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SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1 SCOPE

The scope of this specification is to specify all details required by bidder for supplying:

- (i) Type tested tower design and drawings (structure assembly drawings) along with all extension and Auxiliary cross arms,
- (ii) Type test report from accredited Test lab
- (iii) Shop drawings,
- (iv) Bill of material of Tower structure including extension,
- (v) Design and Drawings of foundation for towers for different soil types such as Dry, Wet, Partially Submerged, Fully Submerged etc including Foundation loading data,
- (vi) Drawing for Stubs & Stub setting template,
- (vii) SAG tension calculation,
- (viii) SAG template drawing,
- (ix) Tower Spotting Data.
- (x) Any other data/documents required for execution of transmission line work

The detailed scope of work is submission and approval of above drawing and documents from customer.

The above drawing / documents shall be used by BHEL for the purpose of construction of one no. projects (i.e. single use)

1.2 SPECIFIC TECHNICAL REQUIREMENTS

Type test reports should not be more than 10 years old. It will be responsibility of Bidder to organize approval from the ultimate customer NTPC/APGENCO.

The projects wise specific technical requirements shall be as per Section 2.

SUPPLY OF DESIGN AND DRAWING OF TYPE TESTED TOWERS AND FOUNDATIONS

1.3 QUANTITIES

The quantities indicated are tentative & it may change to any extent during detailed engineering at contract stage.

S.No.	Item description	Unit	Quantity
A	Providing Type tested tower design and drawings (structure assembly drawings) alongwith all extension and Auxiliary cross arms, Type test report from accredited Test lab, Shop drawings, Bill of material, Design and Drawings of foundation for towers for different soil types, Stubs & Stub setting template, SAG tension calculation, SAG template drawing, Tower Spotting Data for following :		
1	Lattice type 220kV D/C transmission line tower with Twin Zebra suitable for wind Zone-2 and as per specification, required for North Karanpura (NTPC) Project		
a	DA Type	Set	1
b	DB Type	Set	1
c	DD Type	Set	1
2	Lattice type 220kV S/C Transmission line tower with Twin Moose suitable for wind Zone-4 and as per specification, required for Unchahar (NTPC) Project		
a	SA Type	Set	1
b	SD Type	Set	1
3	Lattice type 220kV D/C Transmission line tower with Twin Moose (circuit-1) and Single Moose (Circuit-2) suitable for wind Zone-2 and as per specification, required for Rayalseema (APGENCO) Project		
a	DC Type	Set	1
b	DE Type	Set	1

Note :

01. BIDDER MAY SUBMIT THEIR OFFER FOR ANY ONE OR MORE ITEMS FROM ITEM NO. A1,A2 and A3 FROM ABOVE. EVALUATION SHALL BE MADE BASED ON PROJECT WISE.

02. Rates quoted shall be for one project use by BHEL.

03. The above quoted price includes the approval from customer NTPC / APGENCO as applicable and if required, bidder may have to visit customer/BHEL office for discussions regarding approval. No separate payment shall be made for such visits.

SECTION – 2

TECHNICAL DETAILS

01. Tower design/drg shall be provided with extension of +3M, +6M, +9M for DA/SA , DB, DC, DD/SD and DE towers and +18/25M extension for DD/SD type towers.


02. The creepage requirement is 25mm/kV. Porcelain disc insulators are proposed.


The following Drawings/documents are enclosed for reference:

Annexure	Document Title	No of pages
NORTH KARANPURA		
A-1	Technical Specification of transmission line (NTPC)	47
RAYALSEEMA		
B-1	Design basis report - 220KV D/C Transmission line Doc. No. - TB-344-316-416 Rev-01	2
B-2	Route Alignment Survey Plan & Profile Drg No. TCE-7219A-765-RA-3001 R5	1
B-3	Sag Tension Calculation	10
UNCHAHAAR		
C-1	Design basis report - 220KV D/C Transmission line Doc. No. – 1450-001R-SWYD-PVE-U-019	5
C-2	Sag Tension Calculation	5


DATA TO BE SUBMITTED ALONG WITH OFFER

- A) TECHNICAL PARAMETERS INCLUDING SPAN, DEVIATION ANGLES, MAXIMUM WEIGHT SPAN, MINIMUM WEIGHT SPAN, SUM OF ADJACENT SPAN FOR VARIOUS DEVIATION ANGLE, DESIGN LOAD TENSIONS FOR CONDUCTOR AND GROUND WIRE.
- B) LINE DIAGRAM OF TOWER WITH DIMENSION
- C) COVERING SHEET OF TYPE TEST REPORT WITH STAMP OF TEST AGENCY.
- D) LIST OF PROJECTS WHERE THE PROPOSED DESIGN IS USED. PERFORMANCE CERTIFICATE FROM CUSTOMER IS TO BE ENCLOSED FOR AT LEAST ONE PROJECTS.
- E) DECLARATION FROM THE BIDDER REGARDING HIS SOLE OWNERSHIP OF THE DESIGN/DOCUMENTS AND NO DISPUTE/CLAIM FROM OTHER PARTY.


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 fo 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
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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			
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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 <p>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:</p> <p>a) Span</p> <p>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.</p> <p>b) Extension</p> <p>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.</p> <p>c) Road Crossing</p> <p>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.</p> <p>d) Railways Crossings</p> <p>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):</p> <p>i) The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings.</p> <p>ii) The crossing shall normally be at right angle to the railway track.</p> <p>iii) The crossing span shall be limited to 80% of design span.</p> <p>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..</p> <p>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.</p> <p>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.</p> <p>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</p>			
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	<p>drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.</p> <p>e) River Crossings</p> <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> <p>f) Power Line Crossing</p> <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> <p>g) Telecommunication Line Crossing</p> <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> <p>h) Details Enroute</p> <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> <p>i) Clearance from Ground, Building, Trees, etc.</p> <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>			
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	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.			
11.05.02	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.			
11.06.00	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)		
11.07.00	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		
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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		
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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.		
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CLAUSE NO.	<div data-bbox="657 212 1045 239" style="text-align: center;">TECHNICAL REQUIREMENTS</div> <div data-bbox="1297 176 1435 239" style="text-align: right;">  </div>		
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		
	<u>Table -1</u>		
	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
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	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.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
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:				
a)	Allowance of 150 mm shall be provided to account for errors in stringing.				
b)	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.				
c)	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 the provided between the live parts and steel work of super-structure shall be as per relevant standards.				
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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> <p>E) Angle of Shielding</p> <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> <p>F) Mid Span Clearance</p> <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>			
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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
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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.																			
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12.04.05	However, design approval for such substitution shall be obtained from the Owner before any substitution.			
	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.			
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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).			
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I)	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.			
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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.			
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	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.			
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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>			
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	<div><div>b)</div><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.</div></div>			
12.10.00	PACKING			
12.10.01	<div><div></div><div>The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.</div></div>			
12.11.00	DESIGN CALCULATION AND DRAWINGS			
12.11.01	<div><div></div><div>The following design calculation and drawings are required to be furnished during detailed engineering.</div></div>			
	<div><div>a)</div><div>Computation of wind load</div></div> <div><div>b)</div><div>Sag-tension calculation</div></div> <div><div>c)</div><div>Tower loading</div></div> <div><div>d)</div><div>Single line diagram of towers showing electrical clearances and steel sections.</div></div>			
12.11.02	<div><div></div><div>The Contractor shall also furnish following to the owner:</div></div> <div><div>a)</div><div>Detailed design calculation and drawing for towers and foundations.</div></div> <div><div>b)</div><div>Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc.</div></div> <div><div>c)</div><div>Bill of materials, indicating cutting and bending details against each member.</div></div> <div><div>d)</div><div>Shop drawings showing all details relevant to fabrication.</div></div> <div><div>e)</div><div>All the drawings for the tower accessories.</div></div>			


**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																								
	<table><thead><tr><th>DESCRIPTION</th><th>SYMBOL</th><th>REMARKS</th></tr></thead><tbody><tr><td>Maximum Tension Of Conductor/ Earth Wire under everyday temperature & full wind condition or minimum temperature & 36% Of max. wind which ever is more stringent</td><td>MT</td><td></td></tr><tr><td>Wind On Conductor</td><td>WC</td><td>Wind Span shall be the normal ruling span.</td></tr><tr><td>Wind On Insulator</td><td>WI</td><td>In case of Double String Insulators, both their strings shall be considered</td></tr><tr><td>Angle Of Deviation (Degrees)</td><td>□</td><td></td></tr><tr><td>Load Due To Deviation Of Tower</td><td>DY= 2 x MT x Sin □/2</td><td></td></tr><tr><td>Difference In Tension For unequal adjacent spans considering full ruling span on one side and 50% of ruling span on other side</td><td>MT1</td><td></td></tr></tbody></table>			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		
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	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																								


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	<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>			
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CLAUSE NO.	<div style="text-align: center;">TECHNICAL REQUIREMENTS</div> <div style="text-align: right;"></div>		
	<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> <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.</p> <p>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.</p> <p>13.02.08 The Geotechnical report shall include, but not limited to the following:</p> <ul style="list-style-type: none"> 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. 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. 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: <ul style="list-style-type: none"> 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. 		
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	<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>			
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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.			
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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.			
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	<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			
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	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.			
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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 : 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. 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. c) All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up. d) The bolt position in assembled towers shall be as per IS:5613 (Part-II/Section 2). e) Tower shall be fitted with number plate, danger plate, phase plate and anti-climbing device as described. 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.		
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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			
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	<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>			
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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.		
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14.07.06	Tensioning and Sagging of Conductors and Earthwire <p>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' stinging 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.</p>			
14.07.07	Clipping In <p>A) Clipping of the conductors in positions hall 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.</p> <p>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.</p> <p>C) Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.</p>			
14.07.08	Fixing of Conductor and Earthwire Accessories <p>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.</p>			
14.08.00	REPLACEMENT <p>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.</p>			
14.09.00	FINAL CHECKING TESTING AND COMMISSIONING			
14.09.01	<p>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:</p> <p>a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted.</p> <p>b) Concrete chimneys and their copings are in good finally shaped conditions.</p> <p>c) All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever.</p> <p>d) All bolts are properly tightened and punched/tack welded.</p>			
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	<p>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.</p> <p>f) All conductor and earthwire accessories are properly installed.</p> <p>g) All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed.</p> <p>h) Wherever required it should be ensured that revetment is provided.</p> <p>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.</p> <p>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.</p> <p>k) All towers are properly grounded.</p> <p>l) The line is tested satisfactorily for commissioning purpose.</p>										
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	<p>Parameters of the earthwire</p> <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
(a) Size (strands & wire diameter)	7/3.15 mm										
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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.			
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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:			
	<div>Span length</div> <div><div>i) Ruling design span</div><div>300 meters</div></div> <div><div>ii) Maximum Span</div><div>500 meters</div></div> <div><div>iii) Minimum Span</div><div>50 meters</div></div> <div><div>Tensile load in Conductor /earthwire</div><div>As per sag tension calculation</div></div> <div><div>Armour rods used</div><div>Standard preformed armour rods/AGS</div></div> <div><div>Max. Velocity of wind</div><div>Refer Annexure A of Appendix II of Part I General of Technical specification</div></div> <div><div>Maximum permissible dynamic strains</div><div>150 micro strains</div></div>			
G)	The damper placement chart for spans ranging from 50 m to 500 m shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents and sample calculations.			
H)	The damper placement charts shall include the following:			
i)	Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor/earthwire per span.			
ii)	Placement distances clearly identifying the extremities between which the distances are to be measured.			
iii)	Placement recommendation depending upon type of suspension clamp (viz Free centre type, Armour grip type, etc.)			
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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 4.04.00 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																																		
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	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.			
15.06.00	HARDWARE FITTINGS			
15.06.01	The hardware fittings shall be as per the specification and IS/IES standards			
15.06.02	Each hardware fittings shall be supplied complete in all respects and include the following hardware parts:			
	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.			
	b) Suitable yoke plates			
	c) Suspension and dead end assembly to suit conductor size.			
	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.			
	e) 2.5% extra fasteners shall be supplied along with the hardware fittings.			
	f) Socket fittings shall be provided with only R-shaped security clip in accordance with IS-2486 (part-II).			
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			
	The dead end assembly shall be complete with jumper cone etc.			
	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:			
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15.06.05	Item	Dimensions before compression		Dimension after compression	
		Inner Dia.	Outer Dia.	Corner to corner width	Face to face width
		(mm)	(mm)	(mm)	(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
	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.				
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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 400kV 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
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CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>																																																												
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="3">Single mode stepped index</td></tr><tr><td>Average Transmission Loss:</td><td colspan="3"></td></tr><tr><td>At wavelength 1310 nm</td><td colspan="3">0.38 dB per km maximum</td></tr><tr><td>At Wavelength 1550 nm</td><td colspan="3">0.25 dB per km maximum</td></tr><tr><td>Number of Fiber</td><td colspan="3">12</td></tr><tr><td>Average splicing loss:</td><td colspan="3">0.05db per joint</td></tr><tr><td>Maximum splicing loss:</td><td colspan="3">0.10 dB per joint</td></tr><tr><td>Mode field diameter (MFD):</td><td colspan="3">9.0µm ± 1.0µm</td></tr><tr><td>Cladding diameter:</td><td colspan="3">125 ± 2 µm</td></tr><tr><td>Core / Cladding</td><td colspan="3"></td></tr><tr><td>Mode field concentricity error:</td><td colspan="3">1µm</td></tr><tr><td>Chromatic – dispersion coefficient @ 1310 nm</td><td colspan="3">3.5 ps / nm km. Maximum</td></tr><tr><td>Chromatic – dispersion coefficient @ 1550 nm</td><td colspan="3">20 ps / nm km. Maximum</td></tr><tr><td>Fiber Identification:</td><td colspan="3">each fiber shall be uniquely identifiable throughout the Length of the wire.</td></tr><tr><td>Operating Temperature:</td><td colspan="3">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</td><td></td><td></td><td></td></tr><tr><td>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																																																												
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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>एनटीपीसी 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

CLAUSE NO.	SCOPE OF SUPPLY AND SERVICES			
1.15.00	<p>delay in execution of the contract due to irregular power supply. Contractor shall arrange/provide necessary backup arrangement on his own for uninterrupted power supply.</p> <p>The Contractor shall maintain a minimum drawl power factor as per DISCOM regulations for their substations, and all such devices for maintaining power factor shall be under the scope of contractor. All temporary wiring must comply with local regulations and will be subject to Employer's inspection and approval before connection to supply.</p> <p>Start up power shall be made available by Employer at 220 KV, at the Employer's Chatti Bariatu & Kerandari-A Coal Mine Substation. The Bidder shall extend the startup power, from Chatti Bariatu & Kerandari-A Coal Mine Substation to NKSTPP through 220 KV Double Circuit Transmission Line(01 No) on towers, for the commissioning purpose as per work schedule for initial operation of the equipments required for boiler light up activities.</p>			
	<p>SWITCHYARD</p> <p>The scope of work is for the supply, erection, testing and commissioning of 400KV and 220KV Air Insulated switchyards at North Karanpura STPP and 220 KV Air Insulated switchyard at Chatti Bariatu & Kerandari-A Mine substation, as shown in the Single line diagram along with Switchyard control room building at North Karanpura STPP. The 400kV switchyard shall employ one and half breaker switching scheme while 220 KV switchyard shall have Double main and Transfer Bus scheme at NKSTPP end and Double Main Bus scheme at Chatti Bariatu & Kerandari-A Mine substation.</p> <p>The Scope shall also include supply, erection, testing and commissioning of 01 (one) No. 220 kV double circuit transmission line on towers with ACSR Zebra conductor and with Optical Fiber (OPGW) Ground wire, including associated bays at Plant end (NKSTPP) and 220 KV Chatti Bariatu & Kerandari-A Mine substation for startup power system along with associated equipments and accessories as shown in the Single Line Diagram. The latitude and the longitude of the Chatti Bariatu and Kerandari-A Mine substation are 23°52'35"N and 85°05'24" E.</p> <p>The scope of work shall comprise, but not limited to the design, engineering, manufacture, testing and inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery to site, unloading, storage and equipment erection including associated civil and structural works. Further the scope shall also include the cabling, lighting, lightning protection, earthing, air conditioning & ventilation, association of sub vendors in the erection, supervision, site testing, inspection and commissioning.</p>			
	1.15.01	<p>400KV and 220KV Switchyard: Bay details are as shown in the Single Line diagram of Switchyard</p>		
	1.15.02	<p>220KV Transmission line</p> <p>Construction of 1 (One) no. 220 kV D/C transmission line on towers, associated equipments and accessories including crossings.</p>		
	1.15.03	<p>Equipment and materials:</p> <p>I. 400kV and 220 kV Air Insulated Switchyard Equipments</p> <p>- Circuit Breakers, Isolators with/without earth switch, Current transformers, Surge arresters, Bus Post Insulators, Capacitor voltage transformers, Wave traps etc,</p>		
NORTH KARANPURA STPP (3X660 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-A	SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS	PAGE 8 OF 13

CLAUSE NO.	SCOPE OF SUPPLY AND SERVICES			
	II. 400/220kV Switchyard materials: <ul style="list-style-type: none">- 4" EHIPS Aluminum tube- ACSR 'Moose' Conductor- 10.98 dia G.S. Earthwire- Insulators and hardware- Clamps, connectors and spacers- Bay Marshalling kiosks- AC Bay Kiosks- Complete earthing grid (inclusive of supply of 40mm dia MS rod and GI flat) earthing of all switchyard equipment.- Contractor shall make earth resistivity measurements at site (based on four electrode method) and design the earthing grid as per IEEE: 80 (Latest edition) and connect the earthing grid with power plant earthing grid.- Complete Direct Stroke Lightning Protection using Lightning Mast and/or shield wire and its connection to earth mat.- Switchyard Control room- Optical fibre cables, screened cables- Materials for 1 (One) No. of 220kV Double circuit transmission line like Towers, ACSR Zebra type conductors, insulators, hardware, vibration dampers, Optical Fiber (OPGW) ground wire and all associated accessories.			
1.15.04	The equipment and materials to be supplied by the Contractor shall form a complete 400kV & 220KV switchyard at NKSTPP and Chatti Bariatu & Kerandari-A Mine substation. The equipment and services as detailed in all sections of the bidding documents and as shown on the Single Line diagram shall be within the scope of supply of the Contractor. It is in the interest of the contractor to acquaint himself with the site conditions and scope before submission of offer.			
1.15.05	The list of items covered under the scope of supplies is as mentioned above. Any items though not specifically mentioned but which are required to make the switchyard complete in all respects for its safe, efficient, reliable and trouble free operation shall also be deemed to be included and the same shall be supplied and erected by the Contractor, unless they are specifically excluded in the text of exclusions given in relevant section.			
1.15.06	Following shall be provided for Control & Protection of EHV system and Generator Relay Panels. <ul style="list-style-type: none">a) Substation Automation System (SAS based on IEC 61850 protocol) for control and protection of all 400kV and 220kV bays. Protection system shall be provided with Numerical relays.b) Switchyard Control Room complete in all respect including auxiliary systemsc) AC & DC power supply system for entire EHV system Bay equipments. At Chatti Bariatu & Kerandari-A Mine substation, the Owner shall provide 02 Nos. 415 V AC 400 Amps feeders and 02 Nos. 220 V DC 100 A, feeders for meeting the requirements of AC and DC system. Further distribution of AC and DC power			
NORTH KARANPURA STPP (3X660 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-A	SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS	PAGE 9 OF 13

PROJECT: 400/220kV Switchyard for North Karanpura Super TPP (3x660MW)
CUSTOMER: NTPC LTD.
General Project Details

PROJECT DETAILS

	Particular	Details
a)	Customer	NTPC Ltd.
b)	Engineer/Consultant/ Inspector	NTPC Ltd.
c)	Project Title	North Karanpura Super Thermal Power Project (3x660 MW) : 400/220kV Switchyard at NKSTPP end & 220kV Sub-station at Mine end
d)	Project Location	Place: Near Tandwa town District: Hazaribagh & Chatra State: Jharkhand
e)	Latitude & Longitude	400/220kV S/s at NKSTPP: North: 23°50' to 23°52' and East: 84°59' to 85°2' 220kV S/s at Chatti Bariatu & Kerandari-A mine: North: 23°52'35" and East: 85°05'25"
f)	Nearest Railway Station	Khalari Railway Station Ranchi-Garhwa section of Eastern Railways
g)	Distance of project location from the Railway station	40 Km (approx.)
h)	Nearest Major Town	Hazaribagh city
i)	Distance of the town from the project site	50 Km.
j)	Nearest commercial airport	Ranchi
k)	Distance of airport from the project site	150 Km
	<u>SITE CONDITIONS</u> (for design purposes)	
a)	Design ambient temperature	50°C
b)	Maximum Relative humidity	95 %
c)	Height above mean sea level	Less than 1000 meters
d)	Pollution Severity	Heavily polluted (With Coal dust & Fly ash) and Highly Corrosive environment.
e)	Criteria for Wind Resistant design of structures and equipment	Standard Applicable - IS 875 (Part 3) 1987
f)	Basic Wind speed "Vb" at ten meters above the mean ground level.	39 m/ sec
g)	Category of terrain	Cat -2
h)	Risk Coefficient "K1"	1.06

PROJECT:- 600MW RTPP STAGE-IV (UNIT#6), Rayalseema

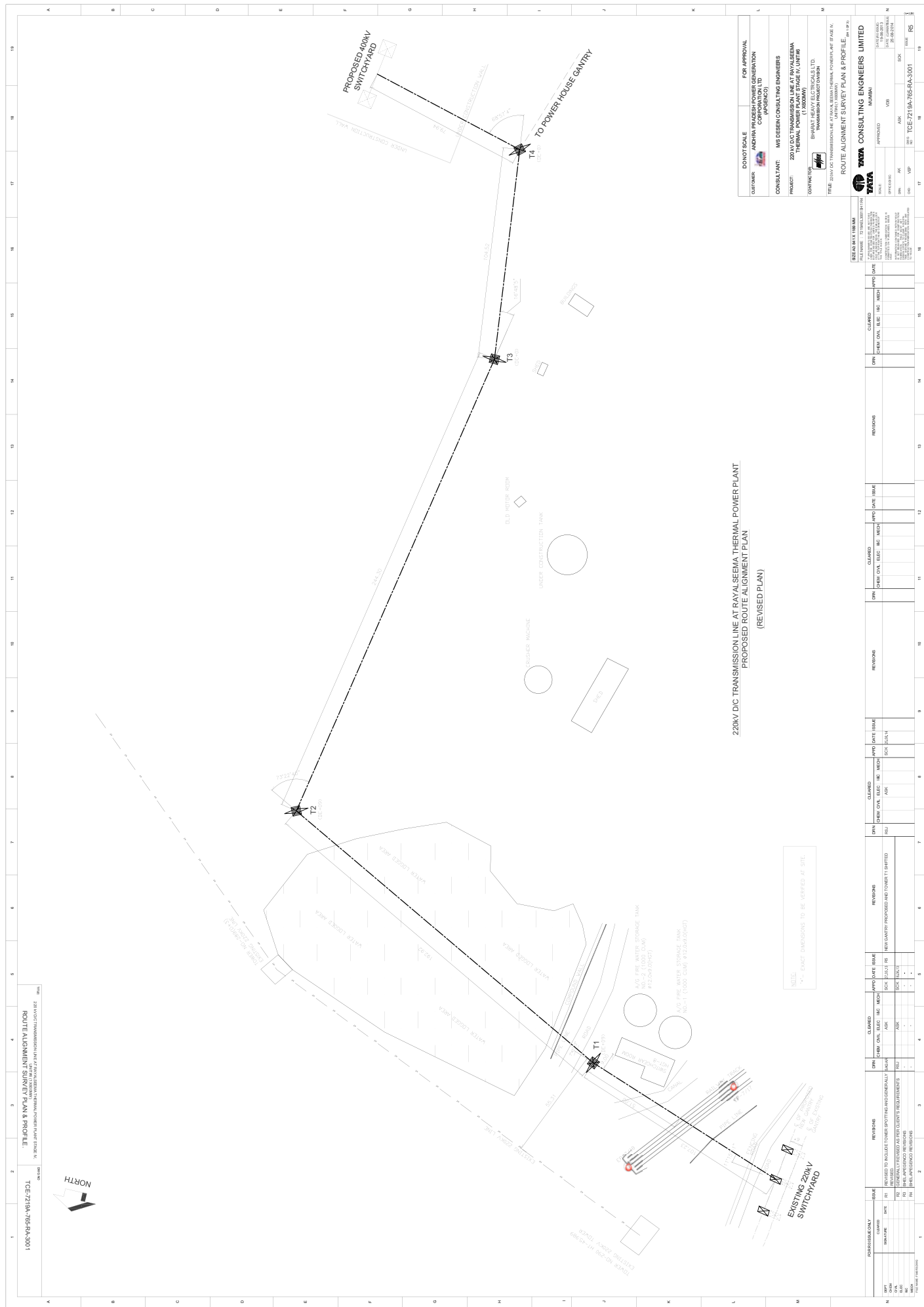
Doc. No. - TB-344-316-416 Rev-01

Transmission Line Data				
Sr. No.	Description	Data		
1	Line kV	220		
2	No. of circuits on tower	2		
3	Tower configuration	Self-supporting Lattice Type Steel Towers with Vertical Configuration		
4	Conductor per phase	Single ACSR 'Moose (Circuit One) / Twin ACSR Moose (Circuit Two)		
5	Shield Wire	Single Galvanised Stranded Steel Wire 7/3.66 (7/9 SWG)		
6	Tower coating	Hot-dipped galvanizing (Thickness:- 610 gms/sq.m)		
7	Tower Types	1) 'DC' Type Angle Tower($10^0 - 30^0$) (to be used for Tower T3)		
		2) 'DE' Type ($0^0 - 80^0$) Terminal Tower with three shield wires on each substation side (slack span) (to be used for Towers at T1, T2 and T4)		
8	Design Spans	1) Basic Span	For all tower types	300 m
		2) Slack span (i.e. span between end tower near substation and gantry structure)	Tower Type 'DE'	100 m
		3) Wind Span	For all tower types	330 m (NC); 200 m (BWC)
		4a) Weight Span (max)	For all tower types under Normal Condition (NC)	450 m
		4b) Weight Span (min)	For all tower types under Normal Condition (NC)	(-)100 m
		5a) Weight Span (max)	For all tower types under Broken Wire Condition (BWC)	275
		5b) Weight Span (min)	For all tower types under Broken Wire Condition (BWC)	(-)150 m
9	Conductor and Shielding Wire Tensions	1) Between the towers = As per sag tension calculations		
		2) For Slack span = 400 kg per sub-conductor		
10	Insulators	1x15 discs for single suspension/tension insulator string with single/twin conductor 2x15 discs for double tension insulator string with single/twin conductor		

PROJECT:- 600MW RTPP STAGE-IV (UNIT#6), Rayalseema

Doc. No. - TB-344-316-416 Rev-01

Transmission Line Data				
11	Electrical Clearances	1) The minimum ground clearance from lowest point of power conductor = not to be less than 7150 mm at maximum sag condition i.e. at conductor temperature of 75 ⁰ C with no wind		
		2) Minimum mid-span vertical clearance between power conductor and ground wire in still air at normal design span = not to be less than 8500 mm		
		3) The earth wire sag to be not more than 90% of the corresponding sag of power conductor under still air conditions for the entire specified temperature range		
		4) Shielding angle = 30 ⁰ maximum		
		5) All other electrical clearances shall be as per the relevant statutory regulations		
		6) Minimum clearances from live parts to tower body:		
			<u>Swing from Vertical (in Degree)</u>	<u>Minimum Clearance (in mm)</u>
		Jumper	0	2130
			10	2130
			20	1675
Pilot Insulator String	0	2130		
	15	1980		
	30	1830		
	45	1675		
12	Temperatures of Conductors and Earth Wire	<u>Parameter</u>	<u>Value</u>	
		Minimum Ambient Temperature	19.1 ⁰ C	
		Average Ambient Temperature or Every Day Temperature	32 ⁰ C	
		Maximum Design Ambient Temperature	50 ⁰ C	
		Maximum Temperature for ACSR 'Moose' Conductor	75 ⁰ C	
		Maximum Temperature for Shielding Wire	53 ⁰ C	
13	Wind Loads	Design wind pressure on tower, conductor, shield wire and insulators - considering wind zone 2 with wind speed (Vb) of 39m/sec as per clause 8.1, reliability level 1 with return of 50 years as per clause 7.2, and terrain category 2 as per clause 8.3.2.1 respectively in accordance with IS: 802 (Part 1/Sec 1):1995.		
14	Foundation	Based on available Geotechnical data, SBC of 30 T/sqm will be considered for foundation design. Foudation design will be done for fully submerged conditions. Geo technical report for power plant area is available. From the report is is evident that soil bearing capacity at 2-3 metre level is much more than the considered value of 30T per sq.m. (relevant sheet attached). Hence conduction of geo technical investigation for transmission line is not required.		
15	Tower Testing	Considering very small route length (0.728 km) and requirement of only 4 number of Towers, tower testing shall not be done. Instead, additional design margin of 10 to 15% shall be considered.		
16	Tower Design	Tower analysis/design will be done using PLS TOWER software.		



Project :	220kV DC TRANSMISSION LINES AT RAYALSEEMA, ANDHRA PRADESH		
Title :	Wind Pressure Calculation		

WIND PRESSURE CALCULATIONS

Wind Zone to be considered for Design	=	2	39.00 m/sec
Design Wind Speed (Vr)	=	39/1.375	
	=	28.36	m/sec
The Basic Span	=	300	m
Reliability Level	=	1	
Terrain Category	=	2	
Factor K1	=	1	
Factor K2	=	1	
Design Wind Speed (Vd)	=	Vr x K1 x K2	
	=	28.36 x 1 x 1	
	=	28.36	m/sec
Design Wind Pressure (Pd)	=	0.6 x (Vd) ²	
	=	0.6 x (28.36) ²	
	=	482.7	N/m ²
	=	49.2	Kg/m ²

(I) Wind Pressure on Conductor (Pc) = Pd x Cd x Gc

Average Height of Conductor considered for Wind Pressure Calculation (h) =	31.934	m
Sag At Minimum Temperature & Nil Wind (m) =	4.293	m

	Tension tower
Minimum Ground Clearance	7.000
Maximum Sag of Conductor	7.111
Allowance of Sag Error or Creep	0.150
Bottom Conductor to Top Conductor	11.500
BM (For Top Conductor)	0.035
Maximum Body Extension	9.000
Height of top conductor attachment point considering +9m body extension for tower (Refer Tower line diagram)	34.796
Less 2/3rd Sag at Minimum Temperature (2/3 x 4.293)	-2.862
Average Height of Conductor in m	31.934

Where, Pd = Design Wind Pressure
Cd = Drag Coefficient
Gc = Gust Response Factor
(Refer Table - 7 of IS 802-1995 Part-1/Sec-1)

	1
	2.177
	= 49.2 x 1 x 2.177

<u>Wind Pressure on Conductor (Pc)</u>	= 107	Kg/m ²
-----------------------------------------------	--------------	-------------------

Project :	220kV DC TRANSMISSION LINES AT RAYALSEEMA, ANDHRA PRADESH		
Title :	Wind Pressure Calculation		

(II) Wind Pressure on Earthwire (Pe) = Pd x Cd x Ge

Average Height of Earthwire considered for Wind Pressure Calculation (h) = **41.295** m

Sag At Minimum Temperature & Nil Wind (m) = 3.864 m

	Tension tower
Minimum Ground Clearance	7.000
Maximum Sag of Conductor	7.111
Allowance of Sag Error or Creep	0.150
Bottom Conductor to Top Conductor	11.500
BM (For Top Conductor)	0.035
Height of G.W. Peak	9.075
Maximum Body Extension	9.000
Height of Earthwire attachment point considering +9m body extension for tower (Refer Tower line diagram)	43.871
Less 2/3rd Sag at Minimum Temperature (2/3 x 3.864)	-2.576
Average Height of Earthwire in m	41.295

Where, Pd = Design Wind Pressure
Cd = Drag Coefficient 1.2
Gc = Gust Response Factor 2.282
(Refer Table - 7 of IS 802-1995 Part-1/Sec-1)

= 49.3 x 1.2 x 2.282

Wind Pressure on Earthwire (Pe) = 135 Kg/m²

(III) Wind Pressure on Insulator (Pi) = Pd x Cd x Gc

Height of Insulator considered for Wind Pressure Calculation (h) **34.761** m

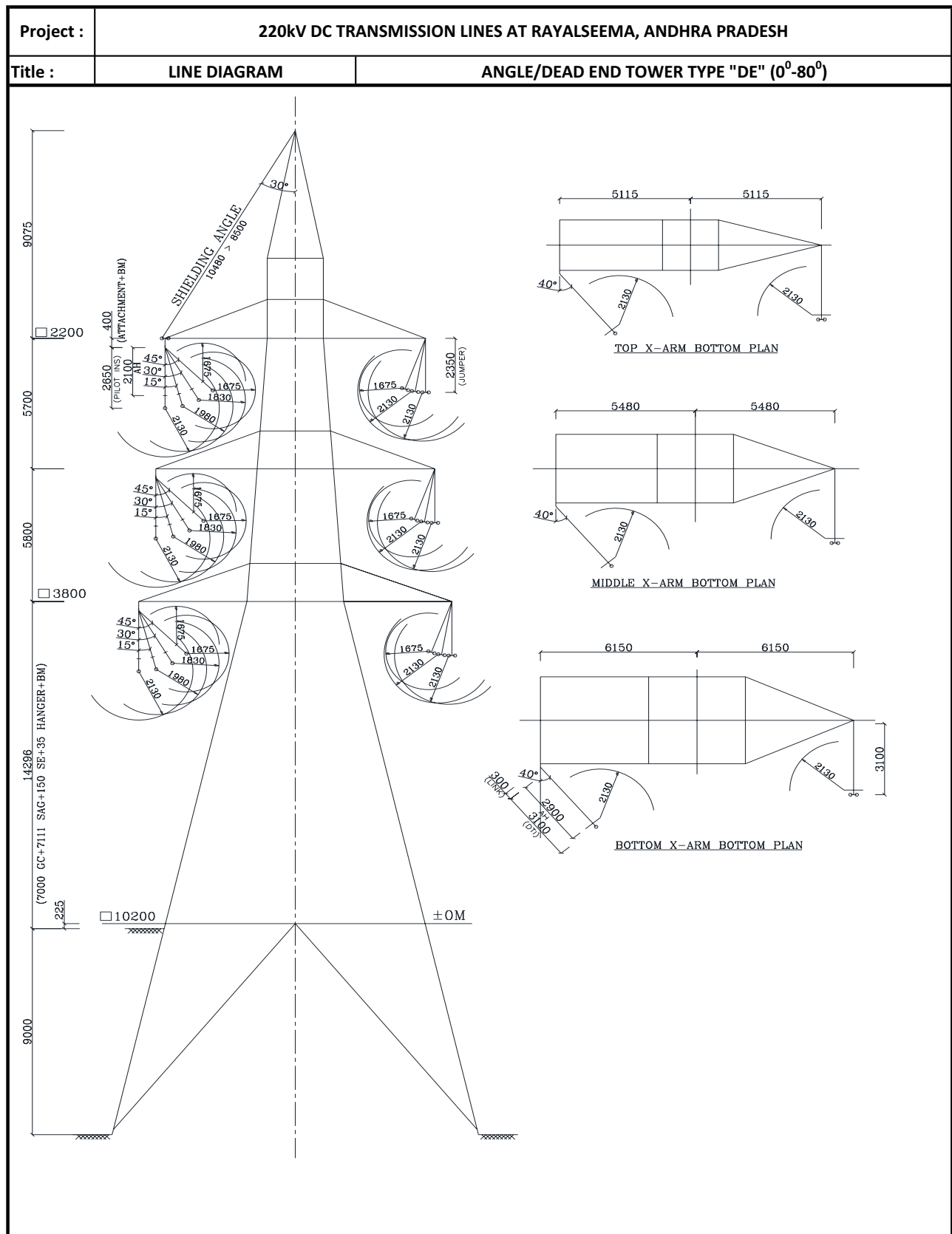
	Tension
Minimum Ground Clearance	7.000
Maximum Sag of Conductor	7.111
Allowance of Sag Error or Creep	0.150
Bottom Conductor to Top Conductor	11.500
BM	0.000
Maximum Body Extension	9.000
Height of Insulator considering +9m body extension for tower (Refer Tower line diagram)	34.761

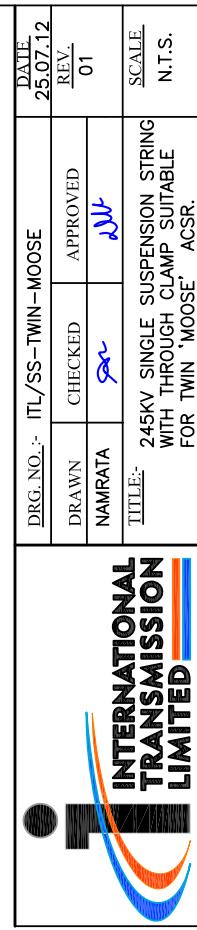
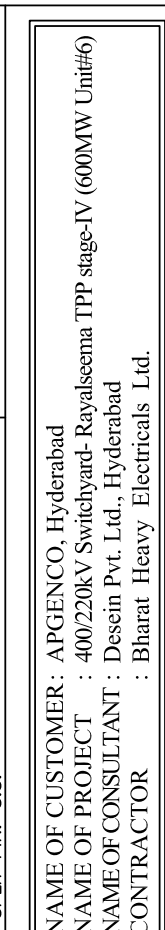
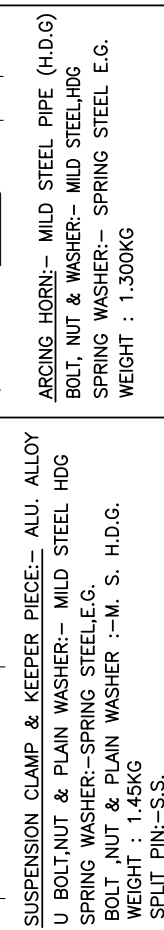
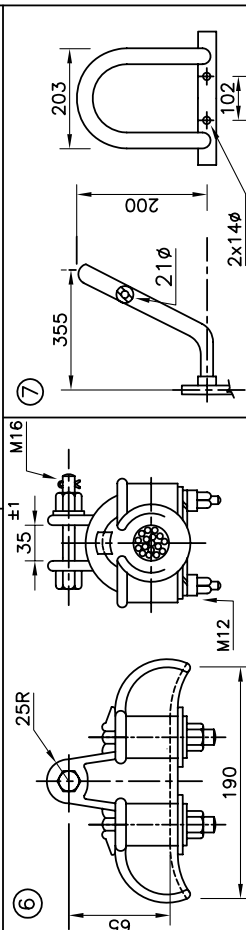
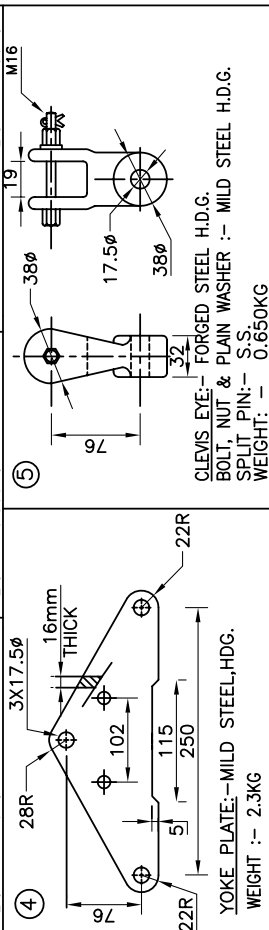
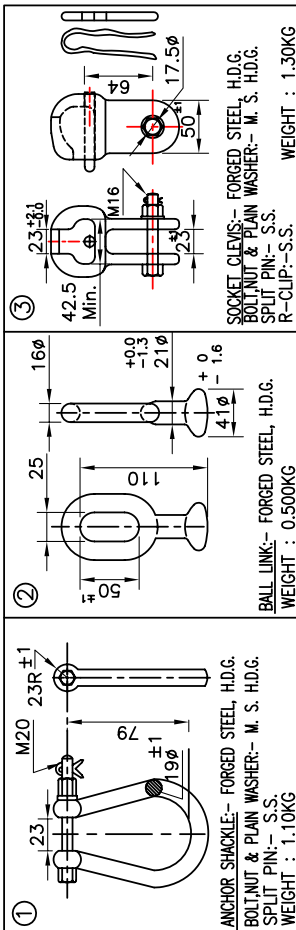
Where, Pd = Design Wind Pressure
Cd = Drag Coefficient 1.2
Gc = Gust Response Factor 2.348
(Refer Table - 6 of IS 802-1995 Part-1/Sec-1)

= 49.2 x 1.2 x 2.348

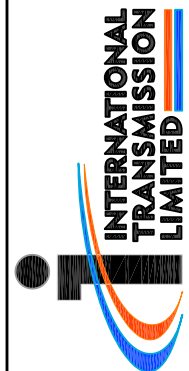
Wind Pressure on Insulator (Pi) = 138.6 Kg/m²

Project :	220kV DC TRANSMISSION LINES AT RAYALSEEMA, ANDHRA PRADESH														
Title :	SAG TENSION FOR 300M SPAN														
Normal Span (m): 300 Equation : Parabolic															
Material Properties :															
Description	Conductor		Earth Wire												
Material	ACSR		GSW												
Name	Moose		7/3.66												
Stranding (Aluminium)	54/3.53														
Stranding (Steel)	7/3.54		7/3.66												
Diameter (mm)	31.77		10.98												
Cross Sectional Area (mm ²)	597		73.65												
Ultimate Tensile Strength (Kg)	16438		6975												
Unit Weight (Kg/m)	2.004		0.583												
Modulus of Elasticity (Kg/mm ²)	7034		19361												
Coefficient of Linear Expansion (1/°C)	1.93E-05		1.15E-05												
Climatic Conditions & Corrospounding Sag & Tension Values for Conductor															
S.No.	Temp (°C)	Wind Pressure (Kg/m ²)	Ice Thk (mm)	Ice Density (Kg/m ³)	Tension (Kg)	FOS (Reqd)	FOS (Actual)	Sag (m)							
1(Initial condition)	32	0	0	0	4110	4.000 (25% of UTS)	4.000	5.486							
2	32	107	0	0	6383	1.4285 (70% of UTS)	2.577	-							
3	32	80	0	0	5609	1.4285 (70% of UTS)	2.932	-							
4	0	39	0	0	5674	1.4285 (70% of UTS)	2.898	-							
5	0	0	0	0	5251	1.4285 (70% of UTS)	3.134	4.293							
6	75	0	0	0	3171	1.4285 (70% of UTS)	5.181	7.111							
7	53	0	0	0	3585	1.4285 (70% of UTS)	4.587	6.289							
Keeping the sag of earthwire 10% less than that of power conductor at 0°C No wind condition, the sag of earthwire will be 4.293*0.9 = 3.864m This condition is treated as initial condition for earthwire and sag tension values at other conditions have been worked out to check their satisfying the reuires limits.															
Climatic Conditions & Corrospounding Sag & Tension Values for Earth Wire															
S.No.	Temp (°C)	Wind Pressure (Kg/m ²)	Ice Thk (mm)	Ice Density (Kg/m ³)	Tension (Kg)	FOS (Reqd)	FOS (Actual)	Sag (m)							
1	32	0	0	0	1430	4.000 (25% of UTS)	4.878	4.585							
2	32	135	0	0	2580	1.4285 (70% of UTS)	2.702	-							
3	32	101	0	0	2230	1.4285 (70% of UTS)	3.125	-							
4	0	49	0	0	1951	1.4285 (70% of UTS)	3.571	-							
5(Initial condition)	0	0	0	0	1697	1.4285 (70% of UTS)	4.115	3.864							
6	53	0	0	0	1290	1.4285 (70% of UTS)	5.405	5.085							





NAME OF CUSTOMER: APGENCO, Hyderabad
NAME OF PROJECT : 400/220kV Switchyard- Rayalseema TPP stage-IV (600MW Unit#6)
NAME OF CONSULTANT : Desein Pvt. Ltd., Hyderabad
CONTRACTOR : Bharat Heavy Electricals Ltd.

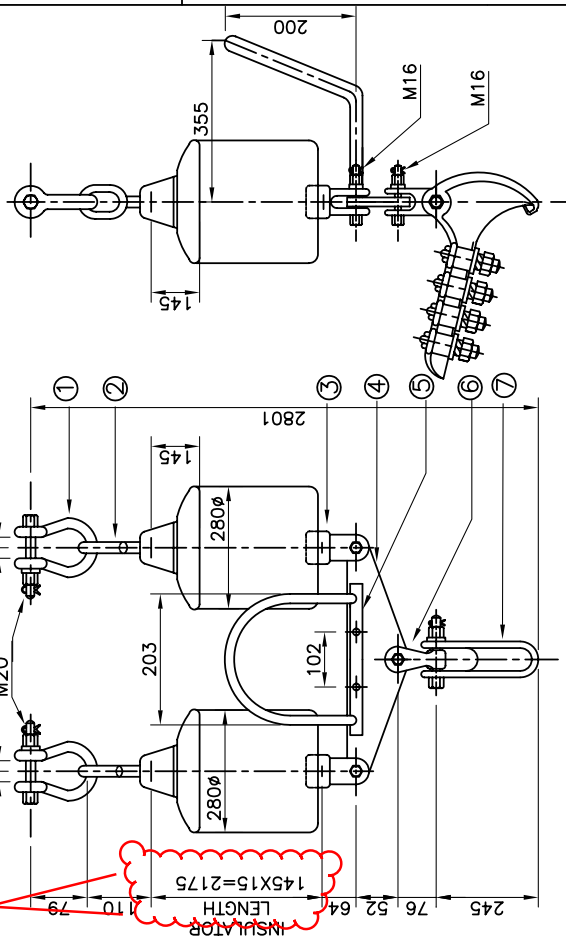


NO	DESCRIPTION	MATERIAL	U.S.	QTY
7	ARCING HORN	MILD STEEL PIPE (H.D.G.)	1.5	1
6	SUSPENSION CLAMP	ALU. ALLOY LM 6	70	2
5	CLEVIS EYE	FORGED STEEL H.D.G.	70	2
4	YOKO PLATE	MILD STEEL,H.D.G.	120	1
3	SOCKET CLEVIS	FORGED STEEL H.D.G.	120	1
2	BALL LINK	FORGED STEEL H.D.G.	120	1
1	ANCHOR SHACKLE	FORGED STEEL H.D.G.	120	1
			U.S.	QTY

- ELECTRICAL CHARACTERISTICS:-
1. RATED VOLTAGE - 245KV.
 2. POWER FREQUENCY WITHSTAND VOLTAGE (WET) - 460KV (rms).
 3. LIGHTNING IMPULSE WITHSTAND VOLTAGE (DRY) - ±1050KVp.
 4. CORONA EXTINCTION VOLTAGE -156KV (rms) MINIMUM.
 5. RIV AT 156KV rms- 1000 MICROVOLTS MAXIMUM.

- NOTE:-
1. ALL DIMENSION IN mm.
 2. GENERAL TOLERANCE:- ±3%.
 3. BALL AND SOCKET SIZE:- 20mm AS PER IS:2486(PT-II).
 4. MIN.BREAKING STRENGTH OF STRING:-120KN.
 5. MIN. BREAKING STRENGTH OF THE CLAMP:-70KN.
 6. ALL FERROUS PARTS HOT DIP GALVANISED AS PER IS:2633.
 7. NUTS, BOLTS & WASHERS BELOW M12 WILL BE ELECTRO GALVANISED.
 8. TOTAL WEIGHT:- 11.00kg (Approx.).
 9. EACH INSULATOR STRING COMPRISES OF 15NOS.DISC INSULATORS.
 10. TOTAL CREEPAGE DISTANCE >6125mm.
 11. ALL HARDWARE SHALL BE BOLTED TYPE.
 12. ALL FORGING COMPONENTS ARE MADE BY DROP FORGING METHOD AS PER IS-2004

disc spacing =
146 ± 5 mm



- 220kV Double Tension String for Single ACSR Moose**
1. Electro-mechanical strength = 120kN
 2. Insulator String Length
= 245+76+52+64+151*15+110+79 + 3% Tolerance
= 2977.73 mm (say 3100 mm)
 3. Corona ring
= 279+110+151*15+64 + 3% Tolerance
= 2799.54 (say 2900 mm)
 4. Corona width = 750mm
 5. Assembly Weight
= Insulator discs (8.0*15*2) + Hardware (20.3)
= 260.3 (say 300 kg)

7. ALL TENSION PARTS NOT TO BE

GALVANISED AS PER IS:2633/2629.

8. NUTS, BOLTS & WASHER BELOW

M12 WILL BE ELECTRO GALVANISED.

9. AND FOR OTHERS HOT DIP GALVANISED.

EACH INSULATOR STRING COMPRISES OF

15NOS. DISC INSULATORS.

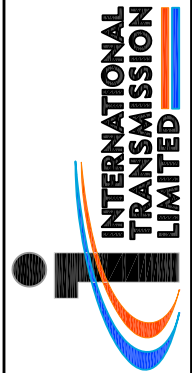
10. TOTAL CREEPAGE DISTANCE >6125mm.

11. ALL HARDWARE SHALL BE BOLTED TYPE.

12. ALL FORGING COMPONENTS ARE MADE BY DROP

FORGING METHOD AS PER IS-2004

NO	DESCRIPTION	MATERIAL	QTY.	U.T.S. KN
7	TENSION CLAMP	ALU. ALLOY, LM-6	1	70
6	CLEVIS EYE	FORGED STEEL H.D.G.	1	70
5	ARCING HORN	MILD STEEL HDG (PIPE)	1	1.5
4	YOKE PLATE	MILD STEEL H.D.G.	1	120
3	SOCKET CLEVIS	FORGED STEEL H.D.G.	2	120
2	BALL LINK	FORGED STEEL H.D.G.	2	120
1	ANCHOR SHACKLE	FORGED STEEL H.D.G.	2	120



DRG. NO. :- ITL/DTS-4U-250-S	DATE 09.04.12
DRAWN NAMRATA	CHECKED APPROVED
REV. 00	SCALE N.T.S.

TITLE:- 220KV DOUBLE TENSION STRING WITH
DOUBLE ANCHORING POINTS FOR SINGLE
MOOSE CONDUCTOR WITHOUT TURN BUCKLE

NAME OF CUSTOMER: APGENCO, Hyderabad

NAME OF PROJECT : 400/220kV Switchyard- Rayalseema TPP stage-IV (600MW Unit#6)

NAME OF CONSULTANT : Desein Pvt. Ltd., Hyderabad

CONTRACTOR : Bharat Heavy Electricals Ltd.



NAME OF CUSTOMER : M/s.APGENCO Ltd RTPP STAGE IV
NAME OF THE PROJECT : 400/220 KV Switchyard -Royalseema TPP Stage -IV
(600MW Unit #6)
NAME OF CONSULTANT : Desein Pvt Ltd, Hyderabad

GUARANTEED TECHNICAL PARTICULARS

SL.NO	PARTICULARS	UNIT	120 KN A/F Disc Insulator
1	Manufacturer's name & Address		Bharat Heavy Electricals Ltd., Electrocorcelains Division Bangalore 560012,INDIA
2	Type of insulator		Ball & Socket type
3	Size & designation of ball & socket parts and standard	mm	20 as per IS:2486- II, IEC - 120
4	Type of security clip		'R' Clip (s,steel)
5	Colour of glaze		Brown
6	Size of insulator: a) Diameter b) Spacing	mm mm	280±12 146±5
7	Total creepage distance(min)	mm	430+50 -00
8	Electromechanical failing load	kN	120
9	P.F. Dry flashover Voltage	kV(rms)	80
10	P.F. Dry withstand voltage	kV(rms)	75
11	P.F. Wet flashover voltage	kV(rms)	45
12	P.F.Wet withstand voltage	kV(rms)	40
13	Impulse flashover voltage – dry (+ ve & - ve)	kVp	130
14	Impulse withstand voltage – dry (+ ve & - ve)	kVp	120
15	Visible discharge voltage	kV(rms)	18
16	RIV test at 1 MHZ (Dry)	Micro volts	50
17	PF Puncture Voltage	kV(rms)	120
18	Weight of unit (approx)	kg	8
19	Standard testing spec.		IS:731/IEC:60383
20	Reference drawing (Unit)		4 980 17 01700/02

DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS

A. Approved/Proceed with fabrication. ☐

B. Approved with comments/proceed with fabrication, considering our comments + resubmit for record. ☒

C. See attached memo. ☐

D. Resubmit for approval. ☐

E. Information furnished noted. ☐

Order No. 02200 Date 29/2/12

DESEIN

The undersigned is authorized to sign on behalf of the company, arrangement only & shall not relieve the supplier from the responsibility of the correctness of dimensions and details and fulfillment of contract obligations.

Page 8 of 10

[Handwritten signature]



11E – 5076

Page 2 of 2

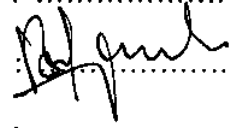
**Guaranteed Technical Particulars of Insulator Strings
(With Disc Insulators) Along With Hardware Fittings**

Sl. No	Description	Unit	400KV (Twin ACSR Moose Conductor)		220KV (Twin ACSR Moose Conductor)	
			Single Suspension String 1x25	Double Tension string 2x25	Single suspension string 1x15	Double Tension string 2x15
1.0	Power frequency withstand voltage of string with arcing horns, corona control rings/grading rings under wet&dry condition	kV(rms)	680	680	460	460
2.0	Impulse withstand voltage (Dry)					
a)	Positive	kV(peak)	1550	1550	1050	1050
b)	Negative	kV(peak)	1550	1550	1050	1050
3.0	Minimum Corona extinction Voltage under dry condition	kV(rms)	320	320	156	156
4.0	RIV at 1 MHZ when the string is energized at 105 kV(rms) under dry condition	Micro volt	1000 (max)	1000 (max)	1000 (max)	1000 (max)
5.0	Maximum Voltage distribution across any disc of line to each voltage	%	9	10	13	14

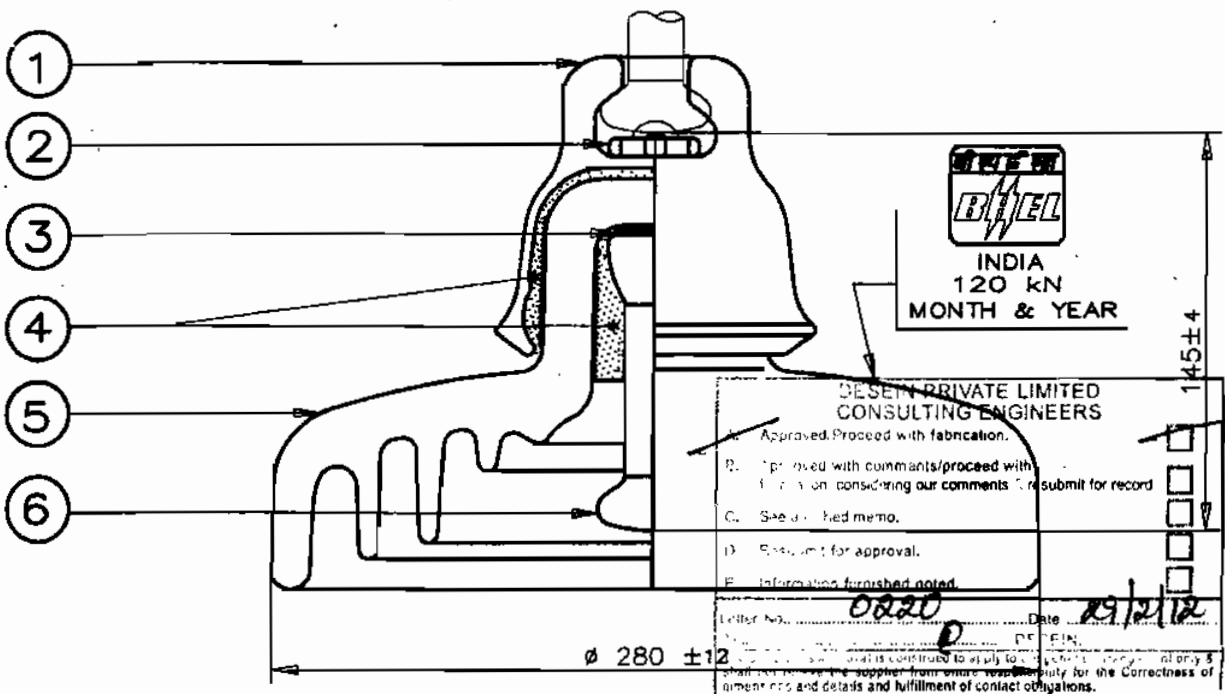
Date :
Place:

Signature :

Printed Name :

Designation : 

Common Seal :

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.,
 IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST
 OF THE COMPANY


NOTES:

- 1 BALL AND SOCKET PARTS CONFORM TO 20 mm DESIGNATION
OF IS:2486 (Part-II)-1989 OR BS:3288:Part 3-1989 OR IEC Pub 120-1984
- 2 PERMISSIBLE LIMITS OF VISUAL DEFECTS ON PORCELAIN CONFORM TO
IS:13305-1992 OR JIS C 3802-1964

CONTROLLED COPY

FERROUS PARTS ARE HOT-DIP GALVANIZED AS PER IS:2629 TESTS CONFORM TO IS:2633 /IEC 383/ BS EN ISO 1461(LATEST REVISION) PORCELAIN BROWN GLAZED	6	BALL PIN	FORGED STEEL	1
	5	SHELL	PORCELAIN	1
	4	BINDING MATERIAL	PORTLAND CEMENT	-
	3	CUSHION	SYN. FOAM/CORK	1
	2	STANDARD SPLIT PIN ('R' TYPE)	STAINLESS STEEL	1
	1	SOCKET CAP	S G IRON	1
	ITEM No.	DESCRIPTION	MATERIAL	QTY
NAME OF CUSTOMER		M/s APGENCO, HYDERABAD		
NAME OF CONSULTANT		DESEIN Pvt Ltd., HYDERABAD		
NAME OF PROJECT		400 KV/220 KV SWITCHYARD FOR RAYALSEEMA TPP STAGE-IV (600 MW UNIT# 6)		
SIGN AND DATE	BHEL	BHARAT HEAVY ELECTRICALS LTD;		
		ELECTROPORCELAINS DIVISION		
		BANGALORE 560 012		
DEPT	GRADE OF TOL. DIM.	SCALE	WEIGHT (kg)	REF. TO ASSY DRG.
CODE	C/M/F	NTS	8.0 (Approx)	ITEM No.
TITLE		CARD CODE	DRAWING No.	
ANTIFOG DISC INSULATOR			EL DG 4 980 17 01700	
FOR 120 kN EMS			SUB No. 126	
			No. OF SHEETS	

DBR for 220kV Transmission Line

Signature Not Verified
 Digitally signed by S K BASAK
 Date: 2014.08.19
 12:37:22 IST
 Reason: CAT I
 Location:
 NTPCEOC

JOB NO. 401		NTPC DBG. No. 1450-001R-SWYD-PVE-U-019	
STATUS CONTRACT		NTPPL DBG. No.	
DISTRIBUTION		PROJECT FERROZE GANDHI UNCHAHAR THERMAL POWER PROJECT	
TO		STAGE-IV 13200MW	
NO. OF		OWNER NTPC Limited	
REV.	DATE	(A Joint Venture Company of NTPC & BHEL)	
DATE	ALTS	Y.S.B. Purnam, Village Mannanwar, Sri Kalakani Mandal, Distt. Chittoor - 517620 (A.P.)	
ALTS	DB	NTPC BHEL Power Projects Private Limited	
APPS	APPS	(A Joint Venture Company of NTPC & BHEL)	
		SHARAT HEAVY ELECTRICALS LTD	
		POWER SECTOR	
		TRANSMISSION BUSINESS GROUP	
		MEDIA	
TITLE DBR for 220kV Transmission Line		REPT. SCALE	
		DRAWING NO. TB-4-359-PVE-U-019	
		SHEET OF	
		REV.	

Transmission Line Data			
Sr. No.	Description	Data	
1	Line kV	220	
2	No. of circuits on tower	1 (Single Circuit)	
3	Tower configuration	Self-supporting Lattice Type Steel Towers with Vertical Configuration.	
4	Conductor per phase	Twin ACSR Moose (Refer Annexure)	
5	Earth Wire	Single Galvanised Stranded Steel Wire 7/3.66 (Refer Annexure)	
6	Tower coating	Hot-dipped galvanizing (Thickness:- 610 gms/sq.m)	
7	Tower Types	Tower Type	Deviation Limit (in Deg)
		DA	0 - 2
		DB	0 - 15
			To be used as tangent tower
		DC	0
			To be used as section tower
		DD	15 - 30
			a) Angle tower 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 below item no 15, Design Loads.
		DD	30 - 60
			a) Angle tower 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 below item no 15, Design Loads. d) Dead end with 0 deg to 15 deg deviation both on line and substation side (slack span).
			0
		DD	90
			To be used near swithyard with reduced design span.
8	Extensions	+3m, +6m & +9m body extensions. For power line crossings, DD towers with maximum +25m body extension may be provided, DD+25m tower shall be designed such that it can also be used as +18m body extension to normal towers after removal of bottom panels.	

Transmission Line Data				
9	Design Spans	1) Normal Ruling Span	For all tower types	320 m
		2) Slack span (i.e. span between end tower near substation and gantry structure)	Tower Type 'DD'	100 m
		3) Wind Span	For all tower types	320 m (NC); 190 m (BWC)
		4a) Weight Span (max)	For all tower types under Normal Condition (NC)	390 m
		4b) Weight Span (min)	For all tower types under Normal Condition (NC)	(-) 100 m
		5a) Weight Span (max)	For all tower types under Broken Wire Condition (BWC)	270 m
		5b) Weight Span (min)	For all tower types under Broken Wire Condition (BWC)	(-) 100 m
10	Conductor and Earth Wire Tensions	1) Between the towers = As per sag tension calculations.		
		2) For Slack span = 400 kg per sub-conductor;		
11	Insulators	Porcelain disc insulators ANTIFOG		
	Insulator String type	Single-I suspension	Double tension	
	Size of disc insulator (mm)	255/280 x 145	255/280 x 145	
	Min. creepage distance of each disc (mm)	280	280	
	No of standard discs	1 x 14	2 x 14	
	Electro-mechanical strength of insulator string (kN)	90	2 x 120	
		Note: Single suspension (Pilot) string will be used for jumpers of tension DD type towers. It will be similar to single suspension type except the clamp of the conductor.		
12	Electrical Clearances	1) The minimum ground clearance from lowest point of power conductor = not to be less than 7150 mm (=7000 mm ground clearance + 150 mm sag error) at maximum sag condition i.e. at conductor temperature of 75°C with no wind.		
		2) Minimum mid-span vertical clearance between power conductor and ground wire in still air, at any temperature for normal design span shall not to be less than 8500 mm.		
		3) The earth wire sag to be atleast 10% less than that of the corresponding sag of power conductor under all temprature loading conditions.		
		4) Shielding angle = 30° maximum.		
		5) Clearance between conductors i). Vertical clearance : 4900 mm ii). Horizontal clearance : 8400 mm		
		6) All other electrical clearances shall be as per the relevant statutory regulations.		
		7) Minimum clearances from live parts to tower body:		
		<u>Type of Insulator Sting</u>	<u>Swing from Vertical (in Degree)</u>	<u>Minimum Clearance (in mm)</u>
		Jumper	0	2130
			10	2130
			20	1675
		Single Suspension String & Pilot Insulator String	0	2130
			15	1980
			45	1830
			60	1675
		Single & Double tension String	0	2130

Transmission Line Data				
16	Soil properties*	Weight of soil	Nature of soil	Weight (kg/cum)
			Dry	1440 kg/cum
			Wet	940 kg/cum
		Water table shall be considered up to the ground level		
		The angle of repose shall be considered as two third (2/3) of the value as obtained from the soil investigation.		
* The soil parameters and types of foundations shall be finalized as per geotechnical investigations; governing parameters shall be followed.				
17	Properties of RCC	The cement concrete used for the foundations shall be of grade M20 with 20mm coarse aggregate.		
		Reinforcement shall be Fe 500 HYSD TMT bars conforming to IS 1786.		
		Unit weight of concrete		
		Type of concrete	Weight of dry region (kg/cum)	Weight in presence of sub-soil water (kg/cum)
		Plain Cement Concrete	2400	1400
		Reinforced Cement Concrete	2500	1500
18	Design of foundations	Structural design of the foundations shall be done by limit State method.		
		Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel.		
		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.		
Annexure: Wire Properties				
Description	Conductor	Earth Wire 1		
Material	ACSR	GSW		
Name	Moose	7 / 3.66		
Stranding (Aluminium)	54/3.53	-		
Stranding (Steel)	7/3.54	7 / 3.66		
Stranding (Optical Fibre)	-	-		
Diameter (mm)	31.77	10.98		
Cross Sectional Area (mm ²)	597	73.65		
Ultimate Tensile Strength (Kg)	16432.21	6972.48		
Unit Weight (Kg/m)	2.004	0.583		
Modulus of Elasticity (Kg/mm ²)	7034	19361		
Coefficient of Linear Expansion(/°C)	1.93E-05	1.15E-05		

TATA CONSULTING ENGINEERS LIMITED

Project :	220kV SC TRANSMISSION LINE AT UNCHAHAR, UTTAR PRADESH		
Title :	Wind Pressure Calculation		

WIND PRESSURE CALCULATIONS

Wind Zone to be considered for Design = 4 47.00 m/sec

Design Wind Speed (Vr) = 47/1.375

= 34.182 m/sec

The Basic Span = 320 m

Reliability Level = 1

Terrain Category = 2

Factor K1 = 1.07

Factor K2 = 1

Design Wind Speed (Vd) = $V_r \times K_1 \times K_2$

= $34.182 \times 1.07 \times 1$

= 36.575 m/sec

Design Wind Pressure (Pd) = $0.6 \times (V_d)^2$

= $0.6 \times (36.575)^2$

= 803 N/m²

= 81.9 Kg/m²

(I) Wind Pressure on Conductor (Pc) = Pd x Cd x Gc

Average Height of Conductor considered for Wind Pressure Calculation (h) 26.259 m

Sag at Minimum Temperature & Nil Wind (m) = 4.980 m

	Suspension	Tension tower
Minimum Ground Clearance	7.000	7.000
Maximum Sag of Conductor	7.929	7.929
Allowance of Sag Error	0.150	0.150
Bottom Conductor to Top Conductor	5.500	5.500
Maximum Body Extension	9.000	9.000
Height of top conductor attachment point considering +9m body extension for tower (Refer Tower line diagram)	29.579	29.579
Less 2/3rd Sag at Minimum Temperature (2/3 x 4.980)	-3.32	-3.32
Average Height of Conductor in m	26.259	26.259

Where, Pd = Design Wind Pressure

Cd = Drag Coefficient 1

Gc = Gust Response Factor 2.095

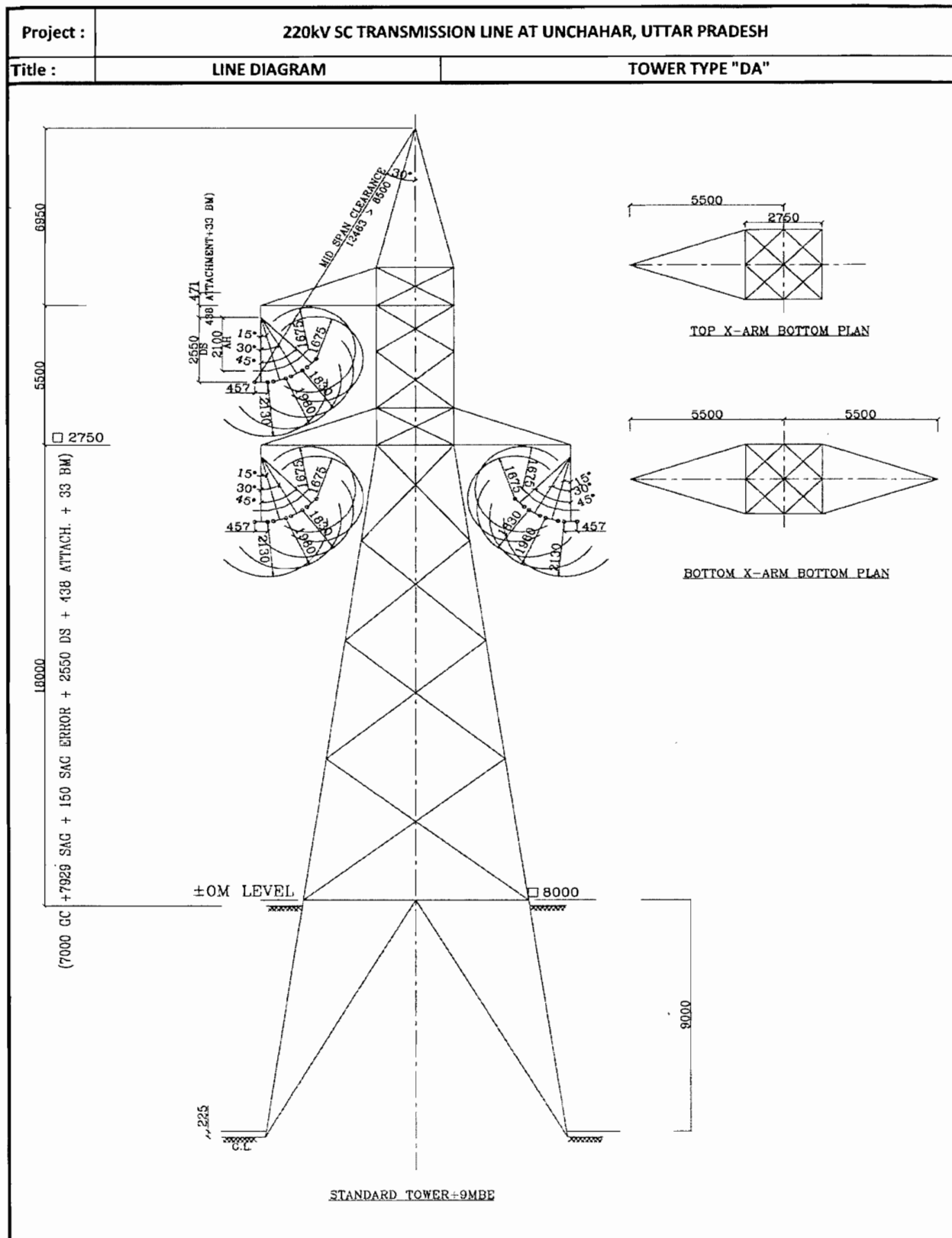
(Refer Table - 7 of IS 802-1995 Part-1/Sec-1)

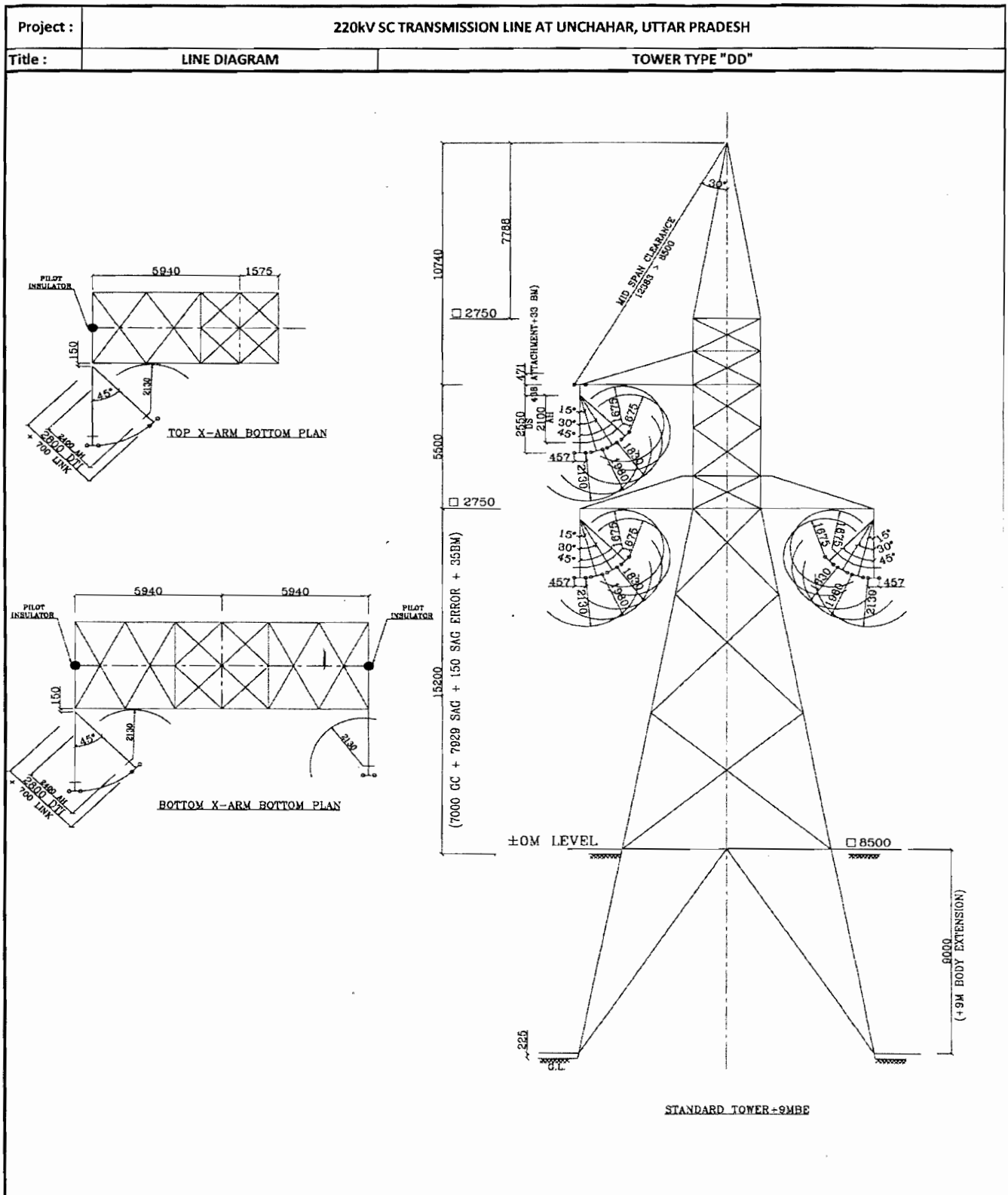
= $81.9 \times 1 \times 2.095$

Wind Pressure on Conductor (Pc) = 171.6 Kg/m²

Project :	220kV SC TRANSMISSION LINE AT UNCHAHAR, UTTAR PRADESH	
Title :	Wind Pressure Calculation	
(II) Wind Pressure on Earthwire (Pe) = Pd x Cd x Ge		
Average Height of Earthwire considered for Wind Pressure Calculation (h)		37.364 m
Sag At Minimum Temperature & Nil Wind (m) =		4.482 m
	Suspension	Tension tower
Minimum Ground Clearance	7.000	7.000
Maximum Sag of Conductor	7.929	7.929
Allowance of Sag Error or Creep	0.150	0.150
Insulator Length	2.550	—
Bottom Conductor to Top Conductor	5.500	5.500
BM (for Top Conductor) +Attachment	0.471	0.033
Height of G.W. Peak	6.950	10.740
Maximum Body Extension	9.000	9.000
Less Hanger for Earthwire	-0.250	—
Height of Earthwire/OPGW attachment point considering +9m body extension for tower (Refer Tower line diagram)	39.300	40.352
Less 2/3rd Sag at Minimum Temperature (2/3 x 4.482)	-2.988	-2.988
Average Height of Earthwire in m	36.312	37.364 (Governing)
Cd = Drag Coefficient		1.2
Ge = Gust Response Factor		2.225
(Refer Table - 7 of IS 802-1995 Part-1/Sec-1)		
		= 81.9 x 1.2 x 2.225
Wind Pressure on Earthwire (Pe)		= 218.7 Kg/m ²
(III) Wind Pressure on Insulator (Pi) = Pd x Cd x Gi		
Average Height of Insulator considered for Wind Pressure Calculation (h)		30.854 m
	Suspension	Tension
Minimum Ground Clearance	7.000	7.000
Maximum Sag of Conductor	7.929	7.929
Allowance of Sag Error or Creep	0.150	0.150
Bottom Conductor to Top Conductor	5.500	5.500
BM	—	0.033
Maximum Body Extension	9.000	9.000
Height of Insulator considering +9m body extension for tower (Refer Tower line diagram)	29.579	29.612
Centre of Insulator (Insulator Length / 2) (2.550/2)	1.275	—
Average Height of Insulator in m	30.854 (Governing)	29.612
Where, Pd = Design Wind Pressure		
Cd = Drag Coefficient		1.2
Gi = Gust Response Factor		2.309
(Refer Table - 6 of IS 802-1995 Part-1/Sec-1)		
		= 81.9 x 1.2 x 2.309
Wind Pressure on Insulator (Pi)		= 226.9 Kg/m ²

Project :	220kV SC TRANSMISSION LINE AT UNCHAHAR, UTTAR PRADESH							
Title :	SAG TENSION FOR 320M SPAN							
Normal Span (m):		320		Equation : Parabolic				
Material Properties :								
Description	Conductor			Earth Wire 1				
Material	ACSR			GSW				
Name	Moose			7/3.66				
Stranding (Aluminium)	54/3.53							
Stranding (Steel)	7/3.54			7/3.66				
Diameter (mm)	31.77			10.98				
Cross Sectional Area (mm ²)	597			73.65				
Ultimate Tensile Strength (Kg)	16432.21			6972.48				
Unit Weight (Kg/m)	2.004			0.583				
Modulus of Elasticity (Kg/mm ²)	7034			19361				
Coefficient of Linear Expansion (/°C)	1.93E-05			1.15E-05				
Climatic Conditions & Corrospounding Sag & Tension Values for Conductor								
S.No.	Temp (°C)	Wind Pressure (Kg/m ²)	Ice Thk (mm)	Ice Density (Kg/m ³)	Tension (Kg)	FOS (Reqd)	FOS (Actual)	Sag (m)
1(Initial Cond.)	32	0	0	0	4108.1	4(25% of UTS)	4.000	6.244
2	32	171.6	0	0	8404	1.429(70% of UTS)	1.955	3.052
3	32	128.7	0	0	7135	1.429(70% of UTS)	2.303	3.595
4	0	61.8	0	0	6163	1.429(70% of UTS)	2.666	4.162
5	0	0	0	0	5150	1.429(70% of UTS)	3.191	4.98
6	75	0	0	0	3235	1.429(70% of UTS)	5.080	7.929
7	53	0	0	0	3623	1.429(70% of UTS)	4.536	7.080
Keeping the sag of earthwire 10% less than that of power conductor at 0°C No wind condition, the sag of earthwire will be 4.980*0.9 = 4.482m This condition is treated as initial condition for earthwire and sag tension values at other conditions have been worked out to check their satisfying the reuiared limits.								
Climatic Conditions & Corrospounding Sag & Tension Values for Earth Wire 1 (GSW)								
S.No.	Temp (°C)	Wind Pressure (Kg/m ²)	Ice Thk (mm)	Ice Density (Kg/m ³)	Tension (Kg)	FOS (Reqd)	FOS (Actual)	Sag (m)
1	32	0	0	0	1420	4.000(25% of UTS)	4.910	5.256
2	32	218.7	0	0	3473	1.429(70% of UTS)	2.008	2.148
3	32	164.0	0	0	2927	1.429(70% of UTS)	2.382	2.549
4	0	78.7	0	0	2231	1.429(70% of UTS)	3.125	3.345
5 (Initial Cond.)	0	0	0	0	1665	1.429(70% of UTS)	4.188	4.482
6	53	0	0	0	1291	1.429(70% of UTS)	5.401	5.781





SECTION - 3

GENERAL SPECIFICATIONS

3.0 GENERAL

This section stipulates the General Technical Requirements under the contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and is not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

3.1 DRAWINGS, BILL OF MATERIALS AND CDs

At each stage following set of Type Tested design and fabrication drawings/Bill of materials shall be submitted.

- | | | |
|-----|-----------------------------------|----------|
| i) | Type tested Tower Design/Drawings | : 4 sets |
| ii) | Bill of Materials | : 4 sets |

After final approval from customer, the following sets of fabrication drawings/shop drawings/bill of materials/CDs shall be submitted:

- | | | |
|------|----------------------|----------|
| i) | Fabrication Drawings | : 4 set |
| ii) | Shop Drawings | : 1 set |
| ii) | Bill Of Materials | : 4 set |
| iii) | CDs | : 2 sets |

3.2 CATEGORIES OF APPROVAL

- | | |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CATEGORY I | This means that the documents/drawings is approved. |
| CATEGORY II | This means that the document/drawing is approved with comments i.e, some corrections are required but the contractor can go ahead with the manufacture after incorporating comments. |
| CATEGORY III | This means that the document/drawing is not approved i.e major revisions are required and the contractor cannot proceed with the manufacture. |

3.3 TERMS OF PAYMENT

Please refer terms and conditions of NIT.

3.4 COMPLETION TIME

The work under this scope of work shall be completed within one month including approval from customer and submission of approved drg/docs in required number of sets.

Bharat Heavy Electricals Ltd.
Doc. No. TB-xxx-618-100 R00

Technical Specification

SUPPLY OF DESIGN AND DRAWING OF TYPE TESTED TOWERS AND FOUNDATIONS

SECTION-4

SCHEDULE OF TECHNICAL DEVIATION.

BHEL ENQUIRY. NO:

BIDDER:OFFER REFERENCE:

6.1 Deviations

Tick

☐ YES

☐ NO

If yes,

S.No.	Deviation	Clause No.
1		
2		
3		
4		
5		
6		
7		
8		
9		

(Signature & Seal of Bidder)