	320 Kg
Pilot string for 60° tower	160 kg	120 Kg

iv) Broken Wire condition

a) **Suspension Tower Type A/DA:** Breaking of any one power conductor in one phase only, resulting in instantaneous unbalance tension of 50% of conductor tension at 32°C without wind or breaking of one earth wire resulting in an unbalance tension equal to the maximum tension of the ground wire whichever is more stringent is to be considered for design along with appropriate impact factor.

b) Tower Type B & C

Breakage of two phases on the same side and on the same span or breakage of any one phase and any one ground wire on the same span whichever combination is more stringent along with appropriate impact factor for a particular member.

c) Tower Type D/DD

Breakage of all the three phases on the same side and on the same span or breakage of two phases and any one ground wire on the same span, whichever combination is more stringent along with appropriate impact factor for a particular member. Cross arms for angle tower shall be of equal length for both sides.

v) Design Load

Employer's requirement for design longitudinal and transverse loads shall confirm to IS: 802(Part-I/Sec-I)-1995. The Bidder shall furnish the details of design loads proposed to be adopted in the tower design in accordance with this specification. The design criteria and other special requirements as stipulated for special towers shall be applicable for river crossing/special towers.

9.6 Tower Steel Sections:

i) **Tower steel sections:** Steel sections of tested quality in conformity with IS: 2062 GRA are to be used in towers, extensions and stub setting templates. No individual members shall be longer than 6000 mm. For designing of towers only rationalized steel sections shall be 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. However, design approval for such substitution shall be obtained from the employer.

ii) **Thickness of Members:** The minimum thickness of angle sections used in the design of towers, shall be kept not less than the following values:

- Main corner leg members excluding the ground wire peak and main cross arm 6 mm.
- For all other main members 5 mm.
- Redundant members 4 mm.

iii) **Bolt Arrangement:** The minimum bolt spacing and rolled edge distance and sheared edge distances of sections from the centers of the bolt holes shall be provided as furnished in Table below.

Dia of Bolts (mm)	Hole Dia (mm)	Min. bolt Spacing (mm)	Min. rolled Distance (mm)	Min. Sheared Edge distance (mm)
12	13.5	30	16	19
16	17.5	40	20	23
20	21.5	50	25	27

Bolts sizes mentioned above shall only be used. The minimum width of flanges without bolt holes shall be 30 mm. For the purpose of calculating stress and bearing stress for bolts refer clause 14.4 and 14.5 of IS: 802 (Part-I/Sec-2)-1992.

iv) **Allowable Stress:** Structural steel angle section manufactured according to the latest ISL: 808(Part-V & VI) and tested according to the latest edition of IS:2062 and having its yield strength not less than 255 N/mm. sq. shall be used in the fabrication of tower members.

v) **Axial Stress in tension:** The estimated tensile stress in various members multiplied by the appropriate factors of safety shall not exceed the value given by the formula specified in Clause 9.2.1 of IS:802(Part-I/Sec-2)-1992.

vi) Axial Stress in Compression: The estimated compressive stress in various members multiplied by the appropriate factors of safety shall not exceed the value given by the formula specified in Clause 9.2.1 of IS:802(Part-I/Sec-2)-1992.

vii) Slenderness ratio: Slenderness ratio for members shall be computed in accordance with IS:802(Part-I/Sec-2)-1992. Slenderness ratio for compression and tension members shall not exceed the values specified therein. The following maximum limits of the slenderness ratio shall be adopted i.e. the ratio of unsupported length of the section in any place to the appropriate radius of gyration.

a)	For main corner leg member including the corner members of earth wire peak and the lower corner members of the arms...	150
b)	For other members having calculated stresses....	200
c)	For redundant members....	250
d)	For members having tensile stress only....	375

viii) Erection Stress: Where erection stresses combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, then additional materials shall be added to the member or such other provision made so as to bring the working stress within the specified limit. For the purpose of this clause the specified working stress shall be the ultimate stress divided by the factor of safety of 2.0.

ix) Design calculation and Drawings: The following design calculations and drawings are required to be furnished to the employer.

- a) **Along with the Bid:** Detailed design calculations and drawing for each type of tower.
- b) **On award of Contract:** The supplier shall submit design of tower extension, stub templates and loading/rigging arrangement of tower testing to enable the employer to make preliminary check regarding structural stability of tower tests. Upon successful testing of tower and subsequent approval of designs, drawings and bill of materials, the supplier shall furnish Photostat copies of the following in 6(six) copies to the employer for necessary distribution along with one copy of reproducible print.
 - a) Detailed design calculations along with drawings of towers and foundations.
 - b) Detailed structural drawings indicating section size, length of member. Sizes of plate along with hole to hole distances, joint details etc.
 - c) Bill of materials indicating cutting and bending details against each member.
 - d) Shop drawings showing all details relevant to fabrication.
 - e) All drawings for the tower accessories.

The supplier is required to submit four copies of the drawings with Photostat copies mentioned above for approval by the employer while submitting the designs, structural drawings, bill of materials & any other drawings pertaining to the subject transmission line. The supplier shall clearly indicate in each drawing the project code number, if any, specification no, name of transmission line, letter reference no. and date on which the submissions are made. The said procedure is to be followed while submitting the distribution copies.

9.7 Statutory Clearances: This should be as per ISS.

(i) Ground Clearances: The minimum ground clearance from the bottom conductor shall not be less than 7.00 meters for 220 kV at the maximum sag conditions i.e. at maximum temperature and in still air. However, to achieve the above clearance the height of the tower shall be increased in the following manner:

(a) An allowance of 4% of the maximum sag shall be provided to account for errors in stringing.

(b) Conductor creep shall be compensated by over tensioning the conductor for a temperature of 26°C lower than the stringing temperature. In case of rail track crossings the minimum height above rail level of the lowest portion of any conductor under conditions of maximum sag, in accordance with the regulations for Electrical Crossing of Railway Tracks are given in Table below.

Sl No	Type of work	Inside stn. Limits (mm)	Outside stn. Limits (mm)
a)	For un-electrified track and tracks electrified on 1500 V.DC		
	i) For metre/narrow gauge	10,000/17,600	
	ii) For broad gauge	11,200	8,800
b)	Tracks electrified on 25 kV AC for meter, narrow and broad gauge	15,400	13,400

Minimum clearance between the subject power line and any other power line crossing shall not be less than 7000 mm.

(ii) Live Metal Clearance: The minimum live metal clearance to be provided between the live parts and steel work of superstructure shall be as given in IS:5613 (Part-2/Sec-I). The Bidder may adopt separate cross arm design and length for 'D' type towers under dead end conditions provided adequate live metal clearance is available with at least 15° angle and also provided that all the other specified conditions of this specifications are fulfilled. In case pilot insulator strings are proposed to be used, the angle of swing to be considered shall be minimum of 15°. In computing live metal clearances, the dimensions of suspension and tension string shall be taken as given in drawings attached herewith. The design of the towers shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the insulator strings.

(iii) Angle Shielding: The angle shielding, defined as the angle formed by the line joining the center lines of the ground wire and outer conductor in still air, at tower supports, to the vertical line through the center line of the ground wire shall not be more than 30°. The drop of the ground wire clamp which is employer supplied item should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of ground wire suspension clamp along with U-bolt may be taken as 150 mm.

(iv) Midspan Clearance: The minimum vertical span clearance between any of the earth wire and the nearest power conductor under all temperatures and in still air condition in the normal ruling span shall be 8.10 meters for 220 kV. Further the tensions of the earth wires and power conductors shall be so co-ordinated that the sag of earth wires shall be at least 10% less than that of the power conductors under all temperatures and loading conditions.

9.8 Packing: Angle sections shall be wire bundled, cleat angles, gusset plates, blackets, filler plates, hanger and similar other loose items shall be netted and bolted together in multiples or securely wired together through holes. Bolts, nuts, washers and other attachments shall be packed in double gunny bags, accurately tagged, in accordance with the contents. The packing shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.

9.9 Special Towers:

(i) Special towers are to be used for Major River crossing requiring very long spans. These towers shall form part of the Bidder's scope. Unit rates for design, fabrication, galvanizing, testing and supply for such towers shall be quoted in the appropriate schedule of Volume IB. Anchoring of Major River crossing towers, shall be with 'D' or DD type towers. All the requirements as meant for standard towers shall apply for such special towers except those noted in the following clauses.

(ii) **Shielding Angle:** The shielding angle shall not be greater than 30°.

(iii) **Clearances:** The minimum clearance of lowest point of power conductor from the highest flood level in navigable rivers for crossing towers shall be obtained from the navigation authority. The minimum electrical clearances between live parts and tower body and cross arm member shall be the same as for normal towers.

(iv) **Stub location:** The approximate height of foundation on which stub for river cross towers are to be set, over the highest flood level of the river shall be fixed only after employer's approval.

(v) **Angle of Deviation:** The minimum angle of deviation to be considered for special towers is 2° and all live material clearances are to be computed considering double suspension insulator strings as per drawing enclosed.

(vi) Factors of Safety:

(1) Towers:

The minimum factors of safety for towers shall be:

a) Under normal conditions 2.0

b) Under broken wire conditions 1.5

(2) **Conductor and Earth wire:** The minimum factor of safety for conductors and ground wire shall be 2.5 maximum tension corresponding to 2/3rd full wind pressure at minimum temperature or full wind pressure at the mean annual temperature such that the initial unloaded tension at the mean annual temperature do not exceed 30% of the ultimate strength of conductor and ground wire respectively.

(vii) **Wind Loads:** The procedure for wind load calculation on conductor and ground wire shall be the same as for normal structures.

(a) The wind pressure values on tower shall be based on IS:802(Part-I/Sec-I)-1995.

(viii) Longitudinal Loads:

a) The longitudinal loads due to power conductors and earth wires for suspension towers shall be nil under normal conditions and 100% of the maximum tension of bundled conductors or earth wire under broken wire conditions.

b) Under normal conditions, unbalanced longitudinal pull due to difference in tension in ruling span for river crossing towers on one side and span of the line on the other wise shall also be considered for the design of anchor towers.

10.0 TESTS

10.1 General

(a) All standard tests including quality control tests in accordance with IS:802 (Part-III)-1978 shall be carried out.

(b) A galvanized tower of each type complete with 6 meters extension shall be subjected to design and destruction test. The tower shall be tested with nuts and bolts of the same make and type which are proposed to be used on the line. The supplier shall submit to

the employer for approval, a detailed programme and proposal for testing the towers showing the method of carrying out the tests and the manner of applying the loads. The supplier on receipt of such approval shall intimate the employer about carrying out of the tests at least 30 days in advance of the scheduled date of tests during which time the employer will arrange to depute his representatives to witness the tests. Six copies of the test reports thereof shall be submitted to the employer for approval.

(c) In case of premature failure, the tower shall be retested and steel already used in the earlier test shall not be used again. The supplier shall provide facilities to the employer for inspection of materials during manufacturing stage and also during testing of the same.

(d) No part of any tower subject to test shall be allowed to be used in the work. The prices to be quoted for such type tests shall be after allowing rebate for the scrap value of the tested tower which is to be retained by the supplier.

(e) The supplier shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully undergone the tests. In case any deviation is detected the supplier shall replace such defective towers free of cost of the employer. All expenditure incurred in erection, to and fro transportation, any other expenditure or losses incurred on this account shall be fully borne by the supplier. No extension in delivery time shall be allowed on this account. The employer, however, reserves the right to waive off the testing of the towers, provided the supplier had earlier successfully tested, erected and commissioned similar towers and certificates for such tests carried out earlier are furnished duly certified by the employer and is found acceptable.

(f) Each type of tower to be tested shall be a full scale prototype galvanized tower and shall be erected vertically on rigid foundation with the stub protruding above ground level as provided in the design/drawing between ground level and concrete level.

(g) The suspension tower to be tested shall be with hanger and 'U' Bolt as per approved design/drawings. The tension tower to be tested shall similarly be with the strain plate as per approved design/drawings.

(h) In case of any premature failure even during waiting period, the tower shall be retested with rectified members. However, if the failures are major in nature and considerable portion of tower is to be re-erected then in such cases all the tests which have been carried out earlier are to be re-conducted to the entire satisfaction of the employer.

(i) The sequence of testing shall be at the discretion of the employer.

10.2 Test for Galvanization: Galvanization of the members of the tower shall withstand tests as per IS: 2633.

10.3 Inspection:

10.3.1 The supplier shall keep the employer informed well in advance of the commencement of manufacture, progress of manufacture thereof and fabrication of various tower parts at various stages. So that arrangements could be made for inspection by the employer.

10.3.2 The acceptance of any batch of items shall in no way relieve the supplier of any his responsibilities for meeting all the requirements and intent of this specification and shall not prevent subsequent rejection if any item of that batch is later found defective.

10.3.3 The employer or his authorized representatives shall have free access at all reasonable time to all parts of the supplier's works connected with the fabrication of the material covered under the contract for satisfying them that the fabrication is being done in accordance with the provisions of this specification.

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

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

10.3.5 Defects which occur during fabrication shall be made good with the consent of and according to the procedure to be laid down by the employer.

10.3.6 All gauges and templates necessary to satisfy the employer for conducting tests shall be made available at the test site by the supplier.

10.3.7 The correct grade and quality of steel shall be used by the supplier. To ascertain the quality of steel the employer may at his discretion get the material tested at an approved laboratory.

10.4 Schedule of requirements:

10.4.1 The present schedule of requirements of different types of towers will be informed to the supplier at the time of lacing order. The supplier should be ready to supply the future tower requirement of OPTCL for the rate contract period in very short notice.

10.4.2 The time frame for executing the work is also indicated in this schedule. The supplier has to match the supply and delivery of stubs, tower-parts etc. to complete the work within the time schedule desired by the employer. Generally the supplier should supply @400MT per month as per the requirement.

10.4.3 The supplier shall, as far as possible, despatch the tower material as completed towers in order to enable erection of complete tower structures at site. Payment for the completed towers shall only be released in case running bills are allowed.

10.5 Schedule of prices: The prices for supply of materials shall be furnished in the relevant schedule in the manner specified in annexure-I and Annexure-II.



TECHNICAL SPECIFICATION

PART- II

SUPPLY OF STRUCTURES FOR SUBSTATION OF OPTCL

Technical specification substations structure.

1. GENERAL

1.1 Design of structures: Substation structures shall be designed in accordance with the requirements of IS 802/1992. The wind pressures for the substation sites shall be as per data in schedules and wind pressure map of the State of ODISHA. **The structure may be MS or mixed of MS and HT Steel. The contractor shall quote the rate as per the Annexures.**

Structures shall be designed to carry the equipment and associated connections, insulator sets, earth conductors and all fittings under all specified conditions of service of operation and loading.

The substation gantry structures shall be designed to carry the down lead spans and the Contractor shall be provided with the details of location of the terminal tower and the type of conductor used on the overhead line in order to do so. All structures intended to carry equipment or materials on more than one side of the structure shall be designed to cater for all possible stages of equipment erection, Installation and maintenance. The substation gantry structures shall be designed to terminate the overhead line down lead spans, which may enter ± 15 degrees vertically.

1.2 Conductor spacing and clearances: Structures shall be dimensioned to maintain the specified minimum phase to earth, phase to phase and insulation height clearances under conditions of maximum conductor swing and sag. The spacing between individual phase conductors, and the clearance between clamps, arcing horns, jumper loops or other live metal and the structure steelwork and other obstacles, under all specified conditions of temperature and loading shall not be less than the specified values.

1.3 Applied loads: The assumed maximum simultaneous loadings on the substation structures shall be as follows –

1.3.1 Wind loads: The normal wind load shall be given by the wind velocity, as stated in the Schedules, acting on the whole projected area of the phase and earth conductors and where applicable, the horizontal resultant of the maximum line and earth conductor tensions, together with the wind pressure, as stated in the Schedules, on 1.5 times the projected area of the members of one face of the structure plus the projected area of the plant being supported.

1.3.2 Vertical loads: The normal vertical load shall be the mass of the line and earth conductors, insulators, the plant item, insulator fittings, earth conductor fittings, spacers, line traps and ancillary apparatus where applicable. For the overhead line-terminating span it shall be assumed that the mass of the conductors and earth wires shall include the actual total mass of the down lead span.

1.4 Electro mechanical loads: Electro dynamic forces due to short circuit conditions snatch forces, and other similar loads shall be computed and applied for design of structures. The different mechanical effects due to short circuit current etc. shall be estimated as per IEC 865 and CIGRE guide No.7

1.5 Construction: The structures shall be of an approved design and construction. All stressed members (tension and compression) of steel structures shall consist of rolled steel sections unless otherwise approved. To facilitate inspection and maintenance all tall structures (other than equipment structures) shall be provided with step bolts and ladders complete with hoops. Handrails, screens, guards and other appropriate facilities shall also be provided for structures with a provision for platforms. Where the structure is to terminate overhead transmission lines supplied under another contract, suitable provisions shall be made to accept the transmission line insulator fittings and earth

conductor clamps. Means shall be provided for fixing and bounding GI flat strip to the steelwork at a minimum of two points. Earth connections shall be made to a vertical face, clear of the ground. Foundation bolts shall not be used for their attachment. GI flats for earth connections, bolts, and nuts washers etc. shall be included in the structures.

i) **Material:** The contractor shall procure all structural steel members i.e. Angles, tees, Plates, nuts & bolts etc. conforming to relevant I.S. Codes from main producers as approved by the Ministry of Steel namely SAIL, TISCO, ISCO and RINL. All MS angles, Tees and Plates shall be of grade 'A' as per IS: 2062-1999 and IS: 8500-1991. Samples shall also be taken and got tested by the Engineer-in-charge as per the provisions in this regard in the relevant I.S. Codes. In case the test results indicate that the steel arranged by the contractor does not conform to I.S. Codes, the same shall stand rejected.

ii) Structural steel section not available from main producers can be procured from secondary producers/re-rollers subject to production of proof of manufacture of structural steel members from virgin billets produced from main steel producers before starting fabrication work. In case of sections not rolled by main producers, can be procured from re-rollers provided production of proof of manufacture of structural steel members from virgin billets produced from main steel producers before starting fabrication work.

- Re-rolling of structural steel sections is done from billets/ingots of tested quality.
- Re-rolled sections are duly tested as per relevant standard.

(iii) The Bidder shall make his own arrangement for procurement of required Bolt- Nuts, and other accessories/ attachments from the following approved vendor of OPTCL well in advance and supply as per scheduled completion period along with the inspection at sub vendor's premises.

Sl No	Name of the approved vendor of OPTCL
1	NEXO/GKW / ASP / MAHESWARI(P) FASTNERS & BRIGHT PVT LTD / REMAX

The bolt nuts shall be procured from the above manufacturer's approved by OPTCL. For any other make of bolt nuts, the Bidder will have to take prior approval of the OPTCL. For such approval the Bidder has to submit the following in respect of prospective bolt-nut supplier.

- (1) Plant Capacity per annum.
- (2) Type test reports for bolt nuts to be supplied (not older than 5 years).
- (3) List of orders executed/ under execution.
- (4) However, OPTCL reserves right to test the samples of Bolts & nuts of the proposed Bolt-nut supplier before approving the make. OPTCL is at liberty to have samples of steel, zinc etc. to be used, test, check in any Laboratory recognized by the Government at the cost of bidder and reject the material if found below standard.
- (5) The zinc used for galvanizing of fabricated materials shall be electrolytic high grade zinc (99.95% Purity).

(iv) All rolled steel sections, flats, plates, bolt and nut bars used shall consist of steel manufactured by an approved process and shall be to the requirements of ISO 630 (minimum yield strength 255 N/mm²). The steel shall be free from blisters, scales, laminations and other defects. Steel sections shall preferably be Metric Standard sections chosen with a view to avoiding delays in obtaining material.

All members shall be cut to jig and all holes shall be drilled /punched as per provisions under the relevant standard. All parts shall be carefully cut and holes accurately located so that when the members are in position the holes will be truly opposite to each other before being bolted up. Drifting or reaming of holes will not be allowed.

Built members shall, when finished, be true and free from all kinks, twists and open joints, and the material shall not be defective or strained in any way.

If the structures are fabricated or galvanized by subcontractors, the Contractor shall, if required by the Project Manager, provide a resident inspector at the works of each sub contractor during the time that the steel work is being fabricated and galvanized.

All bolts and screwed rods shall be galvanized, including the threaded portions, all nuts and bolts shall be Hot Dip galvanized. Nuts may however be tapped after galvanizing and the threads, shall be oiled.

Except where specified to the contrary, all iron and steel used in the construction of the Contract works shall be galvanized after all swing, shearing, drilling, punching, filing, bending and machining are completed.

Galvanizing of all material shall be in accordance with the requirements of this specification. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material.

Other similar process shall not be used.

2.0 SUPPORT STRUCTURES OF SWITCHYARD

2.1 General: The scope of works covers design; fabrication, proto-assembly, supply and erection of galvanized steel structure for portals (columns, girders), lightning masts and equipment support structures.

Portals (columns, girders), lightning masts, and equipment support structures shall be lattice type structures fabricated from structural steel conforming to IS 226/2062 (latest). The design of all support structures for 400/220/132 and 33KV equipment is within the scope of the Contractor. It is stressed that the Contractor has to provide steel sections as per the standard drawings. However, if a higher section is required from design point of view the same shall be acceptable to the owner.

The scope shall include the supply of all types of bolts, nuts, hangers, shackles, clamps, anti-climbing devices, bird guards, climbing systems, insets in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, angles and bolts for structure mounted or ground mounted marshalling boxes (AC/DC marshalling box and equipment control cabinets), and any other items as required to complete the works.

The connection of all structures to their foundations shall be by base plates and embedded anchor/foundation bolts. All steel structures and anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least -0.610kg per sq. m. for structural members and 0.305 kg per square meter for fasteners. One additional nut shall be provided below the base plate, which may be used for the purpose of leveling. In unavoidable circumstances damaged galvanized surface shall be treated with zinc rich paint as per provision of the relevant standard.

2.2 Design requirements: The design of steel structures shall be done by Working stress method. The contractor will submit Design philosophy and a sample of calculations/analysis by using the formulae for approval before taking up detailed engineering and design works. Design and fabrication shall be as per provisions of IS 802-1977 and IS 800 (latest) for provisions not given in IS 802 and other relevant IS

standards. In addition, the work shall be in accordance with the IS 802 (latest) and as follows:

Minimum thickness of galvanized tower member shall be as follows:

Description	Minimum Thickness (in mm)
Leg members, Ground wire and Main members	8-6
Other members	6
Redundant members	5

- Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS 802 (latest)
- Minimum distance from hole center to edge shall be $1.5 \times$ bolt diameter minimum distance between center to center of holes shall be $2.5 \times$ bolt diameter.
- The minimum bolt diameter shall be 16 mm.

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each substation gantry structure shall be provided with step bolts not less than 16mm diameter and 175mm long spaced not more than 450mm apart, staggered on faces of one leg extending from about 2.5 meters above ground level to the top of the tower. The step bolts shall conform to IS 10238. Ladders on lighting masts and other tall structures shall be provided with safety guards.

All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS 802 (latest), seismic forces as per code IS 1893 (latest), 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 40kA.

Substation gantry structures shall be designed in accordance with IS 802 (latest) for the three conditions i.e. normal conditions (Three conductors on one side broken), broken wire condition and short circuit force. The design of all structures shall be based on the condition where stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.

A factor of safety of 2.0 under normal and (as well as) broken wire conditions and 1.5 under combined short circuit and broken wire conditions shall be considered for the design of switchyard structures. For purpose of design 110% of static tension pull and transverse reaction on the gantries as calculated for each span shall be considered.

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. The weight of a man with tools shall be considered as 150kg for the design of structures.

Torsional effect on towers and beams due to unbalanced forces may be taken care of as per American Code DS-10.

Terminal/line take off gantries shall be designed for a minimum conductor tension of four metric tones per phase for 400kV and two metric tones per phase for 220kV. The distance between terminal gantry and dead end tower shall be taken as 200 meters. The design of these terminal gantries shall also be checked considering ± 30 -degree deviation of conductor in both vertical and horizontal planes.

The girders shall be connected with lattice columns by bolted joints.

If luminaries are proposed to be fixed on gantries/towers, then proper loading for these shall be considered in the design. Also holes for fixing the brackets for lighting fittings should be provided wherever required.

Foundation bolts shall be designed for the loads for which the foundations are designed.

2.3 Design drawings, bill of materials and documents: The fabrication drawings to be prepared and furnished by the Contractor shall be based on the design approved by the Project Manager. These fabrications drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, bracing details, weld sizes and lengths, bill of materials in the proforma approved by the Project Manager, bolt details and all customary details in accordance with standard structural engineering practice whether or not approved by the Project Manager.

Fabrication work shall start only after the final approval of the design and fabrication drawings is accorded by the Project Manager.

Such approval shall, however, nor relieve the Contractor of his responsibility for the safety of the structure and good connections. Any loss or damage occurring due to defective fabrication, design, or workmanship shall be borne by the Contractor.

2.4 Fabrication of steel: The Contractor shall bear all the expenditure at all stages on account of loading/unloading, transportation and other miscellaneous expenses and losses and damages for all materials up to the fabrication yard/shop and thereafter to the erection site including all other expenses till the erection of work has been completed and accepted. His unit rates shall be deemed to be inclusive of all such incidental expenses and no extra shall be payable on any account in this regard.

The fabrication and erection works shall be carried out generally in accordance with IS 802 (latest). A reference however may be made to IS 800 (latest), in case of non-stipulation of some particular provision in IS 802 (latest). All materials shall be completely shop fabricated with proper erection marks for ready assembly in the field. All steel structure members shall be connected by means of bolt and nut unless otherwise welding is specifically approved.