

PROJECT400/220kV Switchyard for North Karanpura Super TPP (3x660MW) CUSTOMER: NTPC LTD.	
Technical Specification of 220 kV Double Circuit Transmission Line Section-2: TECHNICAL SPECIFICATION	TB-316-369-031TL REV.02

SECTION - 2

TECHNICAL SPECIFICATION OF 220kV D/C TRANSMISSION LINE

- Sub section-2: Specification for Lattice structure supply (9 pages)
- NTPC TECHNICAL SPECIFICATION (44 pages)

SUB SECTION - 2

2.0 GENERAL

This section covers the standard technical specification for GI Structures.

(In case any variance in Section-2 , NTPC specification shall prevail.)

2.1 STEEL MATERIAL

Mild Steel (MS) materials shall be tested quality and shall conform to IS:2062 and High Tensile (HT) Steel shall be tested quality and shall conform to IS: 8500. Steel material (Both HT and MS) should be procured from NTPC approved source.

Steel shall not be pitted and should be free from scales and rust. If the rolled section and plates are bent or distorted, bend or distortion shall normally be removed by the cold treatment. Straightening under hot stage shall be resorted to only under specific permission from BHEL. If any rolling defects viz., laminations, cracks etc. are discovered in the steel during the processing, it is to be rejected.

TOLERANCE:

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS:1852-1985.

No rolled or fabricated member shall deviate from straightness by more than 1/1000 of the axial length or 10mm whichever is smaller.

2.2 FABRICATION

GENERAL:

All the workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined true and square where so specified. All holes and edges shall be free of burrs. Shearing and cropping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Material at the shops shall be kept clean and protected from weather.

The fabrication of galvanized steel structures shall be carried out generally in accordance with IS:802 part. II, IS:800-1984. All materials shall be completely shop fabricated. Normally, butt splices shall be used. The components constituting the joint shall have a total strength greater than the heavier of the members connected. Lap splices may be used for connecting members of unequal sizes. The inside angle of lap splice shall be grounded at the heel to fit the fillet of the outside angle. The splices shall develop full strength of the members connected through bolts. Butt as well as lap splices shall be made as close to the main panel points as possible.

Joints shall be so designed and detailed as to avoid eccentricity as far as possible. However, where joints are such that the elimination of gusset plates

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES

would result into eccentric joints, gusset plates and spacer plates may be used in conformity with modern practices.

The use of filler in the connections shall be avoided as far as possible. The diagonal members in tension may be connected entirely to the gusset plate where necessary to avoid the use of fillers. Each diagonal shall be in one piece without splices or center gussets, and it shall be connected at the point of intersection by one or more bolts.

The gap between the ends of two connected members in butt joints shall not be more than 6 mm and less than 4mm.

The tower structure members shall be accurately fabricated to bolt together easily at site without any undue strain on them or the bolts.

Drain holes shall be provided at all points where pockets or depressions are likely to hold water.

For designing of towers , preferably rationalized steel sections shall be used. During execution of the project, if any particular section is not available same shall be substituted by higher section at no extra cost to owner and the same shall be borne by the bidder. However design approval for such substitution shall be obtained from owner before substation.

STRAIGHTENING:

For rolled steel material, if straightening or flattening is necessary, it shall be done by methods that will not injure the materials.

CUTTING:

Cutting may be effected by chopping, cropping, sawing or machine flame cutting. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

PUNCHING AND DRILLING:

Holes in members may be punched full size through material not over 12mm thick. Holes must be cleaned of burrs and ragged edges. Drilled holes shall be preferred. Holes made by drilling shall also be cleaned of burrs and ragged edges. Where several parts are to be drilled, they shall be first assembled, tightly clamped together and drilled through.

Punched holes must be square with plates and the walls of the holes shall be parallel. The following maximum allowance in 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 in diameter.

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES

- iii) Holes must be square with the plates. Holes at angle or slant shall not be permitted.

The minimum spacing of bolts and edge distances shall be as given below:

Bolt Diameter (mm)	Minimum Bolt Spacing (mm)	Maximum edge distance	
		Hole center To rolled Edge (mm)	Hole center to cut/ flame edge (mm)
16	40	20	23

WELDING:

The work shall be done as per approved fabrication drawings, qualified welding procedure specifications (WPS) and by qualified welders. Procedure qualification records (PQR) shall be maintained. Electrodes for shielded arc manual welds shall comply with the requirements of IS:814 - 1991. All welds shall be free from defects like blow holes, slag inclusions, lack of penetration, under cutting, cracks etc. All welds shall be cleaned of all slag or flux before galvanizing.

MARKING OF MEMBERS FOR IDENTIFICATION.

All members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on. The erection mark shall be stamped with a metal dye with figures at least 16 mm high and to such optimum depth as to be clearly visible, even after a member is galvanized. All erection marks shall be on outer surface of all sections and near one end, but clear of bolt holes. Marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 3.0 M or more shall have the erection mark at both ends.

PROTOTYPE ASSEMBLY:

Towers shall be trial assembled at shop before galvanizing i.e. prototype assembly keeping in view the actual site condition prior to dispatch to testing station/erection sites. The prototype assembly of each structure shall be got approved from BHEL/Customer as directed. Necessary match marks shall be made on each components before dismantling the prototype assembly and galvanizing. Any error shall be rectified at the expense of the contractor.

No extra charge on account of erecting the assemblies or getting them inspected will be permissible. It is however to be mentioned that the responsibility for proper fitting of various members for the erection of the structure in the field will rest with the supplier and any discrepancy found at the time of erection will have to be rectified by the contractor at his cost.

2.3 GALVANISING:

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES

All structural steel works shall be hot dip galvanized after fabrication. Galvanizing of each members shall be carried out in one complete immersion and double dipping shall not be permitted.

Zinc required for galvanizing will have to be arranged for by the Contractor. Purity of zinc to be used for galvanizing shall be 99.5% as per IS:209-1992.

All burrs and irregular edges shall be ground smooth before galvanizing.

After all shop work is complete, all structural materials shall be punched with the Erection Mark and be hot dip galvanized. Before galvanizing the steel section shall thoroughly be cleaned of any paint, grease, rust, scale, acid/alkali or such other foreign matters as are likely to interfere with the galvanizing process or with the quality and durability of the zinc coating. Pickling shall be carefully done and shall be proper.

Minimum weight of zinc coating shall be 610gms/sqm. However, higher coating may be provided as per requirement.

The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky deposits, blistered surface flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633 - 1986.

When the steel section is removed from the galvanizing kettle excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specification, or lack of quality control in any manner in the galvanizing plant shall render the entire production in the relevant shift liable to rejection.

All the galvanized structural steel members and accessories shall be treated with sodium dichromate or an approved equivalent solution after galvanizing, so as to prevent white storage stains.

If the galvanizing of any member is damaged, BHEL shall be shown of the extent of damage and if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost.

Contractor shall also furnish sufficient quantity of appropriate paint, free of cost, for repairing galvanized surfaces damaged in transit, and minor modifications done at site during erection.

Galvanizing tests shall be made from time to time on as many samples as may be considered necessary. The supplier shall supply all samples and equipment and carry out the tests without any extra cost.

2.4 INSPECTION OF MATERIALS

GENERAL:

Contractor shall give notice to BHEL/ Customer in advance for inspection of materials. All rejected material shall be promptly removed from the shop and replaced with new material for BHEL/ Customer approval/ inspection. The fact that certain material has been accepted at Contractor's shop shall not invalidate final rejection at site by BHEL/ Customer if it fails to be in proper condition or has fabrication inaccuracies which prevent proper assembly. No materials shall be painted, galvanized or dispatched to site without the inspection and approval by BHEL/ Customer unless such inspection is waived off in writing by BHEL/ Customer.

Shop inspection by BHEL/ Customer, for submission of test certificates and acceptance thereof by BHEL/ Customer shall not relieve contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which BHEL/ Customer may make because of defective or unsatisfactory material and workmanship.

Contractor shall provide all the testing and inspection services and facilities for shop work. For fabrication work carried out in the field the standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to BHEL/ Customer.

The supplier shall submit QP (Quality Plan) detailing each stage of manufacturing i.e. raw-material, in process and final inspection for approval by BHEL/Customer in the prescribed format of NTPC. The final Quality plan shall be approved by BHEL/ Customer.

MATERIAL TESTING

If mill test reports are not available for any steel materials the same shall be got tested by the contractor and demonstrate conformity with the relevant specification to the full satisfaction of BHEL/ Customer. The cost of such tests shall be borne by the contractor.

DIMENSIONS AND WORKMANSHIP:

The Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish, are in accordance with the requirements shown in Contractor's approved shop drawings.

INSPECTION OF TEST FAILURE:

In the event of any failure of structural steel members to meet an inspection or test requirement, contractor shall inform BHEL/ Customer and must obtain permission from the BHEL/ Customer before repair is undertaken. The quality control procedures to be allowed to ensure satisfactory repair shall be subject to approval by BHE/ Customer L.

2.5 PACKING TRANSPORTATION AND DELIVERY

After completion of final inspection and marking, the fabricated galvanized structural items shall be packed and loaded for transportation.

Packing must be adequate to protect items against bending and any mechanical injuries and damage to galvanized film during loading and unloading. As far as possible, like member should be bundled together and tied.

Proper lifting devices shall be used for loading at shop and unloading at site in order to protect items against bending, mechanical injuries and damage to galvanized film.

Loading, transporting and unloading shall be done in compliance with transportation rules.

Slender and projected parts shall be braced properly with additional spacer steel bars, spacer wood etc, before loading for transportation, to protect against bending or any other damages during transportation.

If certain parts cannot be transported in the lengths stipulated in the design drawing, the position and type of additional splice joints shall be got approved from BHEL/ Customer.

Items must be carefully loaded and tied up properly to prevent bending, falling etc. during transportation.

The small parts such as plates, gussets, cleats etc. shall be securely tied with the wire, and packed in wooden boxes and properly identified.

As far as possible the delivery of fabricated galvanized structural steel shall be as per the order stipulated by BHEL/ Customer and to suit the erection sequence.

Contractor shall make good/ replace at his own cost any damage occurred during loading, transporting, unloading and stacking of fabricated galvanized steel structures as directed by BHEL/ Customer. No extra payment on this account shall be entertained under any circumstances.

2.6 APPLICABLE STANDARDS

Unless otherwise specified, materials, and workmanship shall conform to the following standards of their latest editions:

1. IS : 209 - Zinc Ingot.

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES


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| 2. | IS : 228 | - Method of chemical analysis of pig iron, cast iron, plain carbon and low alloy steel. |
| 3. | IS : 406 | - Methods of analysis of zinc (Spelter). |
| 4. | IS : 800 | - Code of practice for general construction. |
| 5. | IS : 802 - Part1 -
Part1/Sec.2
- Part 2
- Part 3 | - - Code of Practice for use of structural in over head Transmission line towers. |
| 6. | IS : 806 | - Code of practice for use of steel tubes in general building construction. |
| 7. | IS : 808 | - Dimensions for hot rolled steel beam, column, channel and angle sections. |
| 8. | IS : 814 | - Covered electrodes for manual metal arc welding of carbon and carbon manganese steel. |
| 9. | IS : 816 | - Code of Practice for use of metal arc welding for general construction in mild steel. |
| 10. | IS : 817 | - Code of practice for training & testing of Metal Arc welders. |
| 11. | IS : 1161 | - Steel tubes for structural purposes. |
| 12. | IS : 1599 | - Method of bend test |
| 13. | IS : 1608 | - Method of tensile testing of steel products. |
| 14. | IS : 1852 | - Rolling and cutting tolerances for hot rolled steel products. |
| 15. | IS : 1978 | - Line pipe |
| 16. | IS : 2062 | - Steel for general structural purposes. |
| 17. | IS : 2074 | - Ready Mixed Paint, air drying red oxide zinc, chrome, priming. |
| 18. | IS : 2629 | - Recommended practice for hot dipped galvanising on Iron & Steel. |


SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES


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| 19 | IS : 2633 | - Methods for testing uniformity of coating on zinc coated articles. |
| 20. | IS : 3502 | - Steel chequered plates. |
| 21. | IS : 4759 | - Hot dip zinc coating on structural steel and other allied products. |
| 22. | IS : 6745 | - Method for determination of mass of zinc coating on zinc coated iron and steel articles |
| 23. | IS : 8500 | - Specification for micro-alloyed structural steel |


NTPC SPECIFICATION FOR TRANSMISSION LINE TOWER MATERIAL.

(In case of any variance in Sub Section -2 , NTPC specification shall prevail.)

CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.00.00	220kV TRANSMISSION LINES - GENERAL			
11.01.00	SCOPE AND GENERAL INFORMATION			
	In addition to the project information and scope of work given in this specification, the following is the scope of work for overhead Transmission line work:			
11.01.01	This specification covers detailed survey, tower spotting, optimization of tower location, soil resistivity measurements and geo-technical investigation, tower design, fabrication and supply of all types of transmission line towers including tower which are already designed and tested for equal or higher loads as specified in this specification, bolts, nuts and washers, hanger, D-shackle and all type of tower accessories like phase plate, number plate, danger plate, anti-climbing device, etc.; foundation design, selecting type of foundation for different towers and casting of foundation for towers and erection of towers, tack welding of bolts and nuts along with subsequent application of zinc coating on the welded portion, supply and application of zinc rich paint, tower earthing, fixing of insulator string, stringing of conductors, OPGW/earth wires along with all necessary line accessories and testing and commissioning of the erected transmission lines.			
11.01.02	Further for type tested towers bidder shall furnish design calculation for transmission line tower structures along with foundation design and drawing meeting the requirements of this technical specification.			
11.01.03	This specification includes the design and supply of insulator and their hardware conductor and earthwire, earthwire suspension and tension clamps and all the other line accessories to be incorporated in the towers during erection and stringing.			
11.01.04	All the raw materials such as steel, zinc for galvanising, reinforcement steel and cement for foundation, coke and salt for earthing, bird guards, anti climbing devices, bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plate, number plate etc. required for tower manufacture and erection shall be included in the scope of supply.			
11.01.05	The entire stringing work of conductor and earthwire shall be carried out as per standard stringing practice.			
11.01.06	The Contractor shall carry out the detailed survey and shall submit report/results within one (1) month of date of mobilization at site. No other details except those included in tender documents shall be furnished by the Owner. Also no topographical maps shall be furnished by Owner. However, Owner's assistance may be given in obtaining these maps from Survey of India.			
11.01.07	The tree-cutting shall be responsibility of the Contractor. The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut. Contractor may note that Owner shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.			
11.02.00	ROUTE AND TERRAIN			
11.02.01	The 220kv Double Circuit Transmission Line shall be connecting 220KV North Karanpura Switchyard and 220 KV Chatti Bariatu & Kerandari-A Coal Mine substation. The latitude and Longitude of the Chatti Bariatu & Kerandari-A Coal Mine substation are indicated in clause 1.15.00 of subsection IIB Section – VI Part-A. The Bidder may carryout preliminary / detailed survey of the corridor so as to acquaint himself to the transmission line route, crossings, ground profile and levels.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 59 of 102


CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.02.02	Right of way and way leave clearance shall be arranged by the Owner.			
11.02.03	To evaluate and tabulate the trees and bushes coming within 13.5 meters on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of one meter from ground level. The trees list should contain the following: a) Girth (circumference) measured at a height of 1 meter from ground level. b) Approximate height of the tree with an accuracy of + 2 meters. c) Name of the type of the species/tree. d) The bushy and under growth encountered in the 1.5 meters belt should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement.			
11.02.04	Payment of compensation towards the clearances, etc. will be the responsibility of the Owner.			
11.03.00	DETAILED SURVEY			
11.03.01	The detailed survey shall be carried out along the Transmission Line alignment by successful bidder/contractor.			
11.3.2	Route Marking At the starting point of the commencement of route survey, an angle iron spike of 65 x 65 x 6 mm section and 1000 mm long shall be driven firmly into the ground to project only 150 mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50 x 50 x 650 mm size shall be driven at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed upto the next angle point. Nails of 100 mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100 mm only above ground level. At angle position stone/concrete pillar with "NTPC" marked on them shall be put firmly on the ground for easy identification.			
11.03.03	Profile Plotting & Tower Spotting From the field book entries the route plan with route details and level profile shall be plotted and prepared as per approved procedure. Reference levels at every 20 meters along the profile are also to be indicated on the profile besides R/Ls at undulations. Areas along the profile, which in the view of the Contractor are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels is too high, the chart may be broken up according to requirement. A 10mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be in accordance with the IS Standard. For `as built' profile these shall be A1 size			
11.03.04	Sag Template Necessary data in respect of conductor, earthwire and insulator have been given in the specifications. On the basis of these, the Contractor shall prepare the sag template drawing and tower spotting data and submit the same alongwith sag tension calculations for the approval of the Owner. Sag template prepared based on the approved sag-template curve drawing shall only be used for tower spotting on the profiles. Two numbers of the approved template, prepared on rigid transparent plastic sheets, shall be provided by the Contractor to			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 60 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.03.05	the Owner for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile.			
	Tower Spotting With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:			
a)	Span	The number of consecutive spans between the section points shall not exceed 15 spans. Section point shall comprise of tension point with B type, C type or D Type towers as applicable. For all crossing spans such as major road crossings, railway crossings, power line crossings etc. the span shall not exceed 80% of design span.		
b)	Extension	An individual span shall be as near to the normal design span as far as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification.		
c)	Road Crossing	At all important road crossings, the towers shall be fitted with double tension insulator strings depending on the type of towers but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall be in line with IE rules. At all national highway crossings, tension towers shall be used.		
d)	Railways Crossings	At the time of detail survey all the railway crossings coming enroute the transmission line shall be finalised as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987):		
i)	The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings.			
ii)	The crossing shall normally be at right angle to the railway track.			
iii)	The crossing span shall be limited to 80% of design span.			
iv)	The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track..			
v)	No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.			
vi)	Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained as per IE rules. The approval for crossing railway track shall be obtained by the Owner from the Railway Authority. However, six copies of profile and plan, tower and foundation design and			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
				Page 61 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.</p>			
e)	River Crossings			
	<p>In case of major river crossing, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be C type tower. Clearance required by navigation authority shall be provided. For non navigable river, clearance shall be reckoned with respect to highest flood level (HFL).</p>			
f)	Power Line Crossing			
	<p>Where this line is to cross over another line of the same voltage or lower voltage, towers with suitable extension shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956. The Contractor may be required to under-cross higher voltage lines by erecting gantries/suitable Rail Pole structures.</p>			
g)	Telecommunication Line Crossing			
	<p>The angle of crossing shall be as near 90 degree as possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations. When the angle of crossing has to be below 60 degree, the matter will be referred to the authority incharge of the telecommunication system. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Owner. Also, in the crossing span power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.</p>			
h)	Details Enroute			
	<p>All topographical details, permanent features, such as trees, building etc. 13.5m on either side of the alignment shall be detailed on the profile plan.</p> <p>Ash Pipe Line (If applicable)</p> <p>Adequate clearances shall be maintained from ash pipe line and adjacent road.</p>			
i)	Clearance from Ground, Building, Trees, etc.			
	<p>Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.</p>			
11.04.00	PRELIMINARY LINE SCHEDULE			
	<p>The profile sheets, duly spotted, alongwith preliminary schedules indicating type of towers, wind span, weight span, angle of deviation, river, power line, railway or road crossing and other details shall be submitted for the approval of the Owner. After approval, the Contractor shall submit six more sets of the approved reports along with two sets in soft copy of final profile drawings to the Owner for record purpose.</p>			
11.05.00	CHECK SURVEY OF TOWER LOCATIONS			
11.05.01	<p>The detailed survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule. In the process, it is necessary to have the pit centers marked according to the excavation marking charts. The levels, up or</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 62 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
11.05.02	down of each pit center with respect to the center of the tower locations shall be noted and recorded for determining the amount of earthwork required to meet the approved design parameters.			
11.06.00	Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details.			
11.07.00	ELECTRICAL SYSTEM DATA			
	a) Nominal voltage	220 kV		
	b) Maximum system voltage	245 kV		
	c) BIL (Impulse)	1050kVp		
	d) Power frequency withstand voltage (wet)	460 kV (rms)		
	LIST OF STANDARDS (LATEST EDITION OF STANDARDS SHALL BE FOLLOWED)			
	Unless specified otherwise analysis & design of various components and systems of transmission line shall be in accordance with latest editions, latest amendments, of the relevant Indian & other international standards.(except for those references where the year of publication is specifically mentioned)			
	<u>Indian Standards</u>	<u>Title</u>	<u>International & Internationally recognised standards</u>	
1.	IS:209	Specification for Zinc	ISO/R/752-1968 AST, B6	
2.	IS:2062	Structural Steel (Standard Quality)	ISO/R/6F30-1967 CAN/CSA G40.21 BS 4360	
3.	IS:269	Ordinary rapid hardening & low heat Portland Cement.	ISO/R/597-1967	
4.	IS:278	Specification for barbed wire	ASTM A 121	
5.	IS:383	Coarse and fine aggregates from natural sources for concrete.	CSA A 23.1/A 23.2	
6.	IS:398	Alum. Condr. galvanised steel reinforced		
7.	IS:406	Methods of Chemical Analysis of Slab Zinc		
8.	IS:432 (Part 1 & 2)	Mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement	CSA-G-30	
9.	IS:456-1978	Code of practice for plan and reinforced concrete		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 63 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS		
10.	IS:731-1971	Porcelain Insulators for Overhead lines with a Nominal Voltage greater than 1000 volts	BS:137-1973 (I & II) Power IEC:274-1968 IEC:383-1976
11.	IS:800-1984	Code of practice for use of structural in general Building construction	CSA STEAM 16.1 steel
12.	IS:802	Code of practice for use of structural steel in overhead transmission Line. (Load, Permissible stresses. Fabrication, Galvanising, Inspection, and Packing and Testing)	IEC 826 ASCE 52 BS 8100
13.	IS:1139-1966	Hot rolled mild steel medium tensile steel and high yield strength deformed Bars for concrete reinforcement	CAN / CSA G 30 18
14.	IS:1367-1967	Technical supply conditions for threaded fasteners	
15.	IS:1489-1991	Portland Pozzolana Cement	ISO/863-1968
16.	IS:1521-1972	Method of Tensile Testing of Steel wire	
17.	IS:1573-1976	Electroplated Coating of Zinc on Iron & Steel	
18.	IS:1778-1980	Reels and Drums of Barewire	
19.	IS:1786-1985	High strength deformed steel bars and wires for concrete reinforcement	
20.	IS:1893-1984	Criteria of Earthquake resistant design of structures.	IEEE 693
21.	IS:2016-1967	Plain Washers	ISO/R/887-1968 ANSI B 18.22.1
22.	IS:2070- 1962	Method of impulse voltage testing	
23.	IS:2071	Method of high voltage testing	
24.	IS:2121-1981 Part-I Part-II	Specification for conductors and earthwire Accessories for Overhead Power Lines Armour Rods Mid-span joints & repair sleeves for conductors	
25.	IS:2131-1967	Method of Standard penetration test for soils.	ASTM D 1883
26.	IS:2551-1982	Danger Notice Plates	
27.	IS:2486	Specification for Insulator Fittings for	
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD Page 64 of 102

CLAUSE NO.		TECHNICAL REQUIREMENTS		
		overhead Power Lines with a nominal voltage greater than 1000 volts Part- I General Requirements and Tests Part-II Dimensional Requirements Part-III Locking Devices	BS:3288-1972 IEC:120-1960 IEC:372-1976	
28.	IS:2629-1985	Recommended practice for hot dip galvanising of iron & steel.	ASTM A 123 CAN/CSA G 164	
29.	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles.	ASTM A 123 CAN/CSA G 164	
30.	IS:3043-1987	Code of Practice for earthing (with amendment No. 1 & 2).		
31.	IS:3063-1994	Single Coil Rectangular Section spring washers for bolts, nuts, screws.	DIN - 127-1970	
32.	IS:3138-1966	Hexagonal bolts and nuts	ISO/R 947 and ISO/R 272	
33.	IS:3188-1980	Characteristics of string insulator units	IEC:305-1906	
34.	IS:4091-1979	Code of practice for design and construction of foundation for transmission line tower and poles.	ASCE / IEEE 691	
35.	IS:4218-1976	Metric Screw Threads.	ISO:68-1969 R-26-1963, R-262-1969 R-965-1965	
36.	IS:4826-1979	Galvanised coatings on round steel wire	BS:443-1969	
37.	IS:5300-1980	Porcelain Guy strain insulators		
38.	IS:5358-1969	Hot dip galvanised coatings on fasteners	ASTM A 153 CAN/CSA G 164	
39.	IS:5613 (Part-II) 1985	Code of practice for Design, installation & maintenance of overhead power lines		
40.	IS:6610-1972	Specification for heavy washers for steel structures.		
41.	IS:6639 -1972	Hexagonal bolts for structure	ASTM A 394 CSA B 33.4	
42.	IS:6745-1972	Methods for determination of weight of Zinc coated iron and steel articles	ASTM A 90	
43	Pub. No. 19 (N)/ 700-1963	Regulation for Electrical Crossing of Railway Tracks.		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 65 of 102

44.	IS:7814-1985	Phosphor bronze sheet, strip and foil	BS:2870-1968
45.	IS:8263-1976	Method of Radio Interference tests on high voltage insulators	NEEMA:107 – 1964 CISPR/IEC:437-1973
46.	IS:8269-1976	Method of switching impulse test on high voltage insulators	IEC:506-1975
47.	IS:8500-1991	Specification for weld-able structural steel (Medium and High strength qualities).	BS : 4360
48.	IS:9708-1993	Specifications for Stockbridge Vibration Dampers for overhead power lines	
49.		Thermal mechanical performance test and mechanical performance test on String insulator units	IEC: 575-1974


12.00.00 GENERAL DESCRIPTION OF TOWERS
12.01.00 Types of Towers

- 12.01.01 The towers shall be of self supporting lattice steel type, designed to carry the line conductors with necessary insulators, earth wires/ OPGW and all fittings under all loading conditions.
- 12.01.02 The tower shall be of a fully galvanised structure, using structural mild steel sections for members. Bolts and nuts with spring washers shall be used for connections.
- 12.01.03 Bidders can also use high tensile steel and cold formed steel for fabrication of towers provided they furnish the justification for use of such steel with reference to national or international standards. However, the factors of safety, limitation on member length, requirement of fasteners and galvanisation shall be as specified in this specification.

The towers shall be classified as given in Table -1

Table -1

Type of Tower	Deviation limit	Typical use
A	0 to 2	To be used as tangent/suspension tower
B	0 to 15	a) Angle towers with tension insulator string b) Tension tower for uplift forces resulting from an uplift span up to half of ruling span under broken wire condition c) Also to be designed for unbalanced tension resulting from unequal ruling span as specified in table T1-2.
B	0	d) to be used as section tower

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	C	5 to 30 degree.	a) Angle tower with tension insulator string b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire condition c) Also to be designed for unbalanced tension resulting from unequal ruling span as specified in table T1-2.	
	D	30 deg. To 60 deg.	a) Angle tower with tension insulator string. b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire condition. c) Also to be designed for the unbalanced tension resulting from unequal ruling span as specified in Table T1-2. d) Dead end with 0 deg. to 15 deg deviation both on line and sub- station side (slack span).	
	D	0deg.	e) Complete dead end.	
	D	90deg.	f) To be used near switchyard with Reduced design and span	
	NOTE: 1) For double circuit tower types, A, B, C and D shall be prefixed by 'D'. 2) Special type of tower/ higher voltage class towers, wherever required shall also be provided by the bidder under the contract at no extra cost.			
12.01.04	Extension a) The single and double circuit tower shall be designed so as to be suitable for adding 3M, 6M and 9M body extension for maintaining adequate ground clearance without reducing the specified factor of safety in any manner. b) For power line crossing 25 metre extensions with D type towers are required. The 25 metre extension should be designed in such a manner the same can also be used as 18 metre extension to normal tower after removal of bottom panels. c) For under line crossing of EHV transmission lines the bidder shall have to design minus-three metres and minus six metre extensions to D type tower.			
12.01.05	Stub Setting templates. Stub templates shall be designed and arranged by the contractor at his own cost for all types of tower with or without extension and also for leg extension. Stub templates for standard towers and tower with extension shall be of adjustable type. The stub templates shall be painted. One set of each type of stub setting template for single and double circuit tower shall be supplied to the Owner, on completion of the project, at no extra cost.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
				Page 67 of 102

12.02.00 SPANS AND CLEARANCES
12.02.01 Ruling Span

The normal ruling span of the line shall be 320 meters for 220 KV towers.

12.02.02 Wind Span

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

12.02.03 Weight Span

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

Tower type	Normal Condition		Broken Wire Condition	
	Max. (m)	Min. (m)	Max. (m)	Min. (m)
A, B, C & D (220 KV)	390	-100	270	-100

12.02.04 Electrical Clearance
A) Ground clearance

The minimum ground clearance from the bottom conductor shall be as per IE rules at the maximum sag conditions i.e. at maximum temperature and still air. However, to achieve the above clearance the height of tower shall be increased in the following manner:

- Allowance of 150 mm shall be provided to account for errors in stringing.
- Conductor creep shall be compensated by over tensioning the conductor at a temperature lower than the ambient temperature. The creep correction temperature along with calculations shall be furnished by the Contractor.
- Minimum spacing
The minimum electrical clearance between conductors shall be as per relevant standards.

B) Rail Crossing


In case of rail crossing the min. height above rail level of the lowest portion of any conductor under condition of max. sag, in accordance with the regulations for Electrical Crossing of Railway tracks as prevailing at the time of construction of line shall be applicable.

C) Power Line Crossing

Minimum clearance between power line to power line crossing shall be as per IE rules.


D) Live Metal Clearance


The minimum live metal clearance to be provided between the live parts and steel work of super-structure shall be as per relevant standards.


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>NOTE:</p> <p>i) Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for `D' type tower to be used as dead end and angle tower.</p> <p>ii) The design of the tower shall be such that it will satisfy all the conditions when clearances are measured from any live point of the strings.</p>			
E)	Angle of Shielding	<p>The angle of shielding is defined as the angle formed by the line joining the center lines of the earthwire and outer power conductor, in still air, at tower supports, to the vertical line through the center line of the earthwire. Bidders shall design the tower in such a way that the angle of shielding does not exceed as specified in relevant standard for 220KV towers. The drop of the earthwire clamp, which is in the scope of contractor supplied items, should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of earth wire suspension clamp alongwith shackle shall be taken as 150mm.</p>		
F)	Mid Span Clearance	<p>The minimum vertical mid span clearance between the earthwire and the nearest power conductor as per IE rules, which shall mean the vertical clearance between earthwire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the earthwires and power conductors, shall be so co-ordinated that the sag of earthwires shall be at least 10% less than that of power conductors under all temperature loading conditions.</p>		
12.03.00	LOADING CONDITIONS			
12.03.01	Loads at Conductor And Earthwire Points			
	<p>Contractor shall consider the ultimate external loadings at conductor and earthwire points base on IS 802-1, 1995. The Contractor shall develop the tower designs considering these loadings. The towers are to be designed to cater for the following loads:</p>			
	<p>a) Reliability Loads (Normal condition)</p> <p>b) Security Loads (Broken wire condition)</p> <p>c) Safety Loads (Construction & Maintenance loads)</p>			
12.03.02	Suspension towers shall be designed for full wind load under security condition			
	Wind Loads on Tower Body			
	<p>The wind load on tower body shall be calculated by the Contractor as per IS:802, Part-I, 1995.</p>			
12.03.03	Maximum Tension			
	<p>Maximum tension shall be based on either of the following (whichever is more stringent):</p>			
	<p>a) at 0 deg C with 36% full wind pressure., or</p> <p>b) at 32 deg C with full wind pressure</p>			
	<p>The value of drag co-efficient (Cd) shall be 1.2 for conductor/earthwire if the diameter of the conductor/earth is 15mm or less.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 69 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>																
12.03.04	Sag tension calculation for design purpose shall be calculated considering normal span of 320 meter.																			
12.03.05	The initial conductor and earthwire tension at 32 degree C and without wind shall be 22% of the ultimate tensile strength of the conductor and 20% of the ultimate tensile strength of the Earthwire.																			
12.03.06	Limiting Tensions of conductor & Earthwire The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths.																			
12.03.07	Broken Wire Condition The loads for broken wire conditions shall be considered as per clause 16 of IS 802 (Part I/ Sec 1): 1995. The tower type B & C shall be considered as small and medium angle towers whereas tower type D shall be considered as large angle tension tower/ dead end tower.																			
12.03.08	Design Loads Owner's requirement for most stringent design longitudinal and transverse loads is summarized in Table -2.																			
12.04.00	DESIGN OF TOWERS																			
12.04.01	Design Criteria Towers shall be designed based on spans and clearances, and loading conditions as detailed above.																			
12.04.02	Design Temperatures The following temperature range for the conductors and ground wires shall be adopted for line design: <table><tr><td>a)</td><td>Minimum temperature</td><td>:</td><td>0 deg.C</td></tr><tr><td>b)</td><td>Everyday temperature of conductor</td><td>:</td><td>32 deg.C</td></tr><tr><td>c)</td><td>Max. temperature of Conductor</td><td>:</td><td>75 deg.C</td></tr><tr><td>d)</td><td>Max. temperature of Earthwire exposed to sun:</td><td></td><td>53 deg.C</td></tr></table>				a)	Minimum temperature	:	0 deg.C	b)	Everyday temperature of conductor	:	32 deg.C	c)	Max. temperature of Conductor	:	75 deg.C	d)	Max. temperature of Earthwire exposed to sun:		53 deg.C
a)	Minimum temperature	:	0 deg.C																	
b)	Everyday temperature of conductor	:	32 deg.C																	
c)	Max. temperature of Conductor	:	75 deg.C																	
d)	Max. temperature of Earthwire exposed to sun:		53 deg.C																	
12.04.03	Redundant Design All redundants in the towers are to be triangulated. Redundants, having an angle of 15 deg or less with horizontal are to be designed for a concentric vertical ultimate load of 1.5 KN acting at center of the unsupported length. The Contractor has to furnish the calculation for the same. The redundants shall also be designed for 2.5% of max. axial load of connecting members (i.e. leg members, bracing members etc.).																			
12.04.04	Steel Sections For designing of towers, preferably rationalised steel sections shall be used. During execution of the project, if any particular section is not available same shall be substituted by higher section at no extra cost to Owner and the same shall be borne by the Contractor.																			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD																
Page 70 of 102																				


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
	However, design approval for such substitution shall be obtained from the Owner before any substitution.			
12.04.05	Thickness of Members			
	The minimum thickness of angle sections used in the design of tower, unless otherwise specified elsewhere in this Specification, shall be kept not less than the following values:			
	a)	Main corner leg members including the groundwire peak and main cross arm : 5 mm		
	b)	For all other members : 4 mm		
12.04.06	Bolts & Nuts			
A)	The minimum bolt spacing and rolled edge distance and sheared edge distance from the centers of the bolt holes to be maintained are given below:			
	a)	Diameter of bolts	16 mm	
	b)	Hole diameter	17.5 mm	
	c)	Min. bolt spacing	40 mm	
	d)	Min. rolled distance	20 mm	
	e)	Min. sheared edge distance	23 mm	
B)	Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30mm.			
C)	For the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-1993 may be referred.			
12.04.07	Slenderness Ratio			
A)	Slenderness ratio for members shall be computed in accordance with IS:802, Part-II, 1993. Slenderness ratio for compression and tension members shall not exceed the values specified therein.			
B)	The following maximum limit of the slenderness ratio i.e. the ratio of unsupported length of the section in any plane to the appropriate radius of gyration will be adopted:			
	a)	For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms	120	
	b)	For other members having calculated stresses	200	
	c)	For redundant members	250	
	d)	For members having tensile stress only	400	
12.04.08	The bracing pattern, including that of secondary bracings (redundants) shall be identical on transverse and longitudinal faces of the tower, i.e. staggering of primary and secondary bracings are not permitted. Primary bracings and redundants shall be properly triangulated, i.e. the overall pattern of bracing on tower body and cross arms shall be triangular only.			
12.04.09	Erection Stress			
	Where erection stress combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, such other provisions are to be made as may be necessary to bring the working stress within the specified limit.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 71 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
12.05.00	TOWER MATERIALS			
12.05.01	Tower Steel Sections IS steel sections of tested quality in conformity with IS: 2062 or IS: 8500 are to be used in towers, extensions and stub setting templates. No individual member shall be longer than 6000mm. The Bidder can also use most efficient grades of structural steel angle sections and plates conforming to latest international standards. However, the Bidders are permitted to opt for not more than two (2) grades of steel for any particular package.			
12.05.02	Fasteners: Bolts, Nuts and Washers			
a)	All bolts and nuts shall conform to IS: 6639. All bolts and nuts shall be galvanised 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.			
b)	The bolt shall be of 16 mm dia and of property class 5.6 as specified in IS:1367 (Part-III) 1979 and matching nut of property class as specified in IS:1367 (Part-VI).			
c)	Bolts upto M16 and having length upto 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 MP a minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 Part-I to ensure proper bearing.			
d)	To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing.			
e)	Nuts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be overtapped beyond 0.4 MM oversize on effective diameter for size upto M16.			
f)	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.			
g)	All bolts shall be threaded to take the full depth of the nuts and threaded 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 3 mm and not more than 8mm when fully tightened. All nuts shall fit and tight to the point where the shank of the bolt connects to the head.			
h)	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 dia.			
i)	The Bidder shall furnish bolt schedules giving thickness of members connected, the nut and the washer and the length of shank and the threaded portion bolts and sizes of holes and any other special details of this nature.			
j)	To obviate bending stress in bolts or to reduce to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter.			
k)	The bolt positions in assembled towers shall be as per IS:5613 (Part-II/Section-2).			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 72 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
l)	Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.			
12.06.00	Tower Accessories			
12.06.01	Step Bolts & ladders			
	Each tower shall be provided with step bolts of not less than 16mm diameter and 175 mm long, spaced not more than 450mm apart and extending from about 3.5 meters above the ground level to the top of the tower. Step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special structures, where the height of the super structure exceeds 50 meters, ladders along with protection rings shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 3.5 m to 30 m height of super structure step bolts shall be provided. Suitable railing for access from step bolts to the ladder and from the ladder to each cross arm tip and the groundwire support shall be fixed on tower by using countersunk bolts.			
12.06.02	Insulator Strings and Earthwire Clamps Attachments			
	a)	For the attachment of suspension insulator string a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free from swinging of the string. The hanger shall be designed to withstand an UTS equivalent to that of insulators. The supply of design & supply of hanger is in the scope of the Contractor.		
	b)	At tension towers strain plates of suitable dimensions on the underside of each cross-arm tip and at the top of earthwire peak, suitable plate should be provided for taking the hooks or D-Shackle of the tension insulator strings or earthwire tension clamps, as the case may be. Full details of the attachments shall be submitted by the bidder for Owner's approval before starting the mass fabrication.		
12.06.03	Earthwire peaks/crossarms are to be suitably designed to accommodate the shackle of the suspension clamp/tension clamps.			
12.06.04	Anti-climbing Device			
	Barbed wire type anti-climbing device shall be provided and installed by the Contractor for all towers. The height of the anti-climbing device should be provided approximately 3m above ground level. The barbed wire shall conform to IS-278-1978. The barbed wires shall be given chromating dip as per procedure laid down in IS:1340-1959.			
12.06.05	Danger plate, Number plates, Circuit Plate, Phase plate & Bird Guards.			
	Danger, Number Plates, Phase Plates & Bird Guards shall be provided and installed by the Contractor:			
	a)	Each tower shall be fitted with a number plate, and danger plate. Each tension tower shall be provided with a set of phase plates also. The arrangement for fixing these accessories shall not be more than 4.5m above the ground level.		
	b)	The letters, figures and the conventional skull and bones of data plates shall conform to IS:2551-1963 and shall be in a single red on the front of the plate.		
	c)	The corners of the number and danger plate shall be rounded off to remove sharp edges.		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 73 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
d)	To prevent birds from perching immediately above the suspension insulator strings and thus fouling it with droppings suitable birdguards shall be provided at cross arm tips of all suspension towers. The arrangement shall conform to IS:5613 part-2/Sec.I.			
12.07.00	TOWER FABRICATION			
12.07.01	Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) or the relevant international standards.			
12.07.02	Butt splices shall be used and the inside Angle and outside plate shall be designed to transmit the load and 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.			
12.07.03	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.			
12.07.04	The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.			
12.07.05	The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.			
12.07.06	No angle member shall have the two leg flanges brought together by closing angle.			
12.07.07	The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.			
12.07.08	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 depression are likely to hold water.			
12.07.09	All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, 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 through out. No rough edges shall be permitted in the entire structure.			
12.07.10	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 on punched with a jig but drilled holes shall be preferred. The following maximum tolerance of accuracy of punched holes is permissible.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 74 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	a)	Holes must be perfectly circular and no tolerance in this respect permissible.		
	b)	The max. allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter.		
	c)	Holes must be square with the plates or angles and have their walls parallel.		
C)	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.			
12.07.11	Erection mark			
A)	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.			
B)	Erection Mark shall be “A - BB- CC – DDD”, where			
	A = Owner's code assigned to the Contractor Alphabet.			
	BB = Contractor's Mark-Numerical			
	CC = Tower Type-Alphabet			
	DDD = Number mark to be assigned by Contractor.			
12.07.12	Quantities and Weights			
	The unit weight of each type of tower, stubs and extensions shall be furnished by the bidder. The weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. un-galvanised) weight of steel members of the size indicated in the approved fabrication drawings and bills of materials, without taking into consideration the reduction in weights, holes, notches and bevel cuts etc, but taking into consideration the weight of the fasteners, anti-climbing devices etc.			
12.07.13	Galvanising			
	Fully galvanised towers and stub shall be used for the line. Galvanisation of the member of the towers shall conform to IS:2629 and IS:4759. The minimum weight of galvanisation shall be 610 gms/sqm. The galvanisation 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 Grade 4 of IS:1573.			
12.08.00	TOWER EARTHING			
	The footing resistance of all towers shall be measured by the Contractor in dry weather after tower erection but before the stringing of earthwire. All the tower are to be earthed. In no case tower footing resistance shall exceed 10 ohms. Pipe type earthing and counterpoise type earthing wherever required shall be provided in accordance with the stipulations made in IS:3043-1987 and IS:5613 (part-II/Section-2) 1985. The details for pipe and counterpoise type earthing are given in drawing enclosed with the specification.			
12.09.00	INSPECTION AND TESTS			
12.09.01	All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 75 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
12.09.02	Inspection <p>In addition to the provisions as specified elsewhere in this specification, the following shall also apply:</p> <p>A) The Contractor shall keep the Owner informed in advance about the time of starting and the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.</p> <p>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.</p> <p>C) 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.</p> <p>D) 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.</p> <p>E) Should any member of the structure be found not to comply with the approved design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Owner or his authorised representative considers that the defects can be rectified.</p> <p>F) 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.</p> <p>G) All gauges and templates necessary to satisfy the Owner shall be supplied by the manufacturer.</p> <p>H) The correct 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.</p>			
12.09.03	Tower Load Tests <p>A) The Contractor shall submit one set of shop drawings alongwith the bill of materials. Further, Contractor shall submit one copy of test reports and final tracings of shop drawings and Bill of materials for Owner's reference and record.</p> <p>B) The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective towers free of cost to the Owner. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by the Owner on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.</p>			
12.09.04	Tower Testing Procedure <p>The testing of towers shall be as per the procedure described below:</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 76 of 102


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div>b)</div>	The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) percent after the full design loads have been reached.		
12.10.00	PACKING			
12.10.01	The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.			
12.11.00	DESIGN CALCULATION AND DRAWINGS			
12.11.01	The following design calculation and drawings are required to be furnished during detailed engineering.			
	<div>a)</div>	Computation of wind load		
	<div>b)</div>	Sag-tension calculation		
	<div>c)</div>	Tower loading		
	<div>d)</div>	Single line diagram of towers showing electrical clearances and steel sections.		
12.11.02	The Contractor shall also furnish following to the owner:			
	<div>a)</div>	Detailed design calculation and drawing for towers and foundations.		
	<div>b)</div>	Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc.		
	<div>c)</div>	Bill of materials, indicating cutting and bending details against each member.		
	<div>d)</div>	Shop drawings showing all details relevant to fabrication.		
	<div>e)</div>	All the drawings for the tower accessories.		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 78 of 102				


**TABLE-2
DESIGN LOADS**

S.No	Tower Type	Longitudinal Loads		Transverse Loads	
		Reliability Condition	Security Condition	Reliability Condition	Security Condition
1	2	3	4	5	6
a.	A	0.0	0.5 x MT For Conductor). 1.0 x MT (For Earth Wire)	WC + WI + DY	0.6 WC + WI +0.25 DY (For Conductor) 0.6 WC + 0.5 DY (For Earth Wire)
b.	B (Section Tower-0° Deviation)	MT1	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY
c.	B (15° Deviation)	MT1	1.0 x MT x Cos $\frac{\alpha}{2}$	WC + WI + DY	0.6 WC + WI +0.5 DY
d.	C (Section Tower-0° Deviation)	MT1	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY
e.	C (30° Deviation)	MT1	1.0 x MT x Cos $\frac{\alpha}{2}$	WC + WI + DY	0.6 WC + WI +0.5 DY
f.	D (60° Deviation)	MT1	1.0 x MT x Cos $\frac{\alpha}{2}$	WC + WI + DY	0.6 WC + WI +0.5 DY
g.	D (Dead End with slack span of 100 Mtrs. Max.)	0.7 MT	1.0 x MT	WC + WI + (0.3 MT x Sin 15°)	0.6 WC + WI
h.	D Complete Dead End	MT	1.0 x MT	WC + WI	0.1 WC + WI


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी</div> <div>NTPC</div>
	DESCRIPTION	SYMBOL	REMARKS	
	Maximum Tension Of Conductor/ Earth Wire under everyday temperature & full wind condition or minimum temperature & 36% Of max. wind which ever is more stringent	MT		
	Wind On Conductor	WC	Wind Span shall be the normal ruling span.	
	Wind On Insulator	WI	In case of Double String Insulators, both their strings shall be considered	
	Angle Of Deviation (Degrees)	□		
	Load Due To Deviation Of Tower	DY= 2 x MT x Sin □/2		
	Difference In Tension For unequal adjacent spans considering full ruling span on one side and 50% of ruling span on other side	MT1		
<p>Note:</p> <p>1. Vertical loads shall conform to IS 802 – Part I, 1995. Weight spans as furnished under Clause 2.03.00 shall be considered for computation of vertical loads.</p> <p>2. Safety loads and Anti-cascade loads as specified in IS 802- Part I, 1995 shall also be considered for design of Towers.</p> <p>3. Wind loads on the towers shall be considered in transverse loads as per clause 11, 12 and 13 of IS: 802 (Part-I/ Sec. I)- 1995.</p> <p>4. Any additional loads apart from the loads mentioned above, as required as per IS: 802- 1995 shall be considered for design purpose.</p>				
13.00.00	TOWER FOUNDATIONS			
13.01.00	TYPES OF FOUNDATION			
13.01.01	General			
A)	Reinforced concrete footing shall be used for all type of tower in conformity with the IS Codes and the specifications. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift.			
B)	Foundation includes supply of materials such as cement, sand, coarse aggregates, reinforcement steel etc., and all work related to construction of foundations including excavation and backfilling, form work, stub setting, placing of reinforcement, concreting etc.			
C)	Design criteria for Foundations			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 80 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>The foundation shall be designed for the actual soil parameters based on the soil investigation carried out by the bidder and approved by the owner. For design purposes:</p> <p>(a) The angle of repose shall be considered as two-third (2/3) of the value as obtained from the soil investigation</p> <p>(b) Water table shall be considered up to the ground level.</p> <p>(c) The weight of soil shall be considered as 1440 Kg/m³ under dry condition and 940 Kg/m³ under wet condition.</p> <p>Well foundation or pile foundation shall be provided by the bidder wherever necessitated.</p>			
13.02.00	SOIL INVESTIGATION			
13.02.01	<p>The Contractor is required to carry out detailed soil investigation at various tower locations along the corridor, one borehole at centre of the tower, angle points, crossings, etc. and also where soil strata is different from the other locations investigated. In addition the soil investigation may be required to be carried at other locations at the discretion of the Engineer.</p>			
13.02.02	<p>The investigation comprises of field and laboratory testing. Field investigation includes boreholes, Standard Penetration Test (SPT), Static Cone Penetration Test (SCPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), collection of water samples, etc. Laboratory tests shall include, Physical, chemical and engineering properties of soil/rock.</p>			
13.02.03	<p>This specification covers technical requirements for geotechnical investigation and preparation of a detailed geotechnical report. It shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, carrying out field investigation and tests, laboratory tests, analysis and interpretation of data and results, collecting data regarding change of course of rivers from local sources, velocity, scour, etc., giving flood details of the area (past history), safe bearing capacity for different sizes of foundations, different founding strata for the various locations along the transmission lines and preparation of geotechnical report.</p>			
13.02.04	<p>The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. Depth of bore holes at river/bridge crossings shall be 40m, at angle points depth shall be 15.0m and at the centre of tower along the corridor depth of BH shall be 10.0m. Boring shall be terminated at the above specified depth or 3.0m continuous in rock with RQD>25% for river crossings and for balance areas 3.0m in refusal whichever is earlier. Refusal means SPT 'N' value greater than 100.</p> <p>SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. At refusal penetration shall be measured and the same shall be reported in Borelog. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50. The diameter of UDS sampler shall be 100 mm minimum.</p>			
13.02.05	<p>Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 81 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>a) Laboratory Tests on Soil Samples</p> <p>Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.</p> <p>b) Laboratory Tests on Rock Samples</p> <p>Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.</p>			
13.02.06	The laboratory tests shall be carried out progressively during the field work after sufficient numbers of samples have reached the laboratory in order that the test results of the initial boreholes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel and the tests shall be carried out as per the procedures laid out in the latest editions of the relevant IS codes. Soil shall be classified as per the provisions of Indian standards.			
13.02.07	On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.			
13.02.08	<p>The Geotechnical report shall include, but not limited to the following:</p> <p>a) Borelogs: A true cross section of all individual boreholes with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, details of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with.</p> <p>b) Results of all laboratory tests summarized for each Borehole along with a consolidated table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores shall be furnished.</p> <p>c) Recommendations : The report should contain specific recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total/ differential settlement permissible for structures and equipments, minimum depth and width of foundation. The observation/recommendations shall include but not limited to the following:</p> <p>i) Geological information of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 82 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div>ii) Net safe allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlements characteristics of soil with supporting calculations for the recommendations.</div><div>iii) Based on the chemical nature of soil and ground water and exposure condition, recommendations for protective measures on concrete and steel shall be mentioned.</div><div>iv) If expansive soil is met with, recommendation and removal or retainment of the same under structures/ roads etc. shall be given. In the later case detailed specification of any special treatment required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished.</div><div>iv) Additional investigation other then specified above, if any, the same shall be carried out by the bidder at no extra cost to owner.</div></div>			
13.02.09	<div>Indian Standard References</div> <div>IS:1498 Classification and Identification of Soils for general Engineering Purposes.</div> <div>IS:1892 Code of practice for Subsurface Investigation for Foundation.</div> <div>IS:1904 Code of practice for design and construction of foundations in Soils: General Requirements.</div> <div>IS:2131 Method of Standard Penetration Test for Soils.</div> <div>IS:2132 Code of practice for Thin walled Tube Sampling of Soils.</div> <div>IS:2470 Code of practice for design and construction of Septic (Part-I) Tanks.</div> <div>IS:2720 Method of Test for Soils (Relevant Parts).</div> <div>IS:5313 Guide for Core Drilling Observations.</div> <div>IS:4968 Method for subsurface Sounding for Soils - Dynamic (Part-II) method using Cone and Bentonite slurry.</div> <div>IS:4968 Method for subsurface Sounding for Soils- Static Cone (Part-III) Penetration Test.</div>			
13.03.00	LOADS ON FOUNDATIONS			
13.03.01	<div>The foundations shall be designed to withstand the specific loads of the superstructure and for the full footings reactions obtained from the structural stress analysis in conformity with the relevant over load factors. The over load factor for foundation design shall be 1.10 for all loads except dead loads.</div>			
13.03.02	<div>The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:</div> <div><div>a) Max. tension or uplift along the leg slope.</div><div>b) Max. compression or down-thrust along the leg slope.</div><div>c) Max. horizontal shear or side thrust.</div></div>			
13.03.03	<div>The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.</div>			
13.03.04	<div>The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.</div>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 83 of 102


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
13.04.00	STABILITY ANALYSIS			
13.04.01	In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.			
13.04.02	The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:			
13.04.03	Resistance against uplift The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical. However, the angle of repose for uplift resistance shall be considered two-third (2/3) of the value as obtained from the soil investigation report. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-impose each other, the earth frustum will be assumed truncated by a vertical plane passing through the center line of the tower base.			
13.04.04	Resistance against down thrust The down-thrust load combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.			
13.04.05	Resistance against side-thrust The chimney portion of the foundation shall be designed as per limit state method of IS-456, considering the chimney as a column subjected to axial loads (down thrust loads) and biaxial bending moments resulting from side thrust forces. The passive earth pressure (as per Rankine's formula) shall be considered for the design of chimney against side thrust. If uplift and down thrust are computed in vertical direction for the foundation design, full resultant horizontal shear shall be taken at footing tip for design of the footing to resist side thrust.			
13.05.00	PROPERTIES OF CONCRETE			
13.05.01	The cement concrete used for the foundations shall be of grade M20 (nominal mix) with 20mm coarse aggregate.			
13.05.02	All the properties of concrete regarding its strength under compression tension, shear, punching and bending etc. as well as workmanship will conform to IS:456.			
13.05.03	The material properties for cement, aggregate and reinforcement steel shall be as specified in Chapter-C0 "Switchyard Civil Works".			
13.05.04	The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Potable water is generally preferred.			
13.06.00	DESIGN OF FOUNDATIONS			
13.06.01	Structural design of the foundations shall be done by limit State method conforming to IS 456.			
13.06.02	The chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 84 of 102


CLAUSE NO.	TECHNICAL REQUIREMENTS			
13.06.03	The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto lower most joint level between the bottom lattices and the main corner legs of the tower.			
13.06.04	Minimum thickness of foundation shall be 300 mm.			
13.06.05	The distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 150 mm or more than 200mm.			
13.06.06	The total depth of foundations below the ground level shall not be less than 1.5 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, the same depths of foundations shall be used for different types of foundations.			
13.06.07	The portion of the stub in the chimney and foundation slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design.			
13.06.08	Minimum 50mm thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit.			
13.06.09	Over Load Factor The overload factor for foundations shall be considered as 1.1 i.e. the reaction except due to dead loads on foundations shall be increased by 10 per cent.			
13.07.00	CONSTRUCTION OF TOWER FOUNDATION			
13.07.01	Excavation			
13.07.02	Excavation work must not be started until the tower schedule & profile and foundation drawing are approved by the Owner.			
13.07.03	Except specified otherwise, all excavation for footing shall be made to the lines and grades of the foundation. All excavation shall be protected so as to maintain a clean subgrade, until the footing is placed, using timbering/shuttering, shoring etc., if necessary. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit shall be removed by the Contractor before placing concrete.			
13.07.04	Rock excavation requiring Blasting Wherever blasting is required for excavation in rock, the same shall be done after obtaining license from the competent authority. Following shall be adhered to: i) All provisions of explosive acts shall be adhered to. ii) The magazine for the storage of explosive shall be to suit as per the requirements of explosive department. iii) Where blasting is required, same shall be controlled blasting. iv) Contractor shall prepare the detailed blasting scheme and get the same approved from Engineer-in-charge before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 85 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>v) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.</p> <p>vi) The Contractor shall also observe any specific instructions given by the Engineer-in-charge. The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosives and the blasting operations. The Engineer-in-charge or his authorised representative shall frequently check the Contractor's compliance with these precautions and the manner of storing and accounting of explosives. The Contractor shall provide necessary facilities for this the above.</p> <p>vii) Controlled blasting shall be done by a specialised agency duly approved by Engineer-in-charge. All controlled blasting shall be done by using time delay detonators (i.e. excel type).</p> <p>viii) All rules under the Explosives Act and other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in IS: 4081.</p>			
13.08.00	Setting of Stubs			
13.08.01	The stubs shall be set correctly in accordance with approved method at the exact location and alignment and precisely at correct levels with the help of stub setting templates and leveling instrument. Stubs shall be set in the presence of Owner's representative available at site where required and for which adequate advance intimation shall be given to the Owner by the Contractor.			
13.08.02	Setting of stub at each location shall be approved by the Owner's representative.			
13.08.03	<p>Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without extension and also for leg extension. Stub templates for standard towers and towers with extension upto 6M shall be of adjustable type. The stub templates shall be painted. Generally for each transmission line tower package, following numbers of stub setting templates shall be deployed by the Contractor:</p> <p>For each A type tower : 3 Nos. For each of B, C and D type : 2 Nos.</p> <p>However, if Owner feels that more number of templates are required for timely completion of a particular line the Contractor shall have to deploy the same without any extra cost to Owner.</p>			
13.08.04	One set of each type of stub setting template as applicable, shall be supplied to the Owner, on completion of the project at no extra cost to Owner.			
13.09.00	Mixing, Placing and Compacting of Concrete			
13.09.01	The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain hand mixing may be permitted at the discretion of Owner. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalies. Saltish or blackish water shall not be used.			
13.09.02	Mixing shall be continued until there is uniform distribution of material and the mix is uniform in colour and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 86 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एन टी पी सी NTPC</div>
	which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.			
13.09.03	Form boxes shall be used for casting all type of foundations. The concrete shall be well compacted such that no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compaction of the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of Owner. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge, to drain off any rain water falling on the coping.			
13.09.04	In wet locations, the site must be kept complete de-watered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period.			
13.09.05	After the form-work has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the satisfaction of the Owner's representative before the foundation pits are backfilled.			
13.10.00	Back-Filling and Removal of Stub Template			
13.10.01	After opening of form-work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with excavated soil, unless it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, shall be done by the Contractor at his own cost, irrespective of lead.			
13.10.02	The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled and wetted and tempered properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits, towards the outer ends. After the pits have been backfilled to full depth, the stub template may be removed.			
13.10.03	The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water. After backfilling 50 mm high earthen embankment (bandh) will be made along the sides of excavation pits and sufficient water will be poured in the backfilled earth for atleast 24 hours.			
13.11.00	Curing			
	The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.			
13.12.00	Benching			
	When the line passes through hilly/undulated terrain, for a few tower locations it may be required to level the ground for casting of tower footings on same elevation. All the activities related to make the required area of ground in same elevation for casting of foundation, shall be termed as benching work. Benching work shall include cutting of excess earth and removing the same to a suitable point of disposal as required by the Owner. Benching shall be resorted to only after getting specific approval from the Owner.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 87 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
13.13.00	Protection of Tower Footing			
13.13.01	The work shall include all necessary stone revetments, concreting and earth filling above ground level in hilly/undulated terrain and special measures like RCC retaining walls for protection of foundation close to or in nallah, river bed etc. The top seal cover of the stone revetments shall be done with M20 concrete (nominal mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.			
13.13.02	The quantity of excavated earth obtained from a particular location shall generally be utilised in back-filling work in protection of tower footing of same locations, unless it is unsuitable for such purpose. In the latter case, the back-filling shall be done with borrowed earth of suitable quality. The consolidation of earth shall however be done after backfilling.			
14.00.00	TOWER LINE ERECTION AND STRINGING			
14.01.00	GENERAL REQUIREMENTS			
14.01.01	The details of the scope of erection work shall include the cost of labour, all tools and plants like tension stringing equipment and all other incidental expenses in connection with erection and stringing work.			
14.01.02	The Contractor shall be responsible for transportation of all the materials to be provided by the Contractor as per the scope of work to site, proper storage and preservation at their own cost till such time the erected line is taken over by the Owner.			
14.02.00	TREATMENT OF MINOR GALVANISING DAMAGE			
	In case any minor damage to galvanising is noticed, the same shall be treated with zinc rich paint (having at least 90% zinc content) before erection.			
14.03.00	ASSEMBLY			
14.03.01	The method followed for the erection of towers, shall ensure the points mentioned below :			
	<div>a) Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, tommy bars not more than 450 mm long may be used.</div> <div>b) Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided and tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.</div> <div>c) All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.</div> <div>d) The bolt position in assembled towers shall be as per IS:5613 (Part-II/Section 2).</div> <div>e) Tower shall be fitted with number plate, danger plate, phase plate and anti-climbing device as described.</div> <div>f) All bank holes, if any left, after complete erection of the tower, are to be filled up by bolts and nuts of correct size.</div>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 88 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.03.02	Tightening and Punching of Bolts and Nuts			
A)	All nuts shall be tightened properly using correct size spanner/torque wrench. Before tightening, it shall be ensured that filler washers and plates are placed in gaps between members wherever applicable, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nut. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If during tightening a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.			
B)	The threads of all the bolts projected outside the nuts shall be welded at two diametrically opposite places. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm level for double circuit towers. After welding, cold galvanised paint having at least 90% Zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.			
C)	In addition to the tack welding of nuts with bolts, as described above, the Contractor can also propose some alternative arrangements, like use of epoxy resin adhesive which can serve the purpose of locking the nut permanently with the bolt and thus preventing pilferage of the tower members.			
14.04.00	INSULATOR HOISTING			
	I-Suspension insulator strings shall be used on suspension towers and tension insulator strings on angle and dead end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and fittings, if any, shall not be employed in the assemblies. Before hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for the purpose. Corona control rings/arching horn shall be fitted in an approved manner. The yoke arrangements be horizontal for tensions strings. Torque wrench shall be used for fixing different line materials and their components, like suspension clamp for conductor and earthwire, etc., whenever recommended by the manufacturer of the same of river crossing towers.			
14.05.00	HANDLING OF CONDUCTOR AND EARTHWIRE			
14.05.01	The Contractor shall be entirely responsible for any damage to the towers or conductors during stringing. While running out the conductors, care shall be taken that the conductors do not touch or rub against the ground or objects which could cause scratches or damages to the strands. The conductors shall be run out of the drums from the top in order to avoid damage due to chafing. Immediately after running out, the conductor shall be raised at the supports to the levels of the clamps and placed into the running blocks. The groove of the running blocks shall be of such a design that the seat is semi-circular and larger than the diameter of the conductor earthwire and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.			
14.05.02	The running blocks shall be suspended in a manner to suit the design of the crossarm. All running blocks, especially those at the tension end, will be fitted on the cross-arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. In case suspension, or section towers are used even for temporary terminations, if this be unavoidable, they shall be well guyed			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 89 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>and steps shall be taken by the Contractor to avoid damage. Guying proposal alongwith necessary calculations shall be submitted by the Contractor to Owner by the Contractor for checking the tensions in the guy made available to the Owner by the Contractor for checking the tensions in the guy wires. The drums shall be provided with a suitable braking device to avoid damages, loose running out and kinking of the conductor. The conductor shall be continuously observed for loose or broken strands or any other damage. When approaching end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the manufacturers.</p>			
14.05.03	<p>Repairs to conductors, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface shall be done only in case of minor damage, scuff marks etc. keeping in view both electrical and mechanical safe requirements. The final conductor surface shall be clean smooth and without any projections, sharp points, cuts, abrasions etc.</p>			
14.05.04	<p>Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.</p>			
14.05.05	<p>Derricks shall be used where roads, rivers, channels, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shut down shall be obtained when working at crossing of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth-wire and accessories in the field.</p>			
14.05.06	<p>The sequence of running out shall be from top to downwards i.e. the earthwire shall be run out first, followed by the conductors in succession. Unbalances of loads on towers shall be avoided as far as possible.</p>			
14.05.07	<p>The proposed 400 kV transmission line may run parallel for certain distance with the existing Transmission lines which may remain energised during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwires, which although comparatively small during normal operations can be severe during switching. It shall be the Contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.</p>			
14.05.08	<p>B and C type of towers are not designed for one side stringing. Therefore proper guying arrangement shall be made for B and C type of towers during stringing on one section while the other section is not strung. The Contractor has to submit the detailed proposal alongwith the calculation for guying which shall be approved by the Owner. Proper T&P shall be made available to the Owner by the Contractor for checking the tensions in the guy wires. All the expenditure on account of the above work is deemed to be included in the bid price and no extra payment shall be made for the same.</p>			
14.06.00	STRINGING OF CONDUCTOR AND EARTHWIRE			
14.06.01	<p>The stringing of the conductor shall be done by standard stringing method.</p>			
14.06.02	<p>After being pulled the conductor/earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 90 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.06.03	Conductor creep are to be compensated by over tensioning the conductor at appropriate temperature for which calculations are to be submitted by the contractor for Owner's approval.			
14.06.04	The Bidder shall give complete details of the stringing methods which be proposes to follow. Before the commencement of stringing the Contractor shall submit the stringing charts for the conductor and earthwire for various temperatures and span alongwith equivalent spans for the approval of the Owner.			
14.06.05	Jointing			
A)	All the joints on the conductor and earthwire shall be of compression type, in accordance with the recommendations of the manufacturer for which all necessary tools and equipment like compressors, dies, processes etc. shall have to be arranged by the Contractor. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and properly greased with anti- corrosive compound if required, and as recommended by the contractor before the final compression is done with the compressors.			
B)	All joints or splices shall be made at least 30 meters away from the structures . No joints or splices shall be made in spans crossing over main road, railways, small rivers with tension spans. During compression or splicing operation the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.			
C)	During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint along with protection can be passed over it smoothly.			
14.07.00	Sagging-in-Operation			
14.07.01	The conductor shall be pulled upto the desired sag and left in running blocks for atleast one hour after which the sag shall be re-checked and adjusted, if necessary before transferring the conductor from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in.			
14.07.02	The sag will be checked in the first and the last span of the section in case of sections upto eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.			
14.07.03	The running blocks, when suspended from the transmission structure for sagging shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured,			
14.07.04	At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, he conductor and earthwire shall be checked on the running blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the conductor is clamped.			
14.07.05	Tensioning and sagging operations shall be carried out in clam weather when rapid changes in temperatures are not likely to occur.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 91 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.07.06	Tensioning and Sagging of Conductors and Earthwire The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The 'Initial' stringing chart shall be used for the conductor and 'final' stringing chart for earth-wire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.			
14.07.07	Clipping In			
A)	Clipping of the conductors in positions shall be done in accordance with the recommendations of the manufacturer. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps.			
B)	The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements and shall match the jumper drops shown in the tower drawings.			
C)	Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.			
14.07.08	Fixing of Conductor and Earthwire Accessories Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.			
14.08.00	REPLACEMENT If any replacements are to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arms becomes necessary after stringing, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys as suspension points.			
14.09.00	FINAL CHECKING TESTING AND COMMISSIONING			
14.09.01	After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected keeping in view of the following main points:			
	a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted.			
	b) Concrete chimneys and their copings are in good finally shaped conditions.			
	c) All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever.			
	d) All bolts are properly tightened and punched/tack welded.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 92 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनडीपीसी NTPC</div>								
	<div><div>e) The stringing of the conductors and earthwire has been done as per the approved sag and tension charts and desired clearances are clearly available.</div><div>f) All conductor and earthwire accessories are properly installed.</div><div>g) All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed.</div><div>h) Wherever required it should be ensured that revetment is provided.</div><div>i) The original tracings/ soft copies of profile route alignment and tower, design, structural drawings, bill of material, shop drawings of all towers are submitted to the Owner for reference and record.</div><div>j) The insulation of line as a whole is tested by the Contractor by providing his own equipment, labour etc. to the satisfaction of the Owner.</div><div>k) All towers are properly grounded.</div><div>l) The line is tested satisfactorily for commissioning purpose.</div></div>											
15.00.00	TRANSMISSION LINE MATERIAL											
15.01.00	GENERAL											
15.01.01	All the equipment shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 220 kV AC transmission with twin conductor and will give continued good performance.											
15.01.02	The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and a good finish.											
15.01.03	All ferrous parts shall be hot dip galvanised, after all machining has been completed, nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electrogalvanised. The bolt threads shall be under cut to take care of increase in diameter due to galvanising . Galvanising shall be done in accordance with IS:2629. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall be guaranteed to withstand at least six dips each lasting one minute under the standard preece tests for galvanising.											
15.01.04	The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continues and free from imperfection such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn. 99.95 as per IS:209.											
15.02.00	EARTHWIRE											
15.02.01	The galvanised steel earthwire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part-II)-1976 except where otherwise specified herein.											
15.02.02	<div>Parameters of the earthwire</div> <table><tr><td>(a) Size (strands & wire diameter)</td><td>7/3.15 mm</td></tr><tr><td>(b) Overall diameter</td><td>9.45 mm</td></tr><tr><td>(c) Stranded weight</td><td>428 Kg/km</td></tr><tr><td>(d) Minimum ultimate tensile strength</td><td>56 kN</td></tr></table>				(a) Size (strands & wire diameter)	7/3.15 mm	(b) Overall diameter	9.45 mm	(c) Stranded weight	428 Kg/km	(d) Minimum ultimate tensile strength	56 kN
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NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 93 of 102								

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
15.02.03	The earthwire shall be pre-formed and post-formed to avoid opening of strands at the time of cutting or joining. The finished material shall have minimum brittleness, as it will be subject to appreciable vibration while in use. It shall withstand 3 and ½ number of one minute dips in the standard preece test.			
15.02.04	There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earthwire. There shall be no strand joints or strand splicer in any length of the completed stranded earthwire.			
15.03.00	CONDUCTOR			
15.03.01	The conductor shall be Aluminium Core Steel Reinforced (ACSR) type. The conductor shall confirm to IS:398 (Part-II) except where otherwise specified herein.			
15.03.02	Parameters of the conductor			
	(a) Name	Zebra Conductor'		
	(b) Strands and wire diameter			
	(i) Aluminium	54/3.18 mm		
	(ii) Steel	7/3.18 mm		
	(c) Conductor per phase	twin		
	(d) Inter phase spacing	as per IE rules		
	(e) Overall diameter	28.62 mm		
	(f) Weight (Approx.)	1.621 Kg/km		
	(g) Minimum ultimate tensile strength	130.3 kN minimum		
15.03.03	The steel strands shall generally comply with the requirements stipulated for earthwire at clause 2.00.00 above.			
15.03.04	Joints shall be permitted in the individual Aluminium wires in all layers except the outer most layer of the finished conductor. These joints shall be made by cold pressure butt-welding and shall be such that no two such joints are within 15 metres of each other in the complete stranded conductor.			
15.03.05	The standard length of the conductor shall be 1600 meters for conductor and 2x2000 metres for earth wire. A tolerance of ± 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of random lengths shall not be more than 10% of the total quantity ordered.			
15.04.00	CONDUCTOR ACCESSORIES			
15.04.01	Mid Span Compression Joint for Conductor			
	As per details given in IS: 2121 Part-2.			
15.04.02	Repair Sleeve			
	Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be of rounded that the conductor strands are not damaged during installation.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 94 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
15.04.03	The Bidder shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve for owner's review. The compression pressure shall also be indicated by the Bidder.			
15.04.04	Vibration Damper for conductor and Earthwire			
A)	Vibration dampers of 4 R-Stock bridge type with four (4) different resonance spread within the specified aeolian frequency bandwidth shall be used at all suspension and tension points on each span to damp out the Aeolean vibrations of the conductors to the specified level as mentioned hereinafter. Two dampers minimum on each side per conductor/earthwire shall be used at tension points and one damper minimum on each side per conductor at suspension points for ruling design span.			
B)	The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent.			
C)	The messenger cable shall be made of high strength galvanised steel/stainless steel with a minimum strength of 135 kg/mm ² . It shall be of pre-formed and post-formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826-1979 for heavily coated wires.			
D)	The manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.			
E)	The vibration damper for conductor shall not have magnetic power loss more than 0.5 watt at 350 amps at 50 Hz alternating current.			
F)	The vibration analysis of the system, with and without damper and dynamic characteristics of the damper shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the systems area follows: Span length i) Ruling design span			

CLAUSE NO.	TECHNICAL REQUIREMENTS					<div>एनटीपीसी</div> <div>NTPC</div>																												
iv)	The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.																																	
15.05.00	EARTHWIRE ACCESSORIES																																	
15.05.01	Mid Span Compression Joint for Earthwire																																	
It shall be used for joining two lengths of earthwire. The joint shall be made of mild steel. The steel sleeve should not crack or fail during compression in it or service period. The Brinell Hardness of steel should not exceed 200. The steel sleeve shall be hot dip galvanised. The joints shall not permit slipping off, damage to , of failure of the complete earthwire or any part thereof at a load not less than 95% of the ultimate tensile strength of the earthwire. The joint shall have resistivity less than 75% of resistivity of equivalent length of earthwire. The dimensions and the dimensional tolerance of the joint shall be as given below:																																		
<table><tr><th rowspan="2">Item</th><th colspan="2">Dimensions before compression</th><th colspan="3">Dimension after compression</th></tr><tr><th>Inner Dia.</th><th>Outer Dia.</th><th>Length</th><th>Corner to Corner width</th><th>Face to face width</th></tr><tr><td></td><td>(mm)</td><td>(mm)</td><td>(mm)</td><td>(mm)</td><td>(mm)</td></tr><tr><td>Al. sleeve</td><td>22±0.5</td><td>30±0.5</td><td>315±5</td><td>29.4±0.5</td><td>25±0.5</td></tr><tr><td>Steel sleeve</td><td>10±0.2</td><td>21±0.5</td><td>230±5</td><td>20.2±0.5</td><td>17.5±0.5</td></tr></table>						Item	Dimensions before compression		Dimension after compression			Inner Dia.	Outer Dia.	Length	Corner to Corner width	Face to face width		(mm)	(mm)	(mm)	(mm)	(mm)	Al. sleeve	22±0.5	30±0.5	315±5	29.4±0.5	25±0.5	Steel sleeve	10±0.2	21±0.5	230±5	20.2±0.5	17.5±0.5
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15.05.02	Vibration Damper For Earthwire																																	
Refer Clause 15.04.04 detailed above.																																		
15.05.03	Flexible Copper Bond: As detailed in is:2121 part3.																																	
15.05.04	Suspension Clamp for Earthwire : As Detailed in IS:2121 Part3																																	
A)	At all suspension towers, suitable suspension clamp shall be used to support the earthwire of 7/3.15 mm size, the clamp shall be of either free-centre type or trunion type and shall provide adequate area of support to the earthwire.																																	
B)	The total drop of the suspension assembly from the center point of the attachment to the centre point of the Earthwire shall not exceed 150 mm. The complete assembly shall be guaranteed for slip strength of not less than 9 kN and not more than 14 kN. The breaking strength of the assembly shall not be less than 25 kN.																																	
C)	The clamping piece and the clamp body shall be clamped by at least two U-bolts of size not less than 10 mm diameter having one nut and 3 mm thick lock nut with washer on each of its limbs. Suspension clamps shall be provided with inverted type U-bolts. One limb of the U-bolt shall be long enough to accommodate the lug of the flexible copper bond.																																	
15.05.05	Tension Clamp for Earthwire																																	
The details shall be as per IS:2121 part-3. Only Compression type tension clamp shall be used to hold galvanised steel earthwire. Anchor shackle shall be supplied which shall be suitable for attaching the tension clamp to strain plates. The strain plates supplied with the																																		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD		Page 96 of 102																												

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>towers will have a minimum thickness of 8 mm with a hole of 17.5 mm diameter. Suitable lugs for jumper connection shall also be supplied alongwith necessary bolts and nuts.</p>			
15.06.00	HARDWARE FITTINGS			
15.06.01	The hardware fittings shall be as per the specification and IS/IES standards			
15.06.02	<p>Each hardware fittings shall be supplied complete in all respects and include the following hardware parts:</p> <p>a) Ball hook for suspension hardware fittings suitable for attaching to V-hanger of the tower. Anchor shackle shall be supplied, which shall be suitable for attaching the tension hardware fittings to strain plate, of the tower.</p> <p>b) Suitable yoke plates</p> <p>c) Suspension and dead end assembly to suit conductor size.</p> <p>d) Other necessary fittings such as eye links, ball clevis, socket clevis, clevis eye, U-clevis, ball link, arcing horn etc. to make the hardware fittings complete.</p> <p>e) 2.5% extra fasteners shall be supplied along with the hardware fittings.</p> <p>f) Socket fittings shall be provided with only R-shaped security clip in accordance with IS-2486 (part-II).</p>			
15.06.03	Suspension Assembly for Conductor			
	A)	The suspension assembly shall include AGS type suspension clamps alongwith standard performed armour rods set suitable for ACSR 'Moose conductor. The elastomer used for AGS clamp shall be neoprene rubber with insert. This shall be suitable to withstand upto 75deg. Centigrade temperature and atmospheric ozone.		
	B)	The suspension clamp assembly alongwith standard armour rods shall have a slip strength between 11 to 16 KN.		
	C)	The length and diameter of each rod shall be 1550±16 mm and 6.35±0.10mm respectively. The tolerance in length of the rods in completed set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed or ball ended.		
	D)	The number of armour rods in each set shall be eleven. Each rod shall be marked in the middle with paint for easy applications on the line.		
	E)	The armour rod shall not loose, their resilience even after five applications.		
	F)	The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).		
	G)	The armour rods shall be made of aluminium alloy of type 6061 or equivalent. The alloy shall have a minimum tensile strength of 35 kg / mm ² .		
15.06.04	Dead End Assembly			
	<p>The dead end assembly shall be complete with jumper cone etc.</p> <p>The bidder shall clearly specify the before and after compression dimensions of the dead-end clamp. The compression pressure shall also be indicated by the bidder. The dimensions and dimensional tolerances of the cross section of aluminium dead-end for conductor shall be as given below:</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
				Page 97 of 102

CLAUSE NO.

TECHNICAL REQUIREMENTS

Item	Dimensions before compression		Dimension after compression	
	Inner Dia. (mm)	Outer Dia. (mm)	Corner to corner width (mm)	Face to face width (mm)
Alum. Dead-end	31±0.5	48±1	46±0.5	40±0.5
Steel Dead-end	10±0.2	20±0.5	19±0.5	16±0.5

15.06.05 Yoke Plates

The Plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavourable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations, i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS:800-1984.

15.07.00 INSULATOR

15.07.01 The size of disc insulator, the number to be used in different type of strings, their electromechanical strength and minimum creepage distance shall be as follows :


Type of String	Size of disc insulator (mm)	Min. creepage distance of each disc (mm)	No. of standard discs	Electro-mechanical strength of insulator string (kN)
Single Suspension	255/280 x 145	280	1x 14	90
Double Suspension	-do-	-do-	2x 14	2 x 90
Double tension	-do-	-do-	2x 14	2 x 120
Single tension	-do-	-do-	1x 14	120


Note: Single Suspension (Pilot) string will be used for jumpers of tension type towers. It will be similar to single suspension type except the clamp of the conductor.

A) Disc Insulator: The insulator shall be pin and cap; ball and socket type. The disc insulator shall conform to IS: 731.

B) Ball and Socket Designation

The dimensions of the balls and sockets shall be of 20 mm designation, for 90KN/120KN disc insulator in accordance with the standard dimensions stated in IS:2486-(Part-II)/IEC:120.

CLAUSE NO.	TECHNICAL REQUIREMENTS			
15.07.02	Materials			
A)	Porcelain: The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.			
B)	Glaze: The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of he insulator and shall have a good lustre, smooth, surface and good performance under the extreme weather conditions of a tropical climate. It shall not be cracked or chipped by ageing under the normal service conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range.			
C)	Toughened Glass: In case of glass insulator, the glass used for the shells shall be sound, free from defects such as flows, bubbles, inclusions etc. and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.			
D)	Cement: Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing.			
E)	Pins and Caps: Pins and Caps shall be made of drop forged steel and malleable cast iron/spheriodal graphite iron/drop forged steel respectively, duly hot dip galvanised and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material.			
F)	Security Clips: Security clips shall be made of good quality stainless steel or phosphor bronze as per IS: 1385-1968 2.5% extra Security clip shall be provided.			
15.07.03	Hot Line Maintenance			
	The insulators offered shall be suitable for employment of hot line maintenance technique so that the usual hot line operations can be carried out with ease, speed and safety.			
	Bidders shall indicate the methods generally used in the routine hot and dead line maintenance of HV lines for which similar insulator have been supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance.			
15.08.00	TESTS FOR TL. LINE MATERIAL			
15.08.01	GENERAL REQUIREMENTS			
15.08.02	The materials shall conform to all the type tests as per relevant standards. The acceptance, routine tests and tests during manufacture shall be carried out on the line material as per relevant standards.			
16.00.00	OPGW and its accessories			
16.00.01	General			
	This specification covers the provision of one peak of 220kV tower with Optical Fiber (OPGW). This optical fiber cable will be connected to suitable optical line terminal and multiplex equipment to form part of the Plant's overall communications transmission system. Any expected variation shall be clearly identified in the Bidder's Proposal. Bidder to ensure that optical fiber characteristic of the OPGW cable to be supplied shall be compatible with the existing OPGW cable.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 99 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS																																																																															
16.00.02	<p>Construction</p> <p>The OPGW shall be composed of a layer of aluminum-clad steel wires around a seamless aluminum tube or stainless steel tube. The Optical core, in order to protect the fibers from external forces, shall be laid loose inside buffer tubes.</p> <p>The optical core shall be filled with hydrogen absorbent and water blocking filling compound. The optical fiber itself shall be manufactured by using high grade silica to provide the required performance.</p>																																																																															
16.00.03	<p>Optical Fiber Characteristics</p> <p>Optical fiber shall be supplied in accordance with ITU – T Recommendation G.652 with the following requirements.</p> <table><tr><td>Profile of Optical Fiber:</td><td colspan="4">Single mode stepped index</td></tr><tr><td>Average Transmission Loss:</td><td colspan="4"></td></tr><tr><td>At wavelength 1310 nm</td><td colspan="4">0.38 dB per km maximum</td></tr><tr><td>At Wavelength 1550 nm</td><td colspan="4">0.25 dB per km maximum</td></tr><tr><td>Number of Fiber</td><td colspan="4">12</td></tr><tr><td>Average splicing loss:</td><td colspan="4">0.05db per joint</td></tr><tr><td>Maximum splicing loss:</td><td colspan="4">0.10 dB per joint</td></tr><tr><td>Mode field diameter (MFD):</td><td colspan="4">9.0µm ± 1.0µm</td></tr><tr><td>Cladding diameter:</td><td colspan="4">125 ± 2 µm</td></tr><tr><td>Core / Cladding</td><td colspan="4"></td></tr><tr><td>Mode field concentricity error:</td><td colspan="4">1µm</td></tr><tr><td>Chromatic – dispersion coefficient @ 1310 nm</td><td colspan="4">3.5 ps / nm km. Maximum</td></tr><tr><td>Chromatic – dispersion coefficient @ 1550 nm</td><td colspan="4">20 ps / nm km. Maximum</td></tr><tr><td>Fiber Identification:</td><td colspan="4">each fiber shall be uniquely identifiable throughout the Length of the wire.</td></tr><tr><td>Operating Temperature:</td><td colspan="4">0°C to 80 °C continuously</td></tr></table>					Profile of Optical Fiber:	Single mode stepped index				Average Transmission Loss:					At wavelength 1310 nm	0.38 dB per km maximum				At Wavelength 1550 nm	0.25 dB per km maximum				Number of Fiber	12				Average splicing loss:	0.05db per joint				Maximum splicing loss:	0.10 dB per joint				Mode field diameter (MFD):	9.0µm ± 1.0µm				Cladding diameter:	125 ± 2 µm				Core / Cladding					Mode field concentricity error:	1µm				Chromatic – dispersion coefficient @ 1310 nm	3.5 ps / nm km. Maximum				Chromatic – dispersion coefficient @ 1550 nm	20 ps / nm km. Maximum				Fiber Identification:	each fiber shall be uniquely identifiable throughout the Length of the wire.				Operating Temperature:	0°C to 80 °C continuously			
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16.00.04	<p>OPGW Characteristics</p> <table><tr><td>Ultimate tensile strength</td><td>(kg)</td><td>≥</td><td>7,500</td></tr><tr><td>Outside diameter</td><td>(mm)</td><td>≤</td><td>14</td></tr><tr><td>Cross sectional area of Conduct</td><td>(mm²)</td><td>≥</td><td>80</td></tr><tr><td>D.C. Resistance @ 20 °C</td><td>(□/km)</td><td>≤</td><td>0.76</td></tr><tr><td>Length per reel</td><td>(m)</td><td></td><td>3000 Approx.</td></tr><tr><td>Modulus of elasticity</td><td>(kg/mm²)</td><td>≥</td><td>10,000</td></tr><tr><td>Coefficient of linear expansion</td><td>(/°C)</td><td>≤</td><td>15.0 x 10⁻⁶</td></tr><tr><td>Capacity fault current (KA)² sec.</td><td></td><td></td><td>46</td></tr><tr><td>Maximum allowable temp.</td><td></td><td></td><td></td></tr><tr><td>For optical fiber in loose type</td><td>(°C)</td><td></td><td>160</td></tr><tr><td>Maximum Transmission Loss Change – Temperature Range</td><td></td><td></td><td></td></tr><tr><td>0°C to 150 °C</td><td>(dB/km)</td><td></td><td>0.1</td></tr><tr><td>Unit Weight</td><td>(kg./km)</td><td>≤</td><td>600</td></tr></table> <p>The Bidder shall design the OPGW requirements to suit each span in the system, based on the applicable drawings and field surveys. The Bidder's proposal shall stipulate the characteristics of the OPGW required for each span in the system.</p>					Ultimate tensile strength	(kg)	≥	7,500	Outside diameter	(mm)	≤	14	Cross sectional area of Conduct	(mm ²)	≥	80	D.C. Resistance @ 20 °C	(□/km)	≤	0.76	Length per reel	(m)		3000 Approx.	Modulus of elasticity	(kg/mm ²)	≥	10,000	Coefficient of linear expansion	(/°C)	≤	15.0 x 10 ⁻⁶	Capacity fault current (KA) ² sec.			46	Maximum allowable temp.				For optical fiber in loose type	(°C)		160	Maximum Transmission Loss Change – Temperature Range				0°C to 150 °C	(dB/km)		0.1	Unit Weight	(kg./km)	≤	600																							
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NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD	Page 100 of 102																																																																											

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
16.00.05	<div>Assemblies and Line Accessories</div> <div>a. General</div> <p>The OPGW assemblies and line accessories shall consist of the hardware indicted herein. All hardware and accessories shall be made of aluminum, aluminum alloy, malleable iron, steel (metal mold of drop forging process), stainless steel, or non-ferrous metal, unless otherwise specified. In addition, all hardware and accessories shall have an ultimate tensile strength equal to or exceeding the rated ultimate tensile strength of the overhead ground wire. All metal shall be free from burrs, sharp edges, lumps and dross and shall be smooth so that interconnecting parts will fit properly, and so that the parts maybe assembled and readily.</p> <p>All bolts and other fasteners shall be installed according to manufacturer's recommendations. Materials no specifically covered herein by detailed specifications shall be of standard commercial quality suitable for the intended use. The Contractor shall determine the most suitable type of clamp to be used at each and every transmission tower location.</p> <div>b. Suspension Clamps</div> <p>The suspension clamps for the OPGW shall be of bolt or performed type. The bolt type suspension clamps shall be complete with bolts, keeper pieces, and other required parts. Each clamp shall be capable of holding the OPGW without slipping under an unbalanced tension of 25% of the ultimate tensile strength of the OPGW.</p> <div>c. Tension Clamps</div> <p>The tension clamps shall be of bolt or performed type, and cable of holding the OPGW without slipping or damaging the OPGW under a tension of 75% of the OPGW ultimate tensile strength. A suitable piece shall be of same material as the clamp body. Bolts, nuts and washers shall be hot-dipped galvanized malleable iron or steel.</p> <div>d. Grounding clamps and Parallel Groove Clamp</div> <p>Each clamp shall be capable holding the OPGW using bolts and nuts.</p> <div>e. Vibration dampers</div> <p>Stock bridge type vibration dampers, suitable for use on the OPGW shall be supplied. The dampers shall have an aluminum, clamping bolts, or other suitable device, on the galvanized wire between the weights, and be suitable for attachment to the OPGW. The damper clamp shall be designed to permit installation and removal using hot line tools. Each damper weight, subject to the accumulation of moisture, shall be provided with one drain hold positioned at the bottom of the weight when the damper is installed in the vertical plane. Damper weights shall be made of hot dip galvanized case iron or zinc.</p> <div>f. Armor rods</div> <p>The armor rods for the OPGW shall be of the preformed type. They shall be smooth and fee from corrosion, splitting, cracking, or any other defects. They shall be designed to effectively protect the OPGW from fatigue caused by vibration.</p> <p>Armor rods may or may not be employed, as per OPGW manufacturer recommendations, however the use of armor rods is preferred by the Employer.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 101 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एन टी पी सी NTPC</div>
	<p>g. The joint box shall be air-tight, water-proof. The cover shall be securely fastened to the case by non-loosening fasteners. Both the case and the cover shall be made of non-corrosive aluminum alloy or hot dip galvanized steel or approved materials. The joint box shall be sufficiently rugged and sturdy to withstand outdoor climatic and environmental conditions. The joint box shall accommodate sheath protected arc-fusion splices and up to 1.5 m of additional fiber on each side of the splice; guides shall be provided to keep the extra fiber well above the allowable bending radius of the fiber. The spliced parts of the optical fiber within the joint box shall be reinforced and free from tension after completion of the splicing.</p> <p>The contractor shall provide one set of terminating materials with every joint box for optical fiber connection.</p> <p>1. Way Joint Box for OPGW</p> <p>This type of joint box shall be used to straight joint OPGW to OPGW, or OPGW to approach cable. It shall be used at all locations requiring such a device except those specified otherwise in the text or drawings elsewhere in this specification.</p> <p>2.Way Joint Box for OPGW and approach cable</p> <p>This type of joint box shall be used to spur joint all fibers contained in two OPGW cables to OPGW or one multi-core optical fiber cable at each terminal station, repeater station, or other location, as detailed in the text or drawings elsewhere in this specification.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 102 of 102