

PART- III

400kV TRANSMISSION LINES

PART- III

TECHNICAL SPECIFICATION

CHAPTER – T0

TRANSMISSION LINES – GENERAL

PART- III

TECHNICAL SPECIFICATION CHAPTER – T0

TRANSMISSION LINES - GENERAL

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	CHAPTER – T0 : TRANSMISSION GENERAL
1.00.00	SCOPE In addition to the project information and scope of work given in Part-I, of this specification, the following is the scope of work for overhead Transmission line work:
1.01.00	This specification covers detailed survey, tower/pole spotting, optimization of tower/ pole location, soil resistivity measurements and geo-technical investigation, tower design, fabrication and supply of all type of 400 kV transmission line towers including tower which are already designed and tested for equal or higher loads 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.; 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 and earth wires along with all necessary line accessories and testing and commissioning of the erected transmission lines.
1.02.00	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.
1.03.00	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. Bidders shall clearly indicate in their offer, the sources from where they propose to procure the raw materials and the components.
1.04.00	The entire stringing work of conductor and earthwire shall be carried out as per standard stringing practice. The Bidder shall indicate in the offer, the detail description of the procedure to be deployed for stringing operation.
1.05.00	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.
1.06.00	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

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	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.
2.00.00	ROUTE AND TERRAIN
2.01.00	The preliminary survey drawing of the corridor showing details of the route, crossing, ground profile and levels is enclosed with the tender documents.
2.02.00	Right of way and way leave clearance shall be arranged by the Owner.
2.03.00	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: - Girth (circumference) measured at a height of 1 meter from ground level. - Approximate height of the tree with an accuracy of + 2 meters. - Name of the type of the species/tree. - 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.
2.04.00	Payment of compensation towards the clearances, etc. will be the responsibility of the Owner.
3.00.00	DETAILED SURVEY
3.01.00	The detailed survey shall be carried out along the approved alignment.
3.02.00	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 wire should be fixed on the top of these pages 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.
3.03.00	Profile Plotting & Tower/Pole Spotting From the field book entries the route plan with route details and level profile shall be plotted and prepared to scale of 1:2000 horizontal & 1:200 vertical on

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3.04.00	10 mm squared paper as well 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 594 mm wide in accordance with the IS Standard. For 'as built' profile these shall be A1 size 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 the Owner for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile.
	Tower Spotting With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:
	Span The number of consecutive spans between the section points shall not exceed 15 spans Section point shall comprise of tension point with B type, C type or D Type towers as applicable. For all crossing spans for major road crossings, railway crossings, power line crossings the span shall not exceed 80% of design span (400 m) .
	Extension An individual span shall be as near to the normal design span as far as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification.
	Loading There shall not be any upward force on suspension towers under normal working conditions and the suspension towers shall support at least the minimum weight span as provided in the design. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the towers failing which tension towers designed for the purpose

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3.05.04	shall be employed at such positions. Road Crossing At all important road crossings, the towers shall be fitted with double tension insulator strings depending on the type of towers but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than 6.1 meters. At all national highways tensions towers shall be used.
3.05.05	Railways Crossings All the railway crossings coming enroute the transmission line have already been identified by the Owner. At the time of detailed survey, the railway crossings 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): - The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings. - The crossing shall normally be at right angle to the railway track. - The crossing span shall be limited to 80% of design span. - 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.. - No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area. - Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained at 14.60 meters. 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 drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.
3.05.06	River Crossings 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 suspension 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).

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3.05.07	Power Line Crossing 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.
3.05.08	Telecommunication Line Crossing 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.
3.05.09	Details Enroute 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.
3.05.10	Ash Pipe Line Adequate clearances shall be maintained from ash pipe line and adjacent road.
3.06.00	Clearance from Ground, Building, Trees, etc. Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.
4.00.00	PRELIMINARY LINE SCHEDULE The profile sheets, duly spotted, alongwith preliminary schedules indicating type of towers, type of foundations, 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 one set of reproducible of final profile drawings to the Owner for record purpose.
5.00.00	CHECK SURVEY OF TOWER LOCATIONS
5.01.00	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 down of each pit center with respect to the center of the tower locations shall be noted and recorded for

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	determining the amount of earthwork required to meet the approved design parameters.			
5.02.00	Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details.			
6.00.00	ELECTRICAL SYSTEM DATA			
	a)	Nominal voltage	400 kV	
	b)	Maximum system voltage	420 kV	
	c)	BIL (Impulse)	1050 kVp	
	d)	Power frequency withstand voltage (wet)	630 kV (rms)	
7.00.00	LIST OF STANDARDS			
	<u>Indian Standards</u>	<u>Title</u>	<u>International & Internationally recognised standards</u>	
	1	IS:209-1992	Specification for Zinc	ISO/R/752-1968 AST, B6
	2	IS:226-1975	Structural Steel (Standard Quality)	ISO/R/6F30-1967 CAN/CSA G40.21 BS 4360
	3	IS:269-1976	Ordinary rapid hardening & low heat Portland Cement.	ISO/R/597-1967
	4	IS:278-1978	Specification for barbed wire	ASTM A 121
	5	IS:383-1970	Coarse and fine aggregates from natural sources for concrete.	
	6	IS:398 - Part-II	Alum. Condr. Galvanised steel reinforced	
	7	IS:406-1964	Methods of Chemical Analysis of Slab Zinc	
	8	IS:432-1966 (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.	
	10	IS:731-1971	Porcelain Insulators for Overhead	BS:137-1973 (I&II)

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		Power Lines with a Nominal Voltage greater than 1000 volts	IEC:274-1968 IEC:383-1976
11	IS:800-1984	Code of practice for use of structural steel in general Building construction.	CSA STEAM 16.1
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 Pozzolena Cement	SO/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.	
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 Part-I:1993 voltage testing Part -2 : 1974 Part -3 : 1976		Method of high
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	

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25	IS:2131-1967	Method of Standard penetration test for soils.	ASTM D 1883
26	IS:2551-1982	Danger Notice Plates	
27	IS:2486	Insulator Fittings for	Specification for
		overhead Power Lines with a nominal voltage greater than 1000 volts	
	Part- I:1993	General Requirements and Tests	BS:3288-1972
	Part-II:1989	Dimensional Requirements	IEC:120-1960
	Part-III:1974	Locking Devices	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.	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.	
32	IS:3138-1966	Hexagonal bolts and nuts	ISO/R 947 and ISO/R 272
33	IS:3188-1980	Characteristics of string insulator units	
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	

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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.	
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:437-1937
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:575-1971

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TECHNICAL SPECIFICATION CHAPTER – T1

TRANSMISSION LINES TOWERS

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TECHNICAL SPECIFICATION CHAPTER – T1

TRANSMISSION LINES TOWERS

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	SECTION – T1: TRANSMISSION LINE TOWERS				
1.00.00	GENERAL DESCRIPTION OF TOWERS				
1.01.00	Types of Towers				
1.01.01	400 KV Towers				
	The towers shall be of self supporting lattice steel type, designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions.				
1.01.02	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.				
1.01.03	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 1-1				
	<u>Table T1-1</u>				
	Type of Tower	Deviation limit	Typical use		
	DA	0 to 2	To be used as tangent tower		
	DB	0 to 15	a) Angle towers with tension insulator string		
			b) Tension tower for uplift forces resulting from an uplift span upto 200 metres under broken wire conditon.		
			c) Also to be designed for unblanced tension resulting from unequal ruling span of 305 m and 150 m on each side of the tower.		
	DB	0	d) to be used as section tower		
	DC	15 to 30 degree.	a) Angle tower with tension insulator string		
			b) Tension tower for uplift forces resulting from		
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1.03.00			an uplift span upto 200 meters under broken wire condition.		
			c) Also to be designed for unbalanced tension resulting from unequal ruling span of 305 m and 150 m on each side of the tower.		
	D* and DD	30 deg. To 60 deg.	a) Angle tower with tension insulator string.		
			b) Tension tower for uplift forces resulting from an uplift span upto 200 metres under broken wire condition.		
			c) Also to be designed for the unbalanced tension resulting from unequal ruling span of 305m (*400 m) 150 m (*200 m) on each side of the tower (* For 400 KV towers)		
			d) Dead end with 0 deg. to 15 deg deviation both on line and sub- station side (slack span).		
	D* and DD	0deg.	e) complete dead end.		
	D* and DD	90deg.	f) to be used near switchyard with Reduced design and span		
	NOTE: The above towers may also be used for longer span with smaller angle of deviation. * Indicates Single circuit tower.				
	Extension				
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.					
For power line crossing 25 metre extensions with DD type towers are required. Bidders shall state in relevant clause of volume II-A the maximum reduced span for which type tower with 25 metre extension can be used with the stipulated factor of safety.					
The 25 metre extension should be designed in such a manner the same can also be used as 18.0 metre extension to normal tower after removal of bottom panels.					
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.					
D/DD type towers shall be designed to cater for 90deg. deviation with auxiliary cross arm and reduced tension/span.					
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1.04.00	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. The number of such templates of each type proposed to be supplied shall be stated by the Bidder. 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.				
2.00.00	SPANS AND CLEARANCES				
2.01.00	Normal Span The normal ruling span of the line shall be 400 meters for 400 KV towers..				
2.02.00	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 span.				
2.03.00	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)
	DA, DB, DC & DD (400 KV)	600	-200	360	-200
2.04.00	Electrical Clearance				
2.04.01	Ground clearance The minimum ground clearance from the bottom conductor shall not be less than 8.84 meters for 400 KV lines 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 follows: Vertical : 9.0 mtr. Horizontal : 11.0 mtr.				
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2.04.02	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. However, as per present regulations (revised in 1987) the minimum clearance is stipulated as 18.6 meters for 400 KV towers.			
2.04.03	Power Line Crossing			
	Minimum clearance between power line to power line crossing should be 4580 mm for 220 kV and 6300mm for 400 kV lines.			
2.04.04	Live Metal Clearance			
	The minimum live metal clearance to be provided between the live parts and steel work of super-structure shall conform to IS-5613- 1985/ IS- 5613 Part as follows :			
	<u>Type of Insulator String</u>	<u>Swing in Degrees</u>	<u>Min. Clearance (mm)</u>	
a)	Single suspension string	NIL	3050	
		22	3050	
		44	1860	
b)	Tension string (Single/Double)	NIL	3050	
c)	Jumper	NIL	3050	
		20	3050	
d)	Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for `DD' type tower to be used as dead end and angle tower.			
	The design of the tower shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings.			
2.04.05	Angle of Shielding			
2.04.06	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 20 deg for 400 KV 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.			
2.04.07	Mid Span Clearance			
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	The minimum vertical mid span clearance between the earthwire and the nearest power conductor shall not be less than 6.1 meters, 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.				
3.00.00	LOADING CONDITIONS				
3.01.00	Loads at Conductor And Earthwire Points				
	Owner has calculated the ultimate external loadings at conductor and earthwire points and enclosed alongwith the Specification. The Contractor shall develop the tower designs considering loadings given by the Owner. These loads have been computed based on IS 802/Part - I, 1995and towers are to be designed to cater for the following loads:				
	a) Reliability Loads (Normal condition) b) Security Loads (Broken wire condition) c) Safety Loads (Construction & Maintenance loads)				
	Suspension towers shall be designed for full wind load under security condition				
3.02.00	Wind Loads on Tower Body				
	The wind load on tower body shall be calculated by the Contractor as per IS:802, Part-I, 1995.				
3.03.00	Maximum Tension				
	Maximum tension shall be based on either of the following (whichever is more stringent):				
	a) at 0 deg C with 36% full wind pressure., or b) at 32 deg C with full wind pressure				
	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.				
3.04.00	Sag tension calculation for design purpose shall be calculated considering normal span of 400 meter.				
3.04.05	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.				
3.06.00	Limiting Tensions of conductor & Earthwire				
	The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths.				
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Clause No.	TECHNICAL REQUIREMENTS																				
3.07.00	Broken Wire Condition																				
3.07.01	Suspension Tower Type DA Breaking of conductor in one phase only, resulting in instantaneous unbalanced tension of maximum working conductor tension or breaking of one earthwire resulting in an unbalance tension equal to the maximum tension of the earthwire whichever is more stringent is to be considered.																				
3.07.02	Tower Type DB& DC Breaking conductor is any two phase only or breaking of earthwire and any one phase on the same side and same span resulting is instantaneous unbalanced tension on the tower is to be considered. The unbalanced tension shall be taken as the maximum tension.																				
3.07.03	Tower Type DD Breakage of all the three phases on the same side and on the same span or breakage of two phases and any one earthwire on the same side and one he same span, whichever combination is more stringent for a particular member.																				
3.08.00	Design Loads																				
3.08.01	Owner's requirement for most stringent design longitudinal and transverse loads is summerized in Table T1-2.																				
3.08.02	The Bidder shall furnish the details of design loads proposed to be adopted in the tower design in accordance with this specification. The same design load data be filled in the Data Requirement Sheet.																				
4.00.00	DESIGN OF TOWERS																				
4.01.00	Design Criteria Towers shall be designed based on spans and clearances, and loading conditions as detailed above.																				
4.02.00	Design Temperatures The following temperature range for the conductors and ground wires shall be adopted for line design: <table><tr><td>a)</td><td>Minimum temperature</td><td>:</td><td>0 deg.C</td></tr><tr><td>b)</td><td>Everyday temperature of conductor</td><td>:</td><td>32 deg.C</td></tr><tr><td>c)</td><td>Max. temperature of Conductor</td><td>:</td><td>75 deg.C</td></tr><tr><td>d)</td><td>Max. temperature of Earthwire exposed to sun</td><td>:</td><td>53 deg.C</td></tr></table>					a)	Minimum temperature	:	0 deg.C	b)	Everyday temperature of conductor	:	32 deg.C	c)	Max. temperature of Conductor	:	75 deg.C	d)	Max. temperature of Earthwire exposed to sun	:	53 deg.C
a)	Minimum temperature	:	0 deg.C																		
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c)	Max. temperature of Conductor	:	75 deg.C																		
d)	Max. temperature of Earthwire exposed to sun	:	53 deg.C																		
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Clause No.	TECHNICAL REQUIREMENTS				
4.03.00	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.).				
4.04.00	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. However, design approval for such substitution shall be obtained from the Owner before any substitution.				
4.05.00	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				
4.06.01	Bolts & Nuts				
4.06.02	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				
4.07.00	Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30mm.				
4.07.01	For the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-1993 may be referred.				
4.07.02	Slenderness Ratio				
4.08.00	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.				
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Clause No.	TECHNICAL REQUIREMENTS				
4.09.00	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	375			
4.10.00	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.				
4.11.00	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.				
5.00.00	TOWER MATERIALS				
5.01.00	Tower Steel Sections IS steel sections of tested quality in conformity with IS:226-1975 or IS:2062-1980 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.				
5.02.00	Fasteners : Bolts, Nuts and Washers				
5.02.01	All bolts and nuts shall conform to IS:6639-1972. 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.				
5.02.02	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) 1980.				
5.02.03	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.				
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Clause No.	TECHNICAL REQUIREMENTS				
5.02.04	To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing, at a minimum temperature of 530 deg.C . The temperature should be recorded continuously in the form of a continuous chart. The galvanised coating should be uniform and its value should be between 50 micron to 115 micron to be checked on random sampling basis, on the threaded portion as well. The facility to check the galvanised coating should be by metallographic method.				
5.02.05	Nuts should be double chamfered as per the requirement of IS:1363 Part-III, 1984. It should be ensured by the manufacturer that nuts should not be overtapped beyond 0.4 MM oversize on effective diameter for size upto M16.				
5.02.06	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.				
5.02.07	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.				
5.02.08	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.				
5.02.09	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.				
5.02.10	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.				
5.02.11	The bolt positions in assembled towers shall be as per IS:5613 (Part-II/Section-2)-1976.				
5.02.12	Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.				
5.03.00	Tower Accessories				
5.03.01	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 as per the Owner approved design 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				
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Clause No.	TECHNICAL REQUIREMENTS					
	the ladder to each crossarm tip and the groundwire support shall be fixed on tower by using countersunk bolts.					
5.03.02	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 conditionings 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.				
5.03.03	Earthwire peaks/crossarms are to be suitably designed to accommodate the shackle of the suspension clamp/tension clamps.					
5.03.04	Anti-climbing Device					
	Barbed wire type anti-climbing device, as per enclosed drawing 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.					
5.03.05	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.				
	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.				
6.00.00	TOWER FABRICATION					
6.01.00	Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) 1993 or the relevant international standards.					
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Clause No.	TECHNICAL REQUIREMENTS				
6.02.00	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.				
6.03.00	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.				
6.04.00	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.				
6.05.00	The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.				
6.06.00	No angle member shall have the two leg flanges brought together by closing angle.				
6.07.00	The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.				
6.08.00	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.				
6.09.00	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.				
6.10.00	Drilling and Punching				
6.10.01	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.				
6.10.02	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.				
	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.				
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Clause No.	TECHNICAL REQUIREMENTS				
6.10.03	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.				
6.11.00	Erection mark				
6.11.01	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.				
6.11.02	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.				
6.12.00	Quantities and Weights				
6.12.01	The estimated unit weight of each type of tower, stubs and extensions shall be furnished by the bidder. The final quantity of all the items associated with these lines shall be determined by the contractor after completion of the detailed route survey for which the rate quoted by the bidder shall be valid. 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.				
6.13.00	Galvanising Fully galvanised towers and stub shall be used for the line. Galvanising of the member of the towers shall conform to IS:2629-1985 and IS:4759-1968. All galvanised shall conform to IS:5358-1969. The galvanising shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanising. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanised as per Grade 4 of IS:1573-1970.				
7.00.00	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.				
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Clause No.	TECHNICAL REQUIREMENTS				
8.00.00	INSPECTION AND TESTS				
8.01.00	All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.				
8.02.00	Inspection				
	In addition to the provisions contained in Vol. I of tenders documents, the following shall also apply:				
8.02.01	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.				
8.02.02	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.				
8.02.03	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.				
8.02.04	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.				
8.02.05	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.				
8.02.06	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.				
8.02.07	All gauges and templates necessary to satisfy the Owner shall be supplied by the manufacturer.				
8.02.08	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.				
8.03.00	Tower Load Tests				
8.03.01	The Contractor shall submit one set of shop drawings alongwith the bill of materials after award of Contract. 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.				
8.03.02	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				
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Clause No.	TECHNICAL REQUIREMENTS				
	by the Owner on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.				
8.04.00	Tower Testing Procedure				
	All type of tower offered should be tested type as per the procedure described below:				
8.04.01	Bolt Slip Test				
8.04.02	In the bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition and held for two (2) minutes at that loads and then released gradually.				
	The initial and final readings on the scales (for measurement of defection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of the bolt slip.				
8.04.03	Normal/Broken Wire Load Tests				
	All the loads, for a particular load-combination test shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner:				
	25 percent				
	50 percent				
	75 percent				
	90 percent				
	95 percent				
	100 percent				
8.04.04	Observation Periods				
	a)	Under normal and broken wire load tests, the tower shall be kept under observation for sign of any failure for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading upto and including 95 per cent of full design loads.			
	b)	For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads.			
	c)	While the loading operation are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.			
	d)	The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts.			
	e)	Ovalization of holes and permanent deformation of bolts shall not be considered as failure.			
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Clause No.	TECHNICAL REQUIREMENTS				
8.04.05	Recording				
	The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking upto 5 mm accuracy.				
8.04.06	Destruction Test				
	a) The destruction test shall be carried out under normal condition or broken wire condition. The Owner at the time of approval of rigging chart/test data sheet shall intimate the contractor. Under which load condition the destruction test is to be carried out. b) 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.				
9.00.00	PACKING				
9.01.00	Angle section shall be wire bundled.				
9.02.00	Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tested and bolted together in multiples or securely wired through holes.				
9.03.00	Bolts, nuts, washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents.				
9.04.00	The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.				
10,00,00	DESIGN CALCULATION AND DRAWINGS				
10.01.00	The following design calculation and drawings are required to be furnished during detailed engineering.				
	a) Computation of wind load b) Sag-tension calculation c) Tower loading d) Single line diagram of towers showing electrical clearances and steel sections. e) Sketches of foundation showing dimensions.				
10.02.00	The Contractor shall furnish following to the owner:				
	a) Detailed design calculation and drawing for towers and foundations. b) Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc. c) Bill of materials, indicating cutting and bending details against each member. d) Shop drawings showing all details relevant to fabrication.				
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Clause No.	TECHNICAL REQUIREMENTS 																																																																				
e)	All the drawings for the tower accessories.																																																																				
TABLE-T1-2 DESIGN LOADS																																																																					
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NABINAGAR STPP (3X660MW) 400/132KV SWITCHYARD PACKAGE		Bid Doc. No.: CS-0370-572-2	TECHNICAL SPECIFICATIONS	PART-III SECTION-VI	Page T1-16/17																																																																

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	Note: 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. 2. Safety loads and Anti-cascade loads as specified in IS 802- Part I, 1995 shall also be considered for design of Towers. 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. 4. Any additional loads apart from the loads mentioned above, as required as per IS: 802- 1995 shall be considered for design purpose.																							
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PART- III

TECHNICAL SPECIFICATION CHAPTER – T2

TOWER FOUNDATIONS

PART- III

TECHNICAL SPECIFICATION CHAPTER – T2

TOWER FOUNDATIONS

<u>Clause No.</u>	<u>Description</u>	<u>Page No.</u>
1.00.00	Types of Foundation	T2-1
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Clause No.	TECHNICAL REQUIREMENTS				
	SECTION – T2: TOWER FOUNDATIONS				
1.00.00	TYPES OF FOUNDATION				
1.01.00	General				
1.01.01	Cement concrete/Reinforced concrete footing shall be used for all type of normal tower in conformity with the present day practice followed in the country and the specifications laid herein. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift.				
1.01.02	Foundation includes supply of materials such as cement, sand, coarse aggregates etc. and also reinforcement steel, if required. Rates quoted for foundations in appropriate schedules shall include all items of work related to supply and installation of foundations such as form work, excavation and backfilling, stub setting, providing reinforcement (if required) etc.				
1.02.00	Classifications of Foundations				
	The foundation designs shall depend upon the type of soil, sub-soil water level and the presence of surface water which have been classified as follows:				
1.02.01	Normal Dry				
	To be used for locations where normal dry cohesive or non-cohesive soils are met.				
1.02.02	Wet				
	To be used for locations:				
	a) Where sub-soil water is met at 1.5 meters or more below the ground level.				
	b) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.				
1.02.03	Partially submerged				
	To be used at locations where sub-soil water table is met between 0.75 meter below the ground level.				
1.02.04	Fully submerged				
	To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.				
1.02.05	Black Cotton Soil (Wet)				
	To be used at locations where soil is clayey type, not necessarily black in colour which shrinks when dry and swells when wet, resulting in differential movement extending to a maximum depth of about 3.5 meters below ground level. For designing foundations, for such locations, the soil is to be considered sub-merged in nature.				
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Clause No.	TECHNICAL REQUIREMENTS				
1.02.06	Fissured Rock				
a)	To be used at locations where decomposed or fissured rock, hard gravel kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.				
b)	To be used at fissured rock locations, where water table is met below ground level.				
1.02.07	Hard Rock				
	The locations where chiseling, drilling and blasting is required for excavation hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.				
1.02.08	In addition to the above, depending on the site conditions other types of foundations shall also be provided by the Contractor suitable for :				
a)	Intermediate conditions under the above classifications to effect more economy, or				
b)	For locations where special foundations (well type or piles)are necessitated.				
1.03.00	The proposal for these types of foundations shall be submitted by the Contractor based on the detailed soil investigation and approval for the same shall be obtained from the Owner.				
2.00.00	SOIL INVESTIGATION				
2.01.00	The transmission tower foundations shall be classified based on the soil conditions. Optimisation of foundation design and their safety mainly depends on correctness of soil data and their analysis.				
2.02.00	The Contractor shall be required to carry out detailed soil investigation at various tower locations such as angle points, crossings, etc. 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.				
2.03.00	This specification covers all the work required for detailed soil investigation and preparation of a detailed 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), preparations for the type of foundations and the safe bearing capacity for different sizes of foundations, different founding strata for the various locations along the transmission lines.				
2.04.00	Soil Classification				
2.04.01	The type of soils normally encountered in construction of transmission lines can be broadly classified into the following four types of soils.				
a)	Sand				
b)	Mixed Soils				
c)	Clay soils				
d)	Rocky Soils				
2.04.02	The soil at any location shall be classified only after completion of the following field work and tests:				
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Clause No.	TECHNICAL REQUIREMENTS			
	a) One bore hole of 150 mm id shall be drilled at the center point of tower. b) Standard penetration test (S.P.T) shall be carried out at 1.5 m interval or change of strata upto a depth of 7.0 meters below ground level or to refusal whichever occurs earlier. (By refusal it shall mean that a standard penetration below count (N) of 100 is a recorded for 30 cm penetration. c) Bore details shall be furnished upto 7.0 meters below ground level or refusal whichever occurs earlier. d) Details of water table upto 7.0 meters below ground level shall be furnished.			
2.04.03	Based on the above SPT and other details collected the type of soil shall be classified as per clause 2.04.01 and the same shall be got approved by Engineer-in-Charge.			
2.04.04	If the soil is classified as `same' the bearing capacity and angle of repose shall be furnished alongwith calculations and justification.			
2.04.05	If the soils is classified as `mixed soil' or `clay soil' the following tests shall be carried out. The samples required for the following tests shall be collected at the time of preliminary investigation carried:			
	a) Detailed bore log with the IS classification of soil and its properties such as specific gravity, bulk unit weight, moisture content etc.			
	b) Collecting undisturbed samples of 100/75mm diameter, 450 mm long from the bore holes at 1.5 m intervals of change of strata, starting from 3 meter and upto 7 meter below ground level.			
	c) To find out the following soil properties laboratory tests shall be carried out on the above undisturbed samples:			
	1) Type of soil and gradation (As per IS classification)			
	2) Atterberg limit (Liquid and plastic limit only)			
	3) Triaxial tests to determine shear parameters such as cohesion (c) and angle of internal friction.			
	4) Natural moisture content, specific gravity and bulk unit weight.			
	5) Consolidation test.			
	6) Unconfined compression test.			
	7) Unconsolidated undrained test.			
	8) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates and organic matter and any other chemical harmful to the concrete foundations.			
	9) The bearing capacity of soil at different levels starting from 3.0 meter and upto 7.0 meter below ground levels. The above shall be calculated based on above determined soil data and considering a base width of foundation as 2.0 meters.			
2.04.06	While carrying out the SPT test if the blow count of 100 is recorded for 30 cm of penetration, the soil shall be classified as rocky soil. In case of rock the bore drilling shall be continued 3.0 meters further to ascertain its sufficient thickness. Core recovery and crushing strength of the rock shall also be reported.			
2.05.00	The laboratory tests shall be carried out progressively during the field work after sufficient number 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			
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Clause No.	TECHNICAL REQUIREMENTS				
	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.				
2.06.00	Test Results and Report				
2.06.01	The Character shall submit the detailed report in ten (10) copies containing information, regarding the geological details of the site, summarised observations and test data.				
2.06.02	The report shall include, but not limited to the following:				
a)	Borelogs : Bore logs of each bore hole clearly identifying the satisfaction and the type of soil stratum with depth upto the refusal. The location of water table shall be identified in the borelog. The value of SPT at the depths where the tests were conducted from samples collected at various depths shall be clearly shown against the particular stratum.				
b)	Test results of field and laboratory tests shall be summarised stratawise as well in combined tabular form with all relevant graphs, charts, tables, diagrams and photographs, if any, shall be submitted alongwith the report.				
c)	Recommendations : The report should contain specific recommendations for the type of foundation. The Contractor shall acquaint himself about the type of structures and their functions from the Engineer-in-charge. The observation/recommendations, shall include but not limited to the following :				
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.				
ii)	Limit 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.				
iii)	Comments on the chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.				
iv)	Recommendations for additional investigation, beyond the scope of the present work, if contractor feels that such investigation is necessary.				
2.07.00	Indian Standard References				
	<u>S.No.</u>	<u>Description</u>	<u>IS No.</u>		
	1.	Standard Penetration Test	IS:2131-1983		
	2.	Grain Size Analysis	IS:2720 (part - IV)-1975		
	3.	Moisture Content	IS:2720 (Part-II)1973		
	4.	Specific Gravity	IS:2720 (Part-III)-1980		
	5.	Liquid Limit, Plastic Limit	IS:2720 (Part-V)1970		
	6.	Triaxial Compression Test.	IS:2720 (Part-XI) - 1971		
	7.	Consolidation Test	IS:2720 (Part-XV)-1965.		
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Clause No.	TECHNICAL REQUIREMENTS			
3.00.00	SOIL PROPERTIES			
3.01.00	For design of foundations, the following properties of soil shall be considered:			
3.01.01	Weight of soil			
a)	Dry	1440 Kg/m ³		
b)	In presence of surface water	940 Kg/m ³		
c)	In presence of soil water	10 Kg/m ³		
3.01.02	Submerged Fissured Rock			
a)	Ultimate Bearing Capacity	62,500 Kg/M ²		
b)	Weight of Earth	1440 Kg/M ³		
c)	Angle of Repose Degrees	20 degrees		
3.01.03	Hard Rock			
a)	Limit Bearing Capacity	12,50,00 Kg/M ²		
b)	Ultimate Bond Between Steel and Concrete (M15)	10 Kg/M ²		
3.01.04	Properties of Soil			
	Type of soil	Limit Bearing Capacity	Angle of Repose (Degrees)	
a)	Normal Dry Soil	24,000	20 °	
b)	Wet earth in the presence of sub soil water	12,000	10 °	
c)	Wet earth due to presence of sub surface water	12,000	10 °	
d)	Wet Black Cotton Soil	12,000	0°	
4.00.00	LOADS ON FOUNDATIONS			
4.01.00	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.			
4.02.00	The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:			
a)	Max. tension or uplift along the leg slope.			
b)	Max. compression or down-thrust along the leg slope.			
c)	Max. horizontal shear or side thrust.			
4.03.00	The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.			
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Clause No.	TECHNICAL REQUIREMENTS			
4.04.00	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.			
5.00.00	STABILITY ANALYSIS			
5.01.00	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.			
5.02.00	The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:			
5.02.01	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 as per formula detailed in Annexure-A of this Section on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. 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.			
5.02.02	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.			
5.02.03	Resistance against side-thrust The chimney portion of the foundation shall be designed as per limit load method described at clause 38.6 of IS-456-1978, or as per any other international standard, 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.			
6.00.00	PROPERTIES OF CONCRETE			
6.01.00	The cement concrete used for the foundations shall be of grade M 25 with 20mm coarse aggregate.			
6.02.00	All the properties of concrete regarding its strength under compression tension, shear, punching and bend etc. as well as workmanship will conform to IS:456-1978.			
6.03.00	The weight of concrete to be considered for design of foundations below:			
	<u>Type of concrete</u>	<u>Weight of dry region KN/m³ (Kg/m³)</u>	<u>Weight in presence of sub-soil water KN/M³ (KG/m³)</u>	
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Clause No.	TECHNICAL REQUIREMENTS			
	Concrete	21.96 (2240)	12.16 (1240)	
	Reinforced	23.54 (2400)	13.73 (1400)	
6.04.00	The Portland Cement used in concrete shall conform to IS: 269-1967.			
6.05.00	The Pozzolana cement used in concrete shall conform to IS: 1489-1976. The curing time of Pozzolana cement will be decided at the time of execution of the contract.			
6.06.00	Concrete aggregates shall conform to IS:383-1970.			
6.07.00	The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalis, organic materials or other deleterious substances. Portable water is generally preferred.			
6.08.00	Reinforcement shall conform to IS:432-1966 for MS bars and hard drawn steel wires and to IS:1139-1966 and IS:1786-1966 for deformed and cold twisted bars respectively. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coating, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications.			
7.00.00	DESIGN OF FOUNDATIONS			
7.01.00	Structural design of the foundations shall be done by limit State method.			
7.02.00	Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel.			
7.03.00	The physical properties of soil under various conditions as furnished in clause 3.00.00 are to be considered for the design of various types foundations.			
7.04.00	No extra payment for these foundations shall be made beyond the lumpsum rate quoted by the bidder. However, it may be noted that the soil properties furnished above are tentative in nature. After soil investigations, if it is found that the foundations listed above cannot be used at that location, new foundation design shall be developed based on properties furnished in soil report. No extra payment for these foundations shall be made beyond the rates quoted,			
7.05.00	The thickness of concrete in the chimney portion of the tower footing would be such that it provides minimum cover of not less than 100mm from any part of the stub angle to the nearest outer surface of the concrete in respect of all dry locations limiting the minimum section of chimney to 300mm square. In respect of all wet location, the chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum.			
7.06.00	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.			
7.07.00	The spread of concrete pyramid or slabs for both P.C.C. type foundations shall be limited to 45 degree with respect to the vertical. The centroidal axis of the slab shall coincide with the axis of the chimney and pass through the center of foundation base. The design of the foundations (base slab and its reinforcement) shall take into account the additional stresses in the foundation resulting from the eccentricity introduced due to non-compliance of this requirement.			
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Clause No.	TECHNICAL REQUIREMENTS				
7.08.00	At least 50mm thick pad of size equal to the base of pyramid with its sides vertical will be provided below the pyramid to account for the unevenness of soils and impurities likely to be mixed in concrete due to direct contact of wet concrete with earth and also for allowing stone aggregate reaching upto corner edges. This pad will also be provided in cases where pyramids are provided over concrete slabs.				
7.09.00	In case of fully submerged type foundation, at least one base slab of not less than 200 mm thick shall be provided. In case of reinforced concrete slab, the slab thickness should not be less than 300 mm.				
7.10.00	The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100mm or more than 150 mm in case of dry locations and not less than 150 mm or more than 200mm in case of wet locations.				
7.11.00	The total depth of foundations below the ground level shall not be less than 1.5 meters and more than 3.0 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.				
7.12.00	The portion of the stub in the pyramid (or slab) shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and pyramid concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design.				
7.13.00	In case of foundation having steel reinforcement in pyramid or base slab, at least 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.				
7.14.00	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.				
8.00.00	CONSTRUCTION OF TOWER FOUNDATION				
8.01.00	Excavation				
8.01.01	Excavation work must not be started until the tower schedule and profile has been approved by the Owner.				
8.01.02	Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. The excavation wall shall be vertical and the pit dimensions shall be such as to allow a clearance of 150mm on all sides from the foundation pad. The Contractor should ensure clearance of 150 mm from the foundation pad for quality work. 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.				
8.01.03	The soil to be excavated for tower foundations shall be classified as under:				
a)	Normal Soil : Soil removable by means of an ordinary pick axe, spade and shovel.				
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	b) Wet Soil : Where the subsoil water table is encountered within the range of foundation depth or/and where pumping or bailing out of water is required due to presence of surface water will be treated as wet soil. c) Rocky Soil : hard conglomerate or other soft or fissured rock which can be quarried or split with crow bars, wedges or pickaxes. However, if required, light blasting may be resorted to for loosening the material, but this will not in any way entitle the material to be classified as hard rock. d) Hard Rock : Any rock excavation other than specified under fissured rock above for which blasting, drilling, chiseling are required..								
8.01.04	Where soil is of composite nature, classification of foundation shall be made accordingly.								
8.01.05	No extra charge shall be admissible for the removal of the fallen earth in the pit, when once excavated. Shoring and timbering/shuttering as approved by authorized representative of the Owner shall be provided by the Contractor when the soil condition is so bad that there is likelihood of accident due to the falling of earth.								
8.01.06	Where rock is encountered, the holes for tower footings, shall preferably be drilled, but where blasting is to be resorted to as an economy measure, it shall be done with the utmost care to minimise the use of concrete for filling the blasted area. In case where drilling is done, the stubs may be shortened suitably with the approval of the Owner or his authorised representatives.								
8.01.07	The Contractor shall supply requisite blasting materials and be responsible for the purpose of the storage and use of this material.								
8.02.00	Setting of Stubs								
8.02.01	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.								
8.02.02	Setting of stub at each location shall be approved by the Owner's representative.								
8.02.03	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: <table><tr><td>For each A type tower</td><td>: 3 Nos.</td></tr><tr><td>For each of B, C and D type</td><td>: 2 Nos.</td></tr></table> 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.					For each A type tower	: 3 Nos.	For each of B, C and D type	: 2 Nos.
For each A type tower	: 3 Nos.								
For each of B, C and D type	: 2 Nos.								
8.02.04	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.								
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Clause No.	TECHNICAL REQUIREMENTS			
8.03.00	Mixing, Placing and Compacting of Concrete			
8.03.01	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.			
8.03.02	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 which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.			
8.03.03	Form boxes shall be used for casting all type of foundations. The concrete shall be laid down in 150mm layers and consolidated well, so that the cement cream works up to the top and 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.			
8.03.04	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.			
8.03.05	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.			
8.04.00	Back-Filling and Removal of Stub Template			
8.04.01	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.			
8.04.02	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.			
8.04.03	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.			
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8.05.00	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.				
8.06.00	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.				
8.07.00	Protection of Tower Footing				
8.07.01	The work shall include all necessary stone revetments, concreting and earth filling above ground level and the clearance from stacking on the site of all surplus excavated soil, special measures for protection of foundation close to or in nallahs, river bed hilly/undulated terrain etc, by providing suitable revetments or galvanised wire netting and meshing packed with boulders. The top seal cover of the stone revetments shall be done with M-150 concrete (1:2:4:mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.				
8.07.02	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.				
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PART- III

TECHNICAL SPECIFICATION CHAPTER – T3

TOWER LINE ERECTION AND STRINGING

PART- III

TECHNICAL SPECIFICATION CHAPTER – T3

TOWER LINE ERECTION AND STRINGING

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SECTION –T3 : TOWER LINE ERECTION AND STRINGING					
1.00.00	GENERAL REQUIREMENTS				
1.01.00	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.				
1.02.00	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.				
1.03.00	The quantities of conductor, earthwire, insulators hardware, accessories of conductor & earthwire, etc. are estimated by the Owner include excess material towards wastages and damages during erection.				
2.00.00	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.				
3.00.00	ASSEMBLY				
3.01.00	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)-1976.				
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.				
3.02.00	Tightening and Punching of Bolts and Nuts				
3.02.01	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				
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	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.			
3.02.02	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.			
3.02.03	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.			
4.00.00	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.			
5.00.00	HANDLING OF CONDUCTOR AND EARTHWIRE			
5.01.00	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.			
5.02.00	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 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			
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	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.	
5.03.00	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.	
5.04.00	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.	
5.05.00	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.	
5.06.00	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.	
5.07.00	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.	
5.08.00B 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.	
6.00.00	STRINGING OF CONDUCTOR AND EARTHWIRE	
6.01.00	The stringing of the conductor shall be done by standard stringing method.	
6.02.00	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.	
6.03.00	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.	
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6.04.00	The Bidder shall give complete details of the stringing methods which he 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.				
6.05.00	Jointing				
6.05.01	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.				
6.05.02	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.				
6.05.03	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.				
6.06.00	Sagging-in-Operation				
6.06.01	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.				
6.06.02	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.				
6.06.03	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,				
6.06.04	At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, the 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.				
6.06.05	Tensioning and sagging operations shall be carried out in calm weather when rapid changes in temperatures are not likely to occur.				
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6.06.06	Tensioning and Sagging of Conductors and Earthwire The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The `Initial' 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.				
6.07.00	Clipping In				
6.07.01	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.				
6.07.02	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.				
6.07.03	Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.				
6.08.00	Fixing of Conductor and Earthwire Accessories Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.				
7.00.00	REPLACEMENT				
7.01.00	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.				
7.02.00	The Contractor shall not be required to return to the Owner, empty conductor and earthwire drums and shall dispose off the same at his cost except for steel drums which shall be returned to Owner.				
7.03.00	Any conductor and earthwire drum which has been opened by the Contractor shall not be taken back by Owner and the unused conductor or earthwire in such drum shall be treated as wastage permissible within the overall limits.				
8.00.00	FINAL CHECKING TESTING AND COMMISSIONING				
8.01.00	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				
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	specifications and as approved by the Owner. All the works shall be thoroughly inspected keeping in view of the following main points: a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted. b) Concrete chimneys and their copings are in good finally shaped conditions. c) All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever. d) All bolts are properly tightened and punched/tack welded. 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. f) All conductor and earthwire accessories are properly installed. g) All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed. h) Wherever required it should be ensured that revetment is provided. i) The original tracings 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. 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. k) All towers are properly grounded. l) The line is tested satisfactorily for commissioning purpose.			
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PART- III

TECHNICAL SPECIFICATION CHAPTER – T4

TRANSMISSION LINE MATERIAL

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TECHNICAL SPECIFICATION CHAPTER – T4

TRANSMISSION LINE MATERIAL

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	SECTION – T4: 400 KV TL. LINE MATERIAL				
1.00.00	GENERAL				
1.01.00	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 400 kV AC transmission with twin conductor and will give continued good performance.				
1.02.00	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.				
1.03.00	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:2629-1972. 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.				
1.04.00	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:209-1966.				
1.05.00	Electrical System Data for 400 kV Lines				
	Nominal voltage	400kV			
	Maximum voltage	420 kV			
	BIL(Impulse)	1550 kV(peak)			
	Power Frequency Withstand Voltage (Wet)	680 kV(rms)			
	Switching surge withstand voltage (Wet)	1050 kV(rms)			
	Minimum Corona extinction Voltage at 50Hz AC system Under dry condition.	320kV Min(rms) phase to earth			
	Radio interference voltage at One MHz for phase to earth Voltage of 305kV under dry Condition.	1000 Micro Volts Max.			
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Clause No.	TECHNICAL REQUIREMENTS			
2.00.00	EARTHWIRE			
2.01.00	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.			
2.02.00	Parameters of the earthwire Refer Chapter-E12, clause 7.00.00 of Switchyard Technical Specification.			
2.03.00	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.			
2.04.00	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.			
2.05.00	Standard length and random length shall be as per clause 3.05.00 below. Bidder may offer two lengths in one drum.			
3.00.00	CONDUCTOR			
3.01.00	The conductor shall be Aluminium Core Steel Reinforced (ACSR) type. The conductor shall confirm to IS:398 (Part-II) except where otherwise specified herein.			
3.02.00	Parameters of the conductor Refer Chapter-E12, clause 2.00.00 of Switchyard Technical Specification.			
3.03.00	The steel strands shall generally comply with the requirements stipulated for earthwire at clause 2.00.00 above.			
3.04.00	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.			
3.05.00	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.			
4.00.00	CONDUCTOR ACCESSORIES			
4.01.00	Mid Span Compression Joint for Conductor			
4.01.01	As per details given in IS:2121 Part-2..			
4.02.00	Repair Sleeve			
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Clause No.	TECHNICAL REQUIREMENTS					
4.03.00	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.					
	The Bidder shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve. The compression pressure shall also be indicated by the Bidder. The dimensions and dimensional tolerances for Mid Span Compression Joint and Repair Sleeves for ACSR 'MOOSE' conductor shall be as follows:					
	Item	Dimensions before compression		Length	Dimension after compression	
		Inner Dia.	Outer Dia.		Corner to Corner width	Face to face width
		(mm)	(mm)	(mm)	(mm)	(mm)
	a)	Al.Sleeve				
	Mid Span Compression Joint	34±0.5	54±1	735±5	53±0.5	34±0.5
	Repair Sleeve	34±0.5	54±1	300±5	53±0.5	46±0.5
	b)	Steel Sleeve				
	Mid Span Compression Joint	11.1±0.2	21±0.5	250±5	20.2±0.5	17.5±0.5
4.04.00	Vibration Damper for conductor and Earthwire					
4.04.01	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.					
4.04.02	The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent.					
4.04.03	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					
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Clause No.	TECHNICAL REQUIREMENTS																						
	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.																						
4.04.04	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.																						
4.04.05	The vibration damper for conductor shall not have magnetic power loss more than 1 watt at 600 amps at 50 Hz alternating current.																						
4.04.06	The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Chapter-T5 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: <table><tr><td>Configuration</td><td>Twin conductor per phase / earth wire on peak</td></tr><tr><td>Span length</td><td></td></tr><tr><td>i) Ruling design span</td><td>400 meters</td></tr><tr><td>ii) Maximum Span</td><td>1100 meters</td></tr><tr><td>iii) Minimum Span</td><td>100 meters</td></tr><tr><td>Tensile load in Conductor /earthwire</td><td>4144 Kg/1340 Kg</td></tr><tr><td>Armour rods used</td><td>Standard preformed armour rods/AGS</td></tr><tr><td>Max. Velocity of wind</td><td>30 kms per hour</td></tr><tr><td>Maximum permissible dynamic strains</td><td>150 micro strains</td></tr></table>					Configuration	Twin conductor per phase / earth wire on peak	Span length		i) Ruling design span	400 meters	ii) Maximum Span	1100 meters	iii) Minimum Span	100 meters	Tensile load in Conductor /earthwire	4144 Kg/1340 Kg	Armour rods used	Standard preformed armour rods/AGS	Max. Velocity of wind	30 kms per hour	Maximum permissible dynamic strains	150 micro strains
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4.04.07	The damper placement chart for spans ranging from 50 m to 600 m shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents and sample calculations.																						
4.04.08	The damper placement charts shall include the following: a) 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. b) Placement distances clearly identifying the extremities between which the distances are to be measured. c) Placement recommendation depending upon type of suspension clamp (viz Free centre type, Armour grip type, etc.) d) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.																						
4.05.00	Bundle Spacers																						
4.05.01	Armour grip bundle spacers shall be used to maintain the spacing of 450mm between the two sub-conductors or each bundle under all normal working conditions.																						
4.05.02	Spacers offering equivalent or better performance shall also be accepted provided offer meets the qualifying requirements stipulated in the specification.																						
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Clause No.	TECHNICAL REQUIREMENTS	
4.05.03	The offer shall include placement charts recommending the number of spacers per phase per span and the sub span lengths to be maintained between the spacers while installing on the twin bundle conductors.	
4.05.04	The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span shall be kept more than 30 km/hr and to avoid clashing of sub conductors. The placement shall ensure bundle stability under all operation conditions.	
4.05.05	The placement chart shall be provided for spans ranging from 100 m to 1100 m. The number of spacers recommended for a ruling design span of 400 m shall however be seven with no sub-span greater than 70m and no end sub-span longer than 40 m.	
4.05.06	The Bidder may offer more number of spacers per ruling design span than the specified. However, in such case, suitable price compensation shall be considered for evaluation. For the purpose of price compensation, all the spans shall be assumed to be ruling design spans.	
4.05.07	The Bidder shall also furnish all the relevant technical documents in support of their placement charts along with the bid.	
4.05.08	Jumpers at tension points shall also be fitted with spacers so as to limit the length of free conductor to 3.65 m and to maintain the sub conductor spacing of 450 mm. Bidder shall quote for rigid spacer for jumper. It shall meet all the requirements of spacer used in line except for its vibration performance. Spacers requiring retaining rods shall not be quoted for jumpers.	
4.05.09	The spacers offered by the Bidder shall satisfy the following requirements.	
4.05.10	Spacers shall restore normal spacing of the sub conductors after displacement by wind, electromagnetic and the electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation damage either to conductor or to the assembly itself. They shall have uniform grip on the conductor.	
4.05.11	For spacer requiring retaining rods, the retaining rods shall be designed for the specified conductor size. The preformed rods shall be made of high strength, special aluminum alloy of type 6061/65032 and shall have minimum tensile strength of 35 kg/sq.mm. The ends of retaining rods should be ball ended. The rods shall be heat-treated to achieve specified mechanical properties and give proper resilience and retain the same during service.	
4.05.12	Four numbers of rods shall be applied on each clamps to hold the clamp in position. The minimum diameter of the rods shall be 7.87 ± 0.1 mm and the length of the rods shall not be less than 1100 mm.	
4.05.13	Where elastomer surfaced clamp grooves are used, the elastomer shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061/65032. The insert shall be duly heat treated and aged to retain its consistent characteristics during service.	
4.05.14	Any nuts used shall be locked in a approved manner to prevent vibration loosening. The ends of bolts and nuts shall be properly rounded for specified corona performance or suitably shielded.	
4.05.15	Clamp with cap shall be designed to prevent its cap from slipping out of position when being tightened.	
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Clause No.	TECHNICAL REQUIREMENTS			
4.05.16	The clam grooves shall be in uniform contact with the conductor over the entire surface, except for rounded edges. The groove of the clamp body and clamp cap shall be smooth and free of projections, grit or other material which cause damage to the conductor when the clamp is installed.			
4.05.17	For the spacer involving bolted clamps, 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 5 kN. 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.			
4.05.18	Universal type bolted clamps covering a range of conductor sizes, will not be permitted.			
4.05.19	No rubbing other than that of conductor clamps hinges or clamp swing bolts, shall take place between any parts of the spacer. Joint incorporating a flexible medium shall be such that there is no relative slip between them.			
4.05.20	The spacer shall be suitable designed to avoid distortion or damage to the conductor or to themselves during service.			
4.05.21	Rigid spacers shall be acceptable only for jumpers.			
4.05.22	The spacers shall not damage or chafe the conductor in any way which might affect its mechanical and fatigue strength or corona performance.			
4.05.23	The clamping system shall be designed to compensate for any reduction in diameter of conductor due to creep.			
4.05.24	The spacer assembly shall not have any projection, cuts, abrasions, etc. or chattering parts which might cause corona or RIV.			
4.05.25	The spacer tube shall be made of aluminium alloy of type 6061/65032. If fasteners of ferrous material are used, they shall conform to an be galvanized conforming to relevant Indian Standards. The spacer involving ferrous fasteners shall not have magnetic power loss more than one watt at 600 amps 50 Hz alternating current per sub conductor.			
4.05.26	Elastomer, if used, shall be resistant to the effects of temperature up to 75 deg.,C, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. It shall have good fatigue characters. The physical properties of the elastomer shall be of approved standard..			
4.05.27	The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly in case of spacer having elastomer clamp grooves shall be suitably selected by the manufacturers to ensure satisfactory electrical performance and to avoid deterioration of elastomer under all service conditions.			
4.05.28	The spacer assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.			
4.05.29	The spacer assembly shall be capable of being installed and removed from the energized line by means of hot line technique.			
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Clause No.	TECHNICAL REQUIREMENTS					
5.00.00	EARTHWIRE ACCESSORIES					
5.01.00	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:					
	Item	Dimensions before compression		Length	Dimension after compression	
		Inner Dia.	Outer Dia.		Corner to Corner width	Face to face width
		(mm)	(mm)	(mm)	(mm)	(mm)
	Steel	11.1±0.2	21±0.5	250±5	20.2±0.5	17.5±0.5
	Dead-end					
5.02.00	Vibration Damper For Earthwire					
5.02.01	Refer Clause 4.04.00 detailed above.					
5.03.00	Flexible Copper Bond: As detailed in is:2121 part3. the flexible copper bond shall be fitted with 2 nos. tinned copper connecting lugs which will be pressed jointed to either ends of the bond. One lug shall be suitable for 12 mm dia bolt and other for 16 mm dia bolt. The complete assembly shall also include one 16 mm dia 40 mm lug HRH MS bolt hot dip galvanised with nut and lock washer.					
5.04.00	Suspension Clamp for Earthwire : As Detailed in IS:2121 Part3					
5.04.01	At all suspension towers, suitable suspension clamp shall be used to support the earthwire of 7/3.66 mm size, the clamp shall be of either free-centre type or trunion type and shall provide adequate area of support to the earthwire.					
5.04.02	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 12 kN and not more than 17 kN. The breaking strength of the assembly shall not be less than 25 kN.					
5.04.03	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.					
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Clause No.	TECHNICAL REQUIREMENTS			
5.05.00	Tension Clamp for Earthwire			
5.01.00	The details shall be as per IS:2121 part-3. Only Compression type tension clamp shall be used to hold 7/3.66 mm 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 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.			
6.00.00	HARDWARE FITTINGS			
6.01.00	The hardware fittings shall be as per the specification for hardware fittings along with its component for the following insulator strings:			
	a) Single – 'I' suspension insulator string. b) Single Suspension –I string with Pilot Clamp c) Double suspension insulator string. d) Double tension insulator string.			
6.02.00	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 16 mm thick strain plate having 22 mm dia hole, of the tower. b) Suitable yoke plates for double suspension and double tension hardware fittings for the twin conductor arrangement complying with the specifications given hereinafter. 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).			
6.03.00	Suspension Assembly for Conductor			
6.03.01	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.			
6.03.02	The suspension clamp assembly alongwith standard armour rods shall have a slip strength between 20 to 29 KN.			
6.03.03	Suspension assemblies with magnetic power loss more than 4 watts at a sub conductor current of 600 amp. Shall be rejected. The Bidders are requested to enclose test certificates for magnetic power loss test alongwith the bid.			
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Clause No.	TECHNICAL REQUIREMENTS				
6.03.04	The length and diameter of each rod shall be 2540±25 mm and 9.27±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.				
6.03.05	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.				
6.03.06	The armour rod shall not loose, their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS). 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 .				
6.04.00	Dead End Assembly The dead end assembly shall be complete with jumper cone etc.				
6.04.01	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:				
	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	34±0.5	54±1	53±0.5	46±0.5
	Steel Dead-end	11.1±0.2	21±0.5	20.2±0.5	17.5±0.5
6.05.00	Yoke Plates The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength, as specified in clause 7.01.00 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.				
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Clause No.	TECHNICAL REQUIREMENTS					
7.00.00	INSULATOR					
7.01.00	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 –I Suspension	255/280 x 145	320	1x 23	120	
	Double Suspension	-do-	-do-	2x 23	2 x 120	
	Double tension	255/280x170	-do-	2x 23	2 x 160	
	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.					
7.01.01	Disc Insulator: The insulator shall be pin and cap ; ball and socket type. The disc insulator shall conform to IS:731.					
7.01.02	Ball and Socket Designation					
	The dimensions of the balls and sockets shall be of 20 mm designation, for 120KN/160KN disc insulator in accordance with the standard dimensions stated in IS:2486-(Part-II)/IEC:120.					
7.02.00	Materials					
7.02.01	Porcelain : The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.					
7.02.02	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.					
7.02.03	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.					
7.02.04	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.					
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Clause No.	TECHNICAL REQUIREMENTS																								
7.02.05	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.																								
7.02.06	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.																								
7.03.00	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.																								
7.04.000	PGW and its accessories																								
7.04.01	General This specification covers the provision of one peak of 400 kV 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.																								
7.04.02	Construction 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. 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.																								
7.04.03	Optical Fiber Characteristics Optical fiber shall be supplied in accordance with ITU – T Recommendation G.652 with the following requirements. <table><tr><td>Profile of Optical Fiber:</td><td>Single mode stepped index</td></tr><tr><td>Average Transmission Loss:</td><td></td></tr><tr><td>At wavelength 1310 nm</td><td>0.38 dB per km maximum</td></tr><tr><td>At Wavelength 1550 nm</td><td>0.25 dB per km maximum</td></tr><tr><td>Number of Fiber</td><td>12</td></tr><tr><td>Average splicing loss:</td><td>0.05db per joint</td></tr><tr><td>Maximum splicing loss:</td><td>0.10 dB per joint</td></tr><tr><td>Mode field diameter (MFD):</td><td>9.0µm ± 1.0µm</td></tr><tr><td>Cladding diameter:</td><td>125 ± 2 µm</td></tr><tr><td>Core / Cladding</td><td></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	
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Clause No.	TECHNICAL REQUIREMENTS						
7.04.04	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				
	OPGW Characteristics						
	Ultimate tensile strength	(kg)	≥	7,500			
	Outside diameter	(mm)	≤	14			
	Cross sectional area of Conduct	(mm²)	≥	80			
	D.C. Resistance @ 20 °C	(Ω/km) ≤		0.76			
	Length per reel	(m)		3000 Approx.			
	Modulus of elasticity	(kg/mm²)	≥	10,000			
	Coefficient of linear expansion	(/°C)	≤	15.0 x 10 ⁻⁶			
	Capacity fault current (KA) ² sec.			46			
7.04.05	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			
	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.						
	Assemblies and Line Accessories						
	a. General						
	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.						
	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.						
	b. Suspension Clamps						
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Clause No.	TECHNICAL REQUIREMENTS			
	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. c. Tension Clamps 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. d. Grounding clamps and Parallel Groove Clamp Each clamp shall be capable holding the OPGW using bolts and nuts. e. Vibration dampers Stockbridge 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. f. Armor rods The armor rods for the OPGW shall be of the preformed type. They shall be smooth and free from corrosion, splitting, cracking, or any other defects. They shall be designed to effectively protect the OPGW from fatigue caused by vibration. Armor rods may or may not be employed, as per OPGW manufacturer recommendations, however the use of armor rods is preferred by the Employer. 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. The contractor shall provide one set of terminating materials with every joint box for optical fiber connection. 1. Way Joint Box for OPGW			
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Clause No.	TECHNICAL REQUIREMENTS				
	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. 2. Way Joint Box for OPGW and approach cable 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.				
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PART- III

TECHNICAL SPECIFICATION CHAPTER – T5

TESTS FOR TRANSMISSION LINE MATERIAL

PART- III

TECHNICAL SPECIFICATION CHAPTER – T5

TESTS FOR TRANSMISSION LINE MATERIAL

<u>Clause No.</u>	<u>Description</u>	<u>Page No.</u>
1.00.00	General Requirements	T5-1
2.00.00	Type Test	T5-1
3.00.00	Acceptance Tests	T5-3
4.00.00	Routine Tests	T5-5
5.00.00	Tests during Manufacture	T5-5
	Annexure-A Norms and Procedures Tests	T5-6

Clause No.	TECHNICAL REQUIREMENTS				
CHAPTER – T5 : TESTS FOR 400KV TL. LINE MATERIAL					
1.00.00	GENERAL REQUIREMENTS				
1.01.00	The materials shall conform to all the type tests as per relevant standards. The following type, acceptance, routine tests and tests during manufacturer shall be carried out on the line material.				
1.02.00	The type tests shall be carried out on samples prior to commencement of commercial production against the specification.				
1.03.00	The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this specification, the norms and procedure of these shall be as specified in annexure to this section.				
1.04.00	For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Bidder in his bid or the acceptance value specified in the relevant standard, whichever is more stringent for that particular test.				
2.00.00	TYPE TESTS				
	All the equipment shall conform to the type tests. As specified at clause elsewhere, Contractor shall submit reports of all the type tests as mentioned below as per the relevant standards for Owner's review. The type test reports shall be of the tests conducted in last 5 years prior to the date of bid opening. For the tests whose reports submitted are not acceptable or are not furnished, the same shall be conducted by the Contractor under this contract free of charge prior to the dispatch of the equipment/material.				
2.01.00	Earthwire				
a)	UTS test - As per specification enclosed				
b)	DC resistance test - As per specification enclosed				
2.02.00	Conductor (specification of following tests enclosed at Annexure)				
a)	UTS test on stranded conductor - As per specification enclosed				
b)	DC resistance test on stranded conductor - As per specification enclosed				
2.03.00	Conductor and Earthwire Accessories				
2.03.01	Mid Span Compression Joint for Conductor and Earthwire				
a)	Electrical Resistance Test – As per IS : 2121 - (Part-II) - 1981				
b)	Heating Cycle Test – As per IS:2486 (Part-I, 1971) (not applicable to mid span compression joint for earthwire).				
c)	Slip Strength Test - As per IS: 2486(part-I)-1971				
d)	Chemical analysis of material				
2.03.02	Repair Sleeve for conductor				
a)	Chemical analysis of material				
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Clause No.	TECHNICAL REQUIREMENTS				
2.03.03	Spacer for Line				As per specification enclosed
a)	Chemical analysis of materials				
b)	Clamp slip test				
c)	Vibration tests				
i)	Vertical vibration				
ii)	Longitudinal vibration				
iii)	Sub span oscillation				
d)	Magnetic power loss test (if applicable)				
e)	Tension – Compression test				
f)	Corona extinction voltage test (dry)				
g)	Radio interference voltage test (dry)				
h)	Ozone test				
2.03.04	Rigid Spacer for jumper (For Twin ACSR 'MOOSE')				
a)	Chemical analysis of materials				
b)	Clamp slip test				
c)	Magnetic power loss test (if applicable)				
d)	Tension – Compression test				
e)	Corona extinction voltage test (dry)				
f)	Radio interference voltage test (dry)				
2.03.05	Flexible Copper Bond.				
a)	Slip strength test - As per specification enclosed				
2.03.06	Vibration Damper for Conductor and Earthwire.				
a)	Dynamic characteristics test - As per specification enclosed				
b)	Vibration Analysis - As per specification enclosed				
c)	Clamp Slip Test - As per specification enclosed				
d)	Fatigue Test - As per specification enclosed				
e)	Chemical Analysis of Material				
2.03.07	Earthwire Suspension clamp Assembly				
a)	Mechanical strength Test - As per specification enclosed				
b)	Clamp Slip Strength vs Torque test for suspension assembly - As per specification enclosed.				
2.03.08	Earthwire Tension Clamp Assembly				
a)	Mechanical strength test (excluding Clamp) - As per specification enclosed				
b)	Slip strength test on tension assembly - As per specification enclosed				
c)	Electrical resistance test on tension Clamp - As per specification enclosed				
2.04.00	Hardware Fittings				
2.04.01	On the complete insulator string with hardware fittings				
a)	Power Frequency Voltage withstand test under wet condition - As per IS:731-1971				
b)	Impulse voltage withstand test under dry condition - As per IEC:383-1970.				
c)	Switching surge voltage withstand test under wet condition – As per IEC:383.				
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Clause No.	TECHNICAL REQUIREMENTS				
	d) Impulse voltage Flashover test under dry condition - As per IEC:383-1970. e) Voltage distribution test- As per specification enclosed f) Mechanical strength test for complete string - As per specification enclosed g) Vibration test- As per specification enclosed Notes: 1 All the type tests given above shall be conducted on single suspension and double tension insulator strings alongwith hardware fittings. 2. The mechanical strength test given above shall also be conducted on balance insulator strings alongwith hardware fittings.				
2.04.02	On suspension hardware fittings only a) Magnetic power loss test for suspension assembly - As per specification enclosed b) Clamp slip strength for clamp - As per specification enclosed c) Ozone test on Elastomer – As per specification enclosed				
2.04.03	On Tension Hardware Fittings only (As per IS : 2486 -Part-I) a) Electrical Resistance Test for dead end assembly b) Heating Cycle Test for dead end assembly c) Slip Strength Test for dead end assembly				
2.05.00	On disc insulators a) Verification of dimension – As per IS:731-1971 b) Thermal mechanical performance tests - As per IEC 575 c) Power frequency voltage withstand and Flashover test (wet) - As per IS:731-1971, d) Impulse voltage withstand and flashover test (dry) - As per IS:731-1971 e) Visible discharge test (dry) - As per IS:731 f) RIV test (dry) - As per IS:8263-1976				
3.00.00	ACCEPTANCE TESTS				
3.01.00	Earthwire a) Visual check on drum - As per specification enclosed b) Visual check for joint etc. - As per specification enclosed c) Dimensional check - As per specification enclosed d) Galvanising test - As per specification enclosed e) Lay length check - As per specification enclosed f) Torsion test - As per specification enclosed g) Elongation test - As per IS:398 (Part-II) h) Wrap test - As per IS:398 (Part-II) i) DC resistance test - As per IS:398 (Part-II) j) Breaking load test - As per IS:398 (Part-II) k) Chemical analysis of steel - As per IS:398 (Part-II)				
3.02.00	Conductor a) Visual and dimensional check on drum - As per specification enclosed				
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Clause No.	TECHNICAL REQUIREMENTS				
	b) Visual check for joint scratches and length of conductor - As per specification enclosed c) Dimensional check on individual strands - As per specification enclosed d) Check for lay-rations of various layers - As per specification enclosed e) Breaking load test on individual strands - As per IS:398 (Part IV) f) Wrap test on aluminium strands - As per IS:398 (Part-IV) g) DC resistance test on individual strands - As per IS:398 (Part IV) h) Elongation test - As per IS:398 (Part IV) i) Breaking load test on welded Aluminium strand - As per specification enclosed Note: All the above tests shall be carried out on aluminium strands after stranding only.				
3.03.00	Conductor and Earthwire Accessories				
3.03.01	Mid Span Compression Joint for Conductor and Earthwire				
	a) Visual examination & dimensional verification - IS:2121 (Part-II) b) Galvanising Test - As per IS : 2121 (Part-II) c) Hardness Test - As per specification enclosed				
3.03.02	Repair Sleeve for conductor				
	a) Visual examination and dimensional verification – As per IS:2121 (Part-II)				
3.03.03	Vibration Damper for Conductor and Earthwire.				
	a) Visual examination and dimensional verification – As per IS:2121 (Part-II) b) Galvanising Test on - As per IS:2121 (Part-II) i) Damper mass ii) Messenger Cable c) Verification of Resonance Frequencies - As per specification enclosed d) Clamp Slip vs torque Test - As per specification enclosed e) Clamp Bolt Torque Test - As per specification enclosed f) Strength of the Messenger Cable - As per specification enclosed g) Mass Pull Off Test - As per specification enclosed				
3.03.04	Spacer for Conductor/Spacer for jumper				
	a) Visual examination and dimensional verification - As per IS : 2121 (Part-II) b) Galvanising test c) Movement test (except for spacers for jumpers) d) Clamp slip test e) Clamp bolt torque test f) Compressive and tensile test g) Assembly torque test h) Hardness test for elastomer (if applicable)				
3.03.05	Earth wire Suspension Clamp Assembly				
	a) Visual examination and dimensional verification – As per IS : 2121 (Part-II) b) Galvanising test - As per IS:2121 (Part-II)				
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Clause No.	TECHNICAL REQUIREMENTS			
	c)	Clamp slip strength Vs Torque test - As per specification enclosed		
	d)	Mechanical strength of each component.		
3.03.06		Earth wire Tension Clamp Assembly		
	a)	Visual examination and dimensional verification - As per IS : 2121 (Part-II)		
	b)	Galvanising test (excluding clamp) - As per IS : 2121 (Part-II)		
	c)	Hardness test - As per specification enclosed		
	d)	Mechanical strength test on each component (excluding clamp)		
	e)	Slip strength test on tension clamp - As per specification enclosed		
3.04.00		Hardware Fittings		
3.04.01		On both suspension and tension hardware fittings		
	a)	Visual Examination - As per IS : 2486 - (Part-I) - 1971		
	b)	Verification of dimension - As per IS : 2486 - (Part-I) - 1971		
	c)	Galvanising/Electroplating - As per specification enclosed		
	d)	Mechanical strength test of welded joint - As per specification enclosed		
	e)	Mechanical strength test of each component - As per specification enclosed		
	f)	Test on locking devices for ball and socket coupling – As per IEC:372(2)-1976		
	g)	Chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging /casting- As i)per specification enclosed		
3.04.02		On suspension Hardware fittings only		
	a)	Clamp slip strength vs Torque test for suspension clamp - As per specn. enclosed		
	b)	Shore hardness test of elastomer cushion for AG suspension clamp		
	c)	Bend test for armour rod set - As per IS:2121-(Part-I)1981		
	d)	Resilience test for armour rods set - As per IS:2121		
	e)	Conductivity test for armour rods set. - As per IS:2121		
3.04.03		On Tension Hardware Fittings only		
	a)	Slip strength test for dead end assembly : As per IS:2486-(Part-I)1971		
3.05.00		Disc insulator		
	a)	Visual Examination - As per IS:731-1971		
	b)	Verification of dimensions - As per IS:731-1971		
	c)	Temperature cycle test - As per IS:731-1971		
	d)	Galvanising test - As per IS:731-1971		
	e)	Mechanical performance test – As per IEC:575-1977		
	f)	Tests on locking device for ball and socket coupling – As per IEC:372(2) -1976		
	g)	Eccentricity test - As per specification enclosed		
	h)	Electro-mechanical failing load - As per IEC:383-1993		
	i)	Puncture test - As per IS:731-1971		
	j)	Porosity test - As per IS:731-1971		
4.00.00		ROUTINE TESTS		
4.01.00		Earthwire		
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Clause No.	TECHNICAL REQUIREMENTS					
	a)	Check that there are no cuts, fins etc. on the strands				
	b)	Check for correctness of stranding.				
	c)	Check that drums are as per specification.				
4.02.00	Conductor					
	a)	Check to ensure that the joints are assembly per specification				
	b)	Check that there are no cuts, fins etc. on the strands				
	c)	Check that drums are as per specification.				
	d)	All acceptance test as mentioned in clause 3.02.00 above to be carried out on each coil.				
4.03.00	Conductor and Earthwire Accessories					
	a)	Visual Examination and Dimensional Verification - As per IS : 2121 - (Part-II) - 1981				
4.04.00	Hardware Fittings					
	a)	Visual Examination – As per IS:2486 (Part-I) 1971				
	b)	Proof Load Test - As per specification enclosed				
4.05.00	Insulators					
	a)	Visual inspection - As per IS:731-1971				
	b)	Mechanical routine test - As per IS:731-1971				
	c)	Electrical routine test - As per IS:731-1971				
5.00.00	TESTS DURING MANUFACTURE					
5.01.00	Earthwire					
	a)	Chemical analysis of zinc used for galvanising – As per specification enclosed				
	b)	Chemical analysis of steel				
5.02.00	Conductor					
	a)	Chemical analysis of aluminium used for making strands – As per specification enclosed				
5.03.00	Conductor and Earthwire Accessories					
	a)	Chemical analysis of zinc used for galvanising : Samples taken from the zinc ingots shall be chemically analysed as per IS:209-1966				
	b)	Tests on Malleable Castings, Forgings and Fabricated Hardware. The Chemical analysis, mechanical and metallographic tests, inclusion rating and magnetic particle inspection for malleable castings, chemical analysis, hardness test, grain size and magnetic particle inspection for forgings and chemical analysis and mechanical tests for fabricated hardware will be based on heat number and heat treatment batch. The details regarding these tests will be as discussed and mutually agreed to by the Contractor and Owner in the quality assurance programme.				
5.04.00	Hardware Fittings (on all components as applicable)					
	a)	Chemical analysis of zinc used for galvanising – As per specification enclosed				
	b)	Chemical analysis, hardware tests, grain size, inclusion rating and magnetic particle inspection for forgings/castings				
	c)	Chemical analysis and proof load test for fabricated hardware - As per specification enclosed				
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Clause No.	TECHNICAL REQUIREMENTS			
5.05.00	Insulators (on all components as applicable)			
a)	Chemical analysis of zinc used for galvanising - As per specification enclosed			
b)	Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable/castings - As per specification enclosed			
c)	Chemical analysis hardness tests and magnetic particle inspection for forgings - As per specification enclosed			
d)	Hydraulic internal pressure tests on shell - As per specification enclosed			
e)	Verification of dimensions – As per IS:731-1971			
6.00.00	TESTING EXPENSES			
6.01.00	Bidder shall indicate the schedule for all type tests if required to be conducted under this contract as per clause 2.00.00. Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that the tests can be completed within the time schedule guaranteed by them. The Contractor shall intimate the Owner about carrying out of the type tests alongwith detailed testing program at least 3 weeks in advance (in case of Indian Contractor and at least 6 weeks advance in case of foreign Contractor) of the schedule date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.			
6.02.00	The entire cost of testing for acceptance and routine tests and tests during manufacturer specified herein shall be treated as included in the quoted unit price of disc insulators except for the expenses of the Inspector/Owner's representative.			
7.00.00	SAMPLE BATCH FOR TYPE TESTING			
	The Contractor shall offer at least three times the quantity of material required for conducting all the type tests for sample selection. Before sample selection, the Contractor shall be required to conduct all the acceptance tests successfully in presented of Owner representative.			
8.00.00	ADDITIONAL TESTS			
8.01.00	Owner reserves the right of having at his own expensed any other tests of reasonable nature carried out at Contractor's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy that the material comply with the specifications.			
8.02.00	Owner also reserves the right to conduct all the tests mentioned in this specification at this own expense on the samples drawn from the site at Contractor's premises or at any other test center. In case of any failure, it shall be binding on the part of Contractor to replace that particular lot completely without any extra cost to the Owner.			
9.00.00	TESTS REPORTS			
9.01.00	Copies of type test reports shall be furnished in at least six (6) copies. One copy will be returned, duly certified by the Owner, only after which the commercial production of the concerned material will start.			
9.02.00	Copies of acceptance test reports shall be furnished in at least six (6) copies. One copy will be returned, duly certified by the Owner, only after which the material will be dispatched.			
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Clause No.	TECHNICAL REQUIREMENTS			
9.03.00	Records of routine test reports shall be maintained by the Contractor at his works for periodic inspection by the Owner's representative.			
9.04.00	Test certificates of tests during manufacture as maintained by the Contractor, shall be produced for verification as and when desired by the Owner.			
10.00.00	INSPECTION			
10.01.00	The Owner's representative(s) shall at all times be entitled to have access to works and all places of manufacture, where materials and their components are being manufactured. The representatives shall have full facilities for unrestricted inspection of the Contractor's works, raw materials, manufacture of the material/item for conducting necessary tests as detailed herein.			
10.02.00	The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material / items in their various stages so that arrangement could be made for inspection.			
10.03.00	No material/ item shall be dispatched from its point of manufacturer before it has been satisfactorily inspected and tested, unless the inspection is waived off by the Owner in writing. In the latter case also, the material/items shall be dispatched only after satisfactory testing for all tests specified herein have been completed.			
10.04.00	The acceptance of any quantity of material /item shall in no way relieve the Contractor of his responsibility of meeting all the requirement of the specification, and shall not prevent subsequent rejection if such material / items are later found to be defective.			
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Clause No.	TECHNICAL REQUIREMENTS			
	ANNEXURE - A			
	NORMS AND PROCEDURES OF TESTS			
1.00.00	TESTS ON EARTHWIRE			
1.01.00	UTS Test			
	Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5 m length suitably places compressed with dead end clamps at both ends. The load shall be increased at a steady rate upto 50 % of UTS and held for one minute. The circles drawing shall not be distorted due to relative movement of strands. These after the load shall be increased at a steady rate to 100 % of UTS and held for one minute. The earthwire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and value recorded.			
1.02.00	DC Resistance Test			
	On an earthwire Sample of minimum 5 m length two contact clamps shall be fixed. The resistance shall be measured by a Kelvin double - bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to 20 ° C. The resistance corrected to 20 ° C shall confirm to the requirement of this specification.			
1.03.00	Visual Check for joints			
	One drum from each lot shall be rewound in the presence of the inspector. The inspector shall visually check for scratches etc. and see that the earthwire generally conforms to the requirements of this specification.			
1.04.00	Torsion Test			
	The number of twists which a single steel strand shall withstand during torsion test shall be at least eighteen for a length of 100 time the standard dia of that strand.			
1.05.00	Visual check on Drums			
	The drums shall be visually checked to ensure that they conform to his specification.			
1.06.00	Dimensional Check			
	The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.			
1.07.00	Lay length Check			
	The lay length shall be checked to ensure that they conform to the requirements of this specification.			
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Clause No.	TECHNICAL REQUIREMENTS			
1.08.00	Galvanising Test The test procedure shall be as specified in IS:4826-1968. The material shall conform to the requirements of this specification.			
1.09.00	Chemical Analysis of Zinc used for Galvanising Samples taken from zinc ingots shall be chemically / spectrographically analysed. The same shall be in conformity to the relevant standards.			
1.10.00	Chemical Analysis of Steel Sample taken from the steel ingots/coils/strands shall be chemically / spectrographically analysed. The same shall be in conformity to the relevant standards.			
2.00.00	TESTS ON CONDUCTOR			
2.01.00	UTS Test On Stranded Conductor Circles perpendicular to the axis of the conductor shall be marked at two places on a sample conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 50% of rated UTS and held for one minute. The circles drawing shall not be distorted due to the relative movement of strands. Thereafter the load shall be increased at a steady rate to 100% of the rated UTS for one minute. The conductor sample shall not fail during this period the applied load shall then be increased until the failing load is reached and the value recorded.			
2.02.00	DC Resistance Test On Stranded Conductor On a conductor sample of minimum 5 m length two contact clamps shall be fixed. The resistance shall be measured by a Kevin double bridge by placing the clamps initially zero meter and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 deg.C as per IS:398 (Part-IV)-1979. The resistance corrected at 20 deg. C shall conform to the requirements of this specification.			
2.03.00	Chemical Analysis Of Aluminum Samples taken from the heat treated batch/coils/strands, shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.			
2.04.00	Visual And Dimensional Check On Drums The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification.			
2.05.00	Visual Check For Joints, Scratches, etc.			
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Clause No.	TECHNICAL REQUIREMENTS				
	Conductor drums shall be rewound in the presence of the inspector. The inspector shall visual check for scratches, joints etc. and that the conductor generally conform to the requirements of this specification.				
2.06.00	Dimensional Check On Aluminium Strands The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this specification.				
2.07.00	Check For Lay-Rations Of Various Layers The lay-rations of various layers shall be checked to ensure that they conform to the requirements of this specification.				
2.08.00	Elongations Test The test procedure shall be as specified in IS-398 (Part-IV)-1979. The material shall conform to the requirements of this specification.				
2.09.00	Breaking Load Test On Welded Aluminium Strand The aluminium wires shall be welded and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual strand guaranteed by the bidder.				
3.00.00	CONDUCTOR AND EARTHWIRE ACCESSORIES				
3.01.00	Mid Span Compression Joint for Conductor and Earthwire				
3.01.01	Slip Strength Test The minimum free length between grips and the tests sample shall be three meters for conductor joint and one meter for earthwire joint. The test shall be carried out as per IS:2121-(Part-II) 1981 clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/ earthwire and retained for one minute at this load. There shall be no movement of the conductor/earthwire relative to the fittings during this one minute period and not failure of the fittings.				
3.01.02	Hardness Test The Brineel hardness at various points on the earthwire compression joint and tension clamp shall be measured.				
3.02.00	Flexible Copper Bond Slip Strength Test				
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Clause No.	TECHNICAL REQUIREMENTS				
	On applying a load of 3 KN (300kg) between the two ends, stranded flexible copper cable shall not come out damaged. After the test, the lugs shall be cut open to ascertain that the gripping of cable has not been affected.				
3.03.00	Vibration Damper for Conductor and Earthwire				
3.03.01	Dynamic Characteristics Tests				
a)	The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for frequencies ranging from 5 Hz to 40 Hz conductor and 10 to 60 Hz for earthwire.				
b)	The damper assembly shall be vibrated vertically with double amplitude of 1 mm at different frequencies to determine the following characteristics with the help of suitable record instruments:				
	i) Reactance Vs frequency.				
	ii) Phase angle Vs frequency.				
	iii) Power dissipation Vs frequency.				
c)	The above characteristics shall be determined by averaging the characteristics of the damper by carrying out this test three times on a single damper. This test shall be carried out on atleast five nos, of damper. The mean reactance and phase angle curves shall be drawn with the criteria of best fit method.				
d)	The reactance Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the aeolian vibration frequency band between the lower and upper dangerous frequency limits determined by the vibration analysis of conductor without dampers. The mean damper force response Vs frequency curve shall show a trend compatible with optimum force of the conductor acting on the sinusoidal half wavelength at unit displacement of antinode and it shall lie within the envelope of F1 and F2.				
	Where $F1 = 2 f_i$ and $F2 = 0.5 f_i$ for vibration damper for conductor / earthwire				
	Where $f_i = \frac{1}{2} \times 2 \pi f \sqrt{\frac{T}{M}}$ T = tension of conductor M = mass of conductor				
e)	F1 and F2 are forces in kg/mm and 'f' is the frequency in hertz. Similarly for mean phase angle Vs frequency curve the phase angles shall lie between 25 deg. and 135 deg. within the frequency range of interest.				
3.03.02	Vibration Analysis				
	The vibration analysis of the conductor/earthwire shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach, the following parameters shall be taken into account for the propose of analysis:				
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Clause No.	TECHNICAL REQUIREMENTS				
	a) The analysis shall be done for single conductor / earthwire without armour rods as per the parameters given at relevant clauses of this specification. The tension shall be taken as 43 KN and 14 KN for conductor and earthwire respectively for a span ranging from 50 m to 600 m. b) The self damping factor and flexural stiffness (E1) for conductor shall be calculated on the basis of experimental results. The details of experimental analysis with the data should be furnished. c) The power dissipation curve obtained from dynamic characteristic. Test shall be used for analysis with damper. d) Examine the Aeolian vibration level of the conductor with and without vibration damper installed at the recommended location for wind velocity ranging from 0 to 30 Km. Per hour. Predicting amplitude, frequency and vibration energy input. e) From vibrations analysis of conductor / earthwire without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between the Aeolian vibration level exceeding the specified limits shall be determined. f) From vibrations analysis of conductor / earthwire without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between the Aeolian vibration level exceeding the specified limits shall be determined. g) The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.				
3.03.03	Clamp Slip and Fatigue Tests				
	a) Test Set Up The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum span length of 30 m. The conductor / earthwire shall be tensioned at 43 KN/ 14 KN and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor/earthwire has been tensioned, a clamp shall be installed to support the conductor/ earthwire at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor/ earthwire. There shall be no loose parts, such as suspension clamps, U bolts etc. on the test span supported between clamps mentioned above. The Span shall be equipped with vibrations inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and the amplitude of vibration at any point along the span.				
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Clause No.	TECHNICAL REQUIREMENTS			
b)	Clamp Slip Test The vibration damper shall be installed on the test span. The damper clamp, after tightening with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 KN paralleled to the axis of conductor/ earthwire for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor/ earthwire and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 KN.			
c)	Fatigue Test The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement. The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of the damper clamp be maintained not less than $\pm 25 / f$ mm, where f is the frequency in Hz. The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test if resonance shift is observed the test frequency shall be tuned to the new resonant frequency. The clamp slip test as mentioned here in above shall be repeated after fatigue test without retorquing or adjusting the damper clamp and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute. After the above tests, the damper shall be removed from conductor/ earthwire and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristic of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The conductor/ earthwire under clamp shall be also be free from any damage. For the purpose of acceptance, the following criteria shall be applied: i) There shall not be any frequency shift by more than ± 2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz. ii) The percentage variation in reactance curve after fatigue test shall lie within the limit which is to be guaranteed by the manufacturer. iii) The reduction in power dissipation characteristic after the fatigue test shall not be more than the value guaranteed by the manufacturer. However, in no case the minimum power dissipation shall be less than governed by the lower limits of the reactance and phase angle curves as indicated in clause 3 (a) above. iv) The deterioration of characteristics in respect of reactance and power dissipation shall be compared with respect to guaranteed value.			
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Clause No.	TECHNICAL REQUIREMENTS			
3.03.04	Verification of Resonance Frequencies			
	The damper shall be mounted on a shaker table and vibrated at damper clamp amplitude of +/- 0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum amplitude on itself. The resonance frequency thus identified shall be compared with the guaranteed value.			
3.03.05	Clamp Bolt Torque Test			
	The clamp shall be attached to section of the conductor / earthwire. A torque of 150% of the manufacturers specified torque shall be applied to the bolt. There shall be no failure of component parts.			
3.03.06	Strength of the Messenger Cable			
	The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point in reached. The load shall not be less than the value guaranteed by the Bidder.			
3.03.07	Mass Pull Off Test			
	Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out off the messenger cable. The pull off loads shall not be less than the value guaranteed by the Bidder (min 500 kg.)			
3.04.00	Earthwire Suspension / Tension Clamp			
3.04.01	Mechanical Strength test			
	The suspension assembly / tension assembly (excluding tension clamp) shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and ten removed. After removal of the load, the components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to loosen the nuts initially. The components shall not show any visual deformation and it shall be possible to dis-assemble them by hand. Hand tools may be used to loosen the nuts initially. The assembly shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.			
3.04.02	Clamp Slip Strength Vs Torque Test for Suspension assembly.			
	The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of the G. S. Earthwire shall be fixed in the clamp. The clamp slip strength at various tightening			
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Clause No.	TECHNICAL REQUIREMENTS				
3.04.03	torque shall be obtained by gradually applying the load at one end of the earthwire. The clamp slip strength Vs torques curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be more than 12 KN but less than 17 KN. Slip Strength Test of Tension Clamp Tension clamps shall be compressed on a 5 m length of earthwire on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load of 50% of the specified braking load of the earthwire shall be applied and the sample shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95% of the specified breaking load and maintained for one minute. There shall be no movement of the earthwire relative to the fitting during this one minute period and no failure of the fitting also.				
3.04.04	Resistance Test of Tension Clamp. The tension clamp and the jumper shall be compressed on two suitable lengths of earthwire. The electrical resistance shall be measured between points on earthwire near the clamp and near the jumper mouth keeping 25 mm clearance of the fitting and should not exceed 75% of the measured resistance of equivalent length of earthwire. The test shall be conducted with direct current. The current connections shall be at a distance not less than 50 times the diameter of earthwire from the fitting and shall be made so that effective contact is ensured with all those strands of the earthwire which would be taken into account in calculating its equivalent resistance. The test shall be repeated with the polarity reversed and the average of the two results considered assembly the measured value.				
3.04.05	Hardness test. The Brineel hardness at various points on the steel portion of tension clamp shall be measured.				
3.04.06	Magnetic Power Loss Test The sample shall be tested in a manner to simulate service conditions. A 50 Hz alternating current over the range of 400 Amps to 900 Amps shall be passed and the Wattmeter readings of the power loss with an without damper or sample for the different values of current shall be tabulated and plotted on a graph. The difference in the power loss with and without damper shall be limited to 1 watt for 600 Amps (rms). The losses shall be determined by averaging the figures obtained from at least four samples of vibration dampers.				
3.04.07	Chemical Analysis Test for each components Chemical analysis of the material used for the manufacturer of items shall be conducted to check conformity of the same with technical specification and approved drawings.				
3.05.00	Spacer for line & Rigid spacer				
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Clause No.	TECHNICAL REQUIREMENTS				
3.05.01	Clamp slip Test				
	The spacer assembly shall be installed on test span of twin ACSR 'MOOSE' conductor bundle string at a tension of 43 kN. In case of spacer for jumper, the clamp of sample shall be tightened with a specified tightening torque. One of the clamp of sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of conductor for a minimum duration of one minute shall not slip on the conductor i.e. the permanent displacement between the conductor and the clamp of sample measured after removal of the load, shall not exceed 1.0 mm. Similar test shall be performed on the other clamp of the same sample. Such clamp slip tests shall also be conducted after each of the vibration test mentioned in clause 3.03.02 (a). Each clamp shall withstand a minimum longitudinal load of 2 kN for a minimum duration of one minute after the vibration test without any adjustment of sample.				
3.05.02	Vibration tests				
	The test set up shall be as per Clause 3.03.03 of Annexure – A. The spacer assembly shall be clamped to conductor. During the vibration tests the axis of the clamp of sample be maintained parallel to its initial static position by applying a tension of 43 kN on the ACSR 'MOOSE' conductor. The spacer assembly shall be free to vibrate and shall not be retorqued or adjusted between the tests. All the vibration tests mentioned hereunder shall be conducted on the same sample on same test span. The samples shall withstand the vibration tests without slipping on the conductor, loosening, damage or failure of component parts. After each vibration test, clamp slip test shall be carried out as per the procedure given in clause 3.05.01.				
i)	Longitudinal Vibration Test.				
	The stationary conductor and the vibrating conductor/equivalent diameter of aluminum alloy tube shall be restrained by fixed clamps. The displacement of the vibrating conductor shall be 25 mm minimum on either side. The longitudinal movement shall be parallel to the conductor at frequency not less than 2 Hz for minimum one million cycles.				
ii)	Vertical vibration Test				
	The spacer/spacer damper shall be installed in middle of the test span and the frequency chosen so as to get an odd number of loops. The shaker shall be positioned at least two loops away from the test specimen to allow free movement of the conductor close to the test specimen. One conductor shall be connected to the shaker and vibrated to an amplitude such that $F^{1.8} Y_{max} > 1000 \text{ mm/sec.}$ Where Y_{max} being the antinode displacement (mm) and f is the test frequency (Hz). The test frequency shall be greater than 24 Hz and the total number of cycles shall be more than 10 millions.				
iii)	Sub-span Oscillation Test				
	The test shall be conducted for oscillation in horizontal plane at frequency higher than 3 Hz for minimum one million cycles. The amplitude for oscillation shall be kept equipment to an amplitude of				
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3.05.03	150 mm for a full sub-span of 80m. Both the conductor shall be vibrated 180 deg. out of phase with the above minimum amplitude. Ozone Test for Elastomer This test shall be performed in accordance with astm d-1171 by ozone chamber exposure method (method b). The test duration shall be 500 hours and the ozone concentration 50 pphm. At the test completion, there shall be no visible crack under a 2x magnification.				
3.05.04	Compressive and Tensile Test The spacer assembly shall withstand ultimate compressive load of 15 kN and tensile load of 7.5 kN applied between sub conductor bundle and held for one minute without failure. Line distance between clamps shall be recorded during each of the compression and tension test. Measurement shall be recorded at (i) no load (ii) with load (iii) after release of load. The center line distance under load shall be within ± 100 mm of the nominal design spacing. After release of load it shall be possible to retain the clamps at their original position using only slight hand pressure. There shall be no deformation of damage to the spacer assembly which would impair its function of maintaining the nominal spacing.				
4.00.00	HARDWARE FITTINGS AND INSULATORS				
4.01.00	Voltage Distribution Test The voltage across each insulator Unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The Voltage across any disc should not exceed 10 % of the total voltage applied on the string, in case of tension string and 9% in case of suspension string.				
4.02.00	Mechanical Strength Test for Complete String The complete insulator string alongwith its hardware fittings excluding arcing horn, and suspension assembly /dead end assembly shall be subjected to a load equal to 50% of the specified Minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the string component shall not show any visual deformation and it shall be possible to disassemble term by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS in reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load in reached and the value recorded.				
4.03.00	Vibration test The suspension string shall be tested in suspension mode and tension string in tension mode and tension string in tension mode itself in a laboratory span of minimum 30 meters. In the case of suspension string a tension more than 600 Kg shall be applied with the help of turn buckle. The insulator string alongwith help of turn buckle. The insulator string alongwith hardware fittings shall be strung at a tension of 86 KN and shall be secured with clamps. Vibration dampers shall not be used. The conductor shall be vibrated at the resonant frequency (f) of the insulator string (more than 10 Hz)				
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	corresponding to two or more loops on the insulator string by the means of vibration inducing equipment. The peak displacement in 'mm' at the antinode point nearest to the string shall be measured and the same shall not be less than 900/ (f** 1.8), mm depending upon 'f' selected. The insulator string shall withstand a minimum of 10 million cycles. After the test is over, the disc insulator shall be examined for looseness of pins and cap or any crack in the cement. The hardware fittings shall be examined for fatigue failure, slip strength and mechanical strength test. The slip strength of suspension assembly shall be carried out without any adjustment/removal. The disc insulators shall be further subjected to the following acceptance tests assembly per relevant standards				
	a) Temperature cycle test followed by mechanical performance test assembly per IEC:575 Clause 4.0 : 60% discs of be tested b) Puncture test : 40% discs of be tested				
4.04.00	Chemical analysis of zinc used for galvanising Samples taken from the zinc ingot shall be chemically analysed assembly per IS:209-1979. The purity shall not be less than 99.95% and 99.7% for zinc used for galvanising and sleeve respectively.				
4.05.00	Test for forgings The chemical analysis hardness tests and magnetic particle inspection for forgings, will be conducted as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the contractor and Owner.				
4.06.00	Tests on castings The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the contractor and Owner.				
4.07.00	Hydraulic internal pressure tests on shells The test shall be carried out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the contractor and Owner.				
4.08.00	Thermal mechanical performance test The thermal mechanical performance test shall be performed in accordance with IEC-575, clause 3, with the following modifications: The applied mechanical load during this test shall be 70% of the rated electro-mechanical of mechanical value. The acceptance criteria shall be : a) $X > R + 3S$ where X = Mean value of the individual electro-mechanical/				
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	mechanical failing load. R = Rated Electro-mechanical / mechanical failing load. S = Standard deviation. b) The minimum sample size shall be taken as 10. c) The individual electro-mechanical/ mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.			
4.09.00	Eccentricity Test : The insulator shall be vertically on a fixture using dummy pin and socket. A vertical scale with horizontal slider shall be used for the axial run out. The pointer shall be positioned in contract with the bottom of the outermost petticoat of the disc. The disc insulators shall be rotated with reference to the fixture and the slider shall be allowed to more up and down on the scale but always maintaining contact with bottom of the outermost petticoat. After one full rotation of the disc, the maximum and minimum position the slider has reached can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out. Similarly using a horizontal scale with a vertical slider the radial run out shall be measured. The slider shall be positioned in the scale so as to establish contact with the circumference of the insulator and disc insulator rotated on it's fixture always maintaining contact. After one full rotation the maximum and minimum position the slider has reached on the scale are found out. The difference between the above readings shall satisfy the guaranteed particulars for radial run out.			
4.10.00	Magnetic power Loss Test for Suspension Assembly Same as clause 3.04.06 above			
4.11.00	Clamp slip strength Vs Torque Test and clamp slip for AG Suspension Clamp / envelope type suspension clamp. The suspension clamp shall be vertically suspended by means of a flexible attachment. A suitable length of ACSR 'MOOSE' conductor shall be fixed in the clamp. The clamp slip strength at various tightening torque shall be obtained by gradually applying the load at one end of the conductor. The clamp slip strength vs torque curve shall be drawn. The above procedure is applicable only for free centre type suspension clamp. For AG suspension clamp only clamp slip strength after assembly shall be found out. The clamp slip strength at the recommended tightening torque shall be more than 11 KN but less than 16 KN.			
4.12.00	Galvanising / Electroplating Test The test shall be carried out as per clause no. 5.9 of IS:2496 (Part-I) - 1971 except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.			
4.13.00	Mechanical Strength Test for welded Joints			
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	The welded portion of the component shall be subjected to a load of 2000 kgs for one minute. Thereafter, it shall be subjected to dei penetration/Ultrasonic test. There shall not be any crack at the welded portion.				
4.14.00	Mechanical strength test of each component Each Component shall be subjected to a its 50 % Minimum UTS load which shall be increased at a steady rate to 67 % of min. UTS. The load shall be held for 5 minute and then removed. The component shall then be again be loaded to 50 % of UTS and then load shall be increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The load shall then be increased until the failing load is reached and the value recorded.				
4.15.00	Test For Forging, Casting and Fabricated Hardware The Chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, casting and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognised procedure for these tests The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as in the quality Assurance programme.				
5.00.00	Corona Extinction Voltage Test (Dry) The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV rms line to ground under dry condition for 400 kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731.				
6.00.00	Radio Interference Voltage Test (Dry) Under the conditions as specified under (5.00.00) above, the sample shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV rms line to ground for 400 kV under dry condition. The test procedure shall be in accordance with IS:8263.				
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PART- III

33kV TRANSMISSION LINES

PART- III

TECHNICAL SPECIFICATION

CHAPTER – T0

TRANSMISSION LINES – GENERAL

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TRANSMISSION LINES - GENERAL

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	CHAPTER – T0 : TRANSMISSION GENERAL
1.00.00	SCOPE AND GENERAL INFORMATION
	In addition to the project information and scope of work given in Part-I General Section of this specification, the following is the scope of work for overhead Transmission line work:
1.01.00	This Specification covers detailed survey, tower spotting/optimization of tower location, soil resistivity measurements and geo-technical investigation tower design, testing, fabrication and supply of all type of 33 kV S/C transmission line towers and gantries including bolts, nuts and washers, hanger, D-shackle and all type of tower accessories like phase plate, number plate, danger plate, anti-climbing device etc. Design, selecting type of foundation for different towers and gantries and casting of foundation for tower footing. Erection of towers tack welding of bolts and nuts including supply and application of zinc rich paint, tower earthing, fixing of insulator string, stringing of conductors and earthwires alongwith all necessary line accessories and testing and commissioning of the erected transmission lines.
1.02.00	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.
1.03.00	All the raw materials such as steel, zinc for galvanising reinforcement steel and cement for tower foundation, coke and salt for tower earthing Bird Guards, Anti Climbing devices etc. Bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plate, number plate etc. Required for tower manufacturer and erection shall be included in the bidder's scope of supply. Bidders shall clearly indicate in their offer, the sources from where they propose to procure the raw materials and the components.
1.04.00	The entire stringing work of conductor and earthwire shall be carried out standard stringing practice. The bidder shall indicate in the offer, the detail description of the procedure to be deployed for stringing operation.
1.05.00	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 may be required in obtaining these maps from Survey of India.
1.06.00	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.
2.00.00	ROUTE AND TERRAIN
2.01.00	To evaluate and tabulate the trees and bushes coming within 17.5 meters on either side of the central line alignment. The trees will be numbered and marked with quality paint serially from angle point 1 (I) onwards and the corresponding number will be painted

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	on the stem of trees at a height of 1 meter from ground level. The trees list should contain the following: - Girth (circumference) measured at a height of 1 meter from ground level. - Approximate height of the tree with an accuracy of ± 2 meters. - Name of the type of the species/tree. - 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.
3.00.00	DETAILED SURVEY
3.01.00	The detailed survey shall be carried out along the approved alignment.
3.02.00	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 wire should be fixed on the top of these pages to show the location of instrument. The pegs shall be driven firmly into the ground to project 1000 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.
3.03.00	Profile Plotting & Tower Spotting From the field book entries the route plan with route details and level profile shall be plotted and prepared to scale of 1:2000 horizontal & 1:200 vertical on 1.0 10 mm squared paper as well as per approved procedure. Reference levels at ever 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 10 mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be 594 mm wide in accordance with the IS Standard. For ‘as built’ profile these shall be A1 size.
3.04.00	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 the Owner for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile.

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3.05.00	Tower Spotting With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:
3.05.01	Span The number of consecutive spans between the section points shall not exceed 15 A Section point shall comprise of tension point with B/DB type or C/DC type towers as applicable. In no case the crossing span between two towers shall exceed 150 M.
3.05.02	Extension An individual span shall be as near to the normal design span as well 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.
3.05.03	Loading There shall not be any upward force on suspension towers under normal working conditions and the suspension towers shall support at least the minimum weight span as provided in the design. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the towers failing which tension towers designed for the purpose shall be employed at such positions.
3.05.04	Road Crossing At all important road crossings, the towers shall be fitted with normal suspension or 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 will not be less than meters. At all national highways tensions towers shall be used.
3.05.05	Railways Crossings All the railway crossings coming enroute the transmission line have already been identified by the Owner. At the time of detailed survey, the railway crossings 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): - The crossing shall be supported on 'C' type tower on either side of and double tension insulator string shall be used on both the towers on the side of the crossing. - The crossing shall normally be at right angle to the railway track. - The crossing span shall be limited to or 80% of design span. - The minimum distance of the crossing tower shall be at least equal to the height of the

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	tower plus 6 meters away measured from the centre of the nearest railway track. e) No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area. f) Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained as per IE rules. The approval for crossing railway track shall be obtained by the Owner from the Railway Authority, however six copies of profile and plan, tower and foundation design and drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.
3.05.06	River Crossings 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 'CONTROL' 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) as given in the annexed documents.
3.05.07	Power Line Crossing Where this line is to cross over another line of the same voltage or lower voltage. DA/DC type tower with suitable extensions 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.
3.05.08	Telecommunication Line Crossing 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.
3.05.09	Details Enroute All topographical details, permanent features, such as well as trees, building etc. 75 m on either side of the alignment shall be detailed on the profile plan.
3.05.10	Existing Pipe Lines. Adequate clearances shall be maintained form existing pipe lines and adjacent road etc..
3.06.00	Clearance from Ground, Building, Trees, etc. Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as well as amended upto date.

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4.00.00	PRELIMINARY LINE SCHEDULE The profile sheets, duly spotted, alongwith preliminary schedules indicating type of towers, type of foundations, 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 one set of reproducible of final profile drawings to the Owner for record purpose.
5.00.00	CHECK SURVEY OF TOWER LOCATIONS
5.01.00	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 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.
5.02.00	Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details.

PART- III

TECHNICAL SPECIFICATION CHAPTER – T1

TRANSMISSION LINES TOWERS

PART- III

TECHNICAL SPECIFICATION CHAPTER – T1

TRANSMISSION LINES TOWERS

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2.00.00	Spans and Clearances	T1-1
3.00.00	Loading Conditions	T1-3
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8.00.00	Inspection and Tests	T1-11
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	CHAPTER – T1 : TRANSMISSION LINE TOWERS																		
1.00.00	GENERAL DESCRIPTION OF TOWERS																		
1.01.00	The double circuit towers are self supporting lattice steel type and square, designed to carry the line conductors with necessary insulators, earthwires and all fittings under all loading conditions. The tower shall be fully galvanised structure. The types and grade of steel shall conform to latest applicable standards. However, the Bidders are permitted to opt for not more than two grades of steel.																		
1.02.00	Types of Towers <table><tr><td><u>Type of Tower</u></td><td><u>Deviation Limit</u></td><td><u>Typical Use</u></td></tr><tr><td>A</td><td>0 deg. – 2 deg.</td><td>To be used as tangent tower</td></tr><tr><td>B</td><td>0 deg. – 30 deg.</td><td>a) Angle towers with tension insulator string b) Also to be designed for anti-cascading condition.</td></tr><tr><td>B</td><td>0 deg.</td><td>To be used as section tower</td></tr><tr><td>C</td><td>30 deg. – 60 deg.</td><td>a) Angle towers with tension insulator string b) Dead end with 0 deg. to 15 deg. deviation both on line and substation side (slack span)</td></tr><tr><td>C</td><td>0 deg.</td><td>a) Complete dead end d) For crossing/anchoring with longer wind span with 0 deg. deviation on crossing span side and 0 deg. to 30 deg. deviation on other sides.</td></tr></table> Note: The above towers can be used for longer span with smaller angle of deviations.	<u>Type of Tower</u>	<u>Deviation Limit</u>	<u>Typical Use</u>	A	0 deg. – 2 deg.	To be used as tangent tower	B	0 deg. – 30 deg.	a) Angle towers with tension insulator string b) Also to be designed for anti-cascading condition.	B	0 deg.	To be used as section tower	C	30 deg. – 60 deg.	a) Angle towers with tension insulator string b) Dead end with 0 deg. to 15 deg. deviation both on line and substation side (slack span)	C	0 deg.	a) Complete dead end d) For crossing/anchoring with longer wind span with 0 deg. deviation on crossing span side and 0 deg. to 30 deg. deviation on other sides.
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C	30 deg. – 60 deg.	a) Angle towers with tension insulator string b) Dead end with 0 deg. to 15 deg. deviation both on line and substation side (slack span)																	
C	0 deg.	a) Complete dead end d) For crossing/anchoring with longer wind span with 0 deg. deviation on crossing span side and 0 deg. to 30 deg. deviation on other sides.																	
1.03.00	Extensions The single circuit towers shall be designed so as to be suitable for adding 3m, 6m, 9m and 12m body extensions for maintaining adequate ground clearance without reducing the specified factor of safety in any manner. All above extension provisions to normal tower shall be treated as part of normal tower body.																		
2.00.00	SPANS AND CLEARANCES																		
2.01.00	Normal Span The normal ruling span of the line shall be 150 meters.																		

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2.02.00	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 span.																					
2.03.00	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.																					
		<table> <tr> <th rowspan="2">Tower type</th><th colspan="2">Normal Condition</th><th colspan="2">Broken Wire Condition</th></tr> <tr> <th>Max. (m)</th><th>Min. (m)</th><th>Max. (m)</th><th>Min. (m)</th></tr> <tr> <td>A</td><td>225</td><td>120</td><td>135</td><td>72</td></tr> <tr> <td>B & C</td><td>225</td><td>160</td><td>135</td><td>-160</td></tr> </table>			Tower type	Normal Condition		Broken Wire Condition		Max. (m)	Min. (m)	Max. (m)	Min. (m)	A	225	120	135	72	B & C	225	160	135	-160
Tower type	Normal Condition		Broken Wire Condition																				
	Max. (m)	Min. (m)	Max. (m)	Min. (m)																			
A	225	120	135	72																			
B & C	225	160	135	-160																			
2.04.00	Electrical Clearance																						
2.04.01	Ground clearance	The minimum ground clearance from the bottom conductor shall not be less than 5.2 meters 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.																					
2.04.02	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. However, as per present regulations (revised in 1987) the minimum clearance is stipulated as 14.1 meters.																					
2.04.03	Power Line Crossing	a) Minimum clearance between power line to power line crossing should be 4580 mm for 220 kV and 6300mm for 400 kV lines. b) For power line crossing, suitable gantries/Rail Pole structures may be used.																					
2.04.04	Live Metal Clearance	The minimum live metal clearance to the provided between the live parts and steel work of super-structure shall conform to IS-5613 (Part-2/Sec-1) - 1985.																					

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	<u>Type of Insulator String</u>	<u>Swing in Degrees</u>	<u>Min. Clearance (mm)</u>
a)	Pin Insulator	NIL	330
b)	Tension string (Single/Double)	NIL	330
c)	Jumper	10°	330
		20°	330
		30°	330
d)	Single suspension string	Nil	330
		15°	330
		30°	330
		45°	330
		60°	330
e)	Double suspension string	30°	330
2.04.05	Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for 'C' type tower to be used as dead end and angle tower.		
2.04.06	The design of the tower shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings.		
2.04.07	Angle of Shielding 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 30 deg for double circuit 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.		
2.04.08	Mid Span Clearance The minimum vertical mid span clearance between the earthwire and the nearest power conductor shall not be less than 1.5 meters, 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.		
3.00.00	LOADING CONDITIONS		
3.01.00	Loads at Conductor And Earthwire Points Owner has calculated the ultimate external loadings at conductor and earthwire points and enclosed alongwith the Specification. The Contractor shall develop the tower designs considering loadings given by the Owner. These loads have been computed based on IS 802/Part - I, 1996 and towers are to be designed to cater for the following		

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	loads: a) Reliability Loads (Normal condition) b) Security Loads (Broken wire condition) c) Safety Loads (Construction & Maintenance loads)
3.02.00	Wind Loads on Tower Body The wind load on tower body shall be calculated by the Contractor as per IS: 802, Part-I, 1996.
3.03.00	Maximum Tension Maximum tension shall be based on either of the following (whichever is more stringent): a) at 0 deg C with 36% full wind pressure., or b) at 32 deg C with full wind pressure
3.04.00	Sag tension calculation for design purpose shall be calculated considering normal span of 200 meter.
3.05.00	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.
3.06.00	Limiting Tensions of conductor & Earthwire The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths.
3.07.00	Broken Wire condition(Security Condition) All tower under this condition shall be designed for maximum wind condition
3.07.01	Suspension Tower Type A Any one phase or earthwire broken: whichever is more stringent for a particular member. The design longitudinal load under this conditions shall be 100% of maximum tension for earthwire and 50% of maximum tension for conductors.
3.07.02	Tension Tower Type B Any two phases broken on the same side and same span or any one phase and ground wire broken : whichever is more stringent for a particular member.
3.07.03	Tension tower type C Any three phases broken on the same side and same span or groundwire and any two phases on the same span and same side broken whichever is more stringent for a particular member.

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4.00.00	DESIGN OF TOWERS		
4.01.00	Design Criteria		
	Towers shall be designed based on spans and clearances, and loading conditions as detailed above.		
4.02.00	Design Temperatures		
	The following temperature range for the conductors and ground wires shall be adopted for line design:		
	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
4.03.00	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.).		
4.04.00	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. However, design approval for such substitution shall be obtained from the Owner before any substitution.		
4.05.00	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	
4.06.00	Bolts & Nuts		
4.06.01	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

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4.06.02	Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30mm.
4.06.03	For the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-1973 may be referred.
4.07.00	Slenderness Ratio
4.07.01	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.
4.07.02	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 375
4.08.00	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.
4.09.00	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.
5.00.00	TOWER MATERIALS
5.01.00	Tower Steel Sections IS steel sections of tested quality in conformity with IS:226-1975 or IS:2062-1980 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.
5.02.00	Fasteners : Bolts, Nuts and Washers
5.02.01	All bolts and nuts shall conform to IS:6639-1972. 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.

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5.02.02	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) 1980.
5.02.03	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.
5.02.04	To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing, at a minimum temperature of 530 deg.C . The temperature should be recorded continuously in the form of a continuous chart. The galvanised coating should be uniform and its value should be between 50 micron to 115 micron to be checked on random sampling basis, on the threaded portion as well. The facility to check the galvanised coating should be by metallographic method.
5.02.05	Nuts should be double chamfered as per the requirement of IS:1363 Part-III, 1984. It should be ensured by the manufacturer that nuts should not be overtapped beyond 0.4 MM oversize on effective diameter for size upto M16.
5.02.06	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.
5.02.07	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.
5.02.08	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.
5.02.09	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.
5.02.10	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.
5.02.11	The bolt positions in assembled towers shall be as per IS:5613 (Part-II/Section-2)-1976.
5.02.12	Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.
5.03.00	Tower Accessories
5.03.01	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

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	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 as per the Owner approved design 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 crossarm tip and the groundwire support shall be fixed on tower by using Countersunk bolts.
5.03.02	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 conditionings 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.
5.03.03	Earthwire peaks/crossarms are to be suitably designed to accommodate the shackle of the suspension clamp/tension clamps.
5.03.04	Anti-climbing Device Barbed wire type anti-climbing device, as per enclosed drawing 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.
5.03.05	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. 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.
6.00.00	TOWER FABRICATION
6.01.00	Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) 1993 or the relevant international standards.

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6.02.00	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.
6.03.00	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.
6.04.00	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.
6.05.00	The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.
6.06.00	No angle member shall have the two leg flanges brought together by closing angle.
6.07.00	The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.
6.08.00	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.
6.09.00	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.
6.10.00	Drilling and Punching
6.10.01	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.
6.10.02	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. 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.

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6.10.03	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.
6.11.00	Erection mark
6.11.01	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.
6.11.02	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.
6.12.00	Quantities and Weights
6.12.01	The provisional quantities required are mentioned in the respective Schedule of Prices. Final quantities shall be determined after completion and approval of the detailed route survey. The final quantities of tower shall be confirmed by the Owner based on the requirement of quantities of various towers furnished by the Contractor after completion of detailed survey. Hence it will be responsibility of the Contractor to intimate the exact requirements of all towers and various line materials required for line immediately after the survey. The Owner reserves the right to order the final quantities (including spare towers) for which the rates quoted in the Bid shall be valid.
6.12.02	The Owner shall/may purchase few towers as spare which shall be supplied at the rate quoted in the bid.
6.12.03	The estimated 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.
6.13.00	Galvanising Fully galvanised towers and stub shall be used for the line. Galvanising of the member of the towers shall conform to IS:2629-1985 and IS:4759-1968. All galvanised shall conform to IS:5358-1969. The galvanising shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanising. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanised as per Grade 4 of IS:1573-1970.
7.00.00	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

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	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.
8.00.00	INSPECTION AND TESTS
8.01.00	All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.
8.02.00	Inspection In addition to the provisions contained in Vol. I of tenders documents, the following shall also apply:
8.02.01	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.
8.02.02	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.
8.02.03	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.
8.02.04	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.
8.02.05	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.
8.02.06	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.
8.02.07	All gauges and templates necessary to satisfy the Owner shall be supplied by the manufacturer.
8.02.08	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.
8.03.00	Tower Load Tests
8.03.01	Testing of Tower Galvanised tower of each type complete with 6M extension shall be subjected to design and destruction tests by first applying test loads applied in a manner approved by the

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	Owner. The tower shall withstand these tests without showing any sign of failure or permanent distortion in any part. Thereafter the tower shall be subjected to destruction by increasing the loads further in an approved manner till it fails. The tower shall be tested for all the conditions considered for the design of tower. The contractor shall submit to the Owner for approval, the detailed programme and proposal for testing the towers showing the methods of carrying out the tests and manner of applying the loads. After the Owner has approved the test procedures and programmes the Contractor will intimate the Owner about carrying out the tests at least 30 days in advance of the scheduled date of tests during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests. Six copies of the test reports shall be submitted.
8.03.02	The Contractor shall submit one set of shop drawings alongwith the bill of materials at the time of prototype tower testing for checking the tower material. Further, at the time of submitting test report, the Contractor has to submit the final tracings of shop drawings and Bill of materials for Owner's reference and record. The type testing charges shall be released only after approval of test report, shop drawings, bill of material and structural drawings of tower.
8.03.03	In case of premature failure the tower shall be re-tested and steel already used in the earlier test shall not be used again. However, in case of minor failures, the Contractor can replace the members with higher section and carry out the testing. The Contractor shall provide facilities to the Owner or their representatives for inspection of materials during manufacturing stage and also during testing of the same.
8.03.04	In case of any premature failure even during waiting period, the tower is to be re-tested with rectified members. However, if the failures are major in nature and considerable portion of tower is to be re-erected, in such cases all the tests which has been carried out earlier are required to be conducted again in compliance with Specification.
8.03.05	No part of any tower subject to test shall be allowed to be used on the line. The price will be quoted after allowing rebate for the scrap value of the tower material which shall be retained by the Contractor.
8.03.06	The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully undergone the tests. In case any deviation is detected, the 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.
8.03.07	Each type of tower to be tested shall be a full scale prototype galvanised tower and shall be erected vertically on rigid foundation of the stub protruding above ground level as provided in the design/drawing between ground level and concrete level. This portion of the stub shall be kept unbraced while testing. The tower erected on test bed shall not be out of plumb by more than 1 in 360.
8.03.08	All the measuring instruments shall be calibrated in systematic/approved manner with the help of standard weight/device. Calibration shall be done before commencing the test of each tower upto the maximum anticipated loads to be applied during testing.
8.03.09	The sequence of testing shall be decided by the Owner at the time of approving the

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	rigging chart/test data sheet.
8.03.10	The Owner may decide to carry out the tensile test, bend test etc. as per relevant IS on few members of the test tower after completion of the test or in case of any premature failure. The Contractor shall make suitable arrangement for the same without any extra cost of the Owner.
8.03.11	Prefix 'T' shall be marked on all members of test tower in addition to the mark number already provided.
8.04.00	Method of Load Application
8.04.01	Loads shall be applied according to the approved rigging arrangement through normal wire attachments angles on bent plates.
8.04.02	The various types of loads, transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the tower due to jerks from the winches.
8.04.03	All the loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of the strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided, the same will be measured by means of standard weights and accounted for in the test loads.
8.05.00	Tower Testing Procedure
	The procedure for conducting the tower test shall be as follows:
8.05.01	Bolt Slip Test
a)	In the bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition and held for two (2) minutes at that loads and then released gradually.
b)	The initial and final readings on the scales (for measurement of defection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of the bolt slip.
8.05.02	Normal/Broken Wire Load Tests
	All the loads, for a particular load-combination test shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner:
	25 percent
	50 percent
	75 percent
	90 percent
	95 percent
	100 percent
8.05.03	Observation Periods
a)	Under normal and broken wire load tests, the tower shall be kept under observation for sign of any failure for two minutes (excluding the time for adjustment of loads) for all

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	intermediate steps of loading upto and including 95 per cent of full design loads.
b)	For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads.
c)	While the loading operation are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.
d)	The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts.
e)	Ovalization of holes and permanent deformation of bolts shall not be considered as failure.
8.05.04	Recording The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking upto 5 mm accuracy.
8.05.05	Destruction Test a) The destruction test shall be carried out under normal condition or broken wire condition. The Owner at the time of approval of rigging chart/test data sheet shall intimate the contractor. Under which load condition the destruction test is to be carried out. b) 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.
9.00.00	PACKING
9.01.00	Angle section shall be wire bundled.
9.02.00	Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tested and bolted together in multiples or securely wired through holes.
9.03.00	Bolts, nuts, washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents.
9.04.00	The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.
10.00.00	DESIGN CALCULATION AND DRAWINGS
10.01.00	The following design calculation and drawings are required to be furnished alongwith

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	the bid.
	a) Computation of wind load b) Sag-tension calculation c) Tower loading d) Single line diagram of towers showing electrical clearances and steel sections. e) Sketches of foundation showing dimensions.
10.02.00	After the award the Contractor shall submit detailed design of tower & extension alongwith stress diagram/computer output together with sample calculations for few critical members etc.. stub templates and loading/rigging arrangement of tower testing to enable the Owner to make a preliminary check regarding structural stability of tower (before) tests.
10.03.00	After successful testing of tower and subsequent approval of design, drawing and bill of materials, the Contractor shall furnish the following in to the Owner. a) Detailed design calculation and drawing for towers and foundations. b) Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc. c) Bill of materials, indicating cutting and bending details against each member. d) Shop drawings showing all details relevant to fabrication. e) All the drawings for the tower accessories.

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PART- III

TECHNICAL SPECIFICATION CHAPTER – T2

TOWER FOUNDATIONS

PART- III

TECHNICAL SPECIFICATION CHAPTER – T2

TOWER FOUNDATIONS

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	CHAPTER – T2 : TOWER FOUNDATIONS
1.00.00	TYPES OF FOUNDATION
1.01.00	General
1.01.01	Cement concrete/Reinforced concrete footing shall be used for all type of normal tower in conformity with the present day practice followed in the country and the specifications laid herein. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift.
1.01.02	Foundation includes supply of materials such as cement, sand, coarse aggregates etc. and also reinforcement steel, if required. Rates quoted for foundations in appropriate schedules shall include all items of work related to supply and installation of foundations such as form work, excavation and backfilling, stub setting, providing reinforcement (if required) etc.
1.02.00	Classifications of Foundations The foundation designs shall depend upon the type of soil, sub-soil water level and the presence of surface water which have been classified as follows:
1.02.01	Normal Dry To be used for locations where normal dry cohesive or non-cohesive soils are met.
1.02.02	Wet To be used for locations: a) Where sub-soil water is met at 1.5 meters or more below the ground level. b) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.
1.02.03	Partially submerged To be used at locations where sub-soil water table is met between 0.75 meter below the ground level.
1.02.04	Fully submerged To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.
1.02.05	Black Cotton Soil (Wet) To be used at locations where soil is clayey type, not necessarily black in colour which shrinks when dry and swells when wet, resulting in differential movement extending to a maximum depth of about 3.5 meters below ground level. For designing foundations, for such locations, the soil is to be considered sub-merged in nature.

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1.02.06	Fissured Rock
a)	To be used at locations where decomposed or fissured rock, hard gravel kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.
b)	To be used at fissured rock locations, where water table is met below ground level.
1.02.07	Hard Rock
	The locations where chiseling, drilling and blasting is required for excavation hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.
1.02.08	In addition to the above, depending on the site conditions other types of foundations shall also be provided by the Contractor suitable for :
a)	Intermediate conditions under the above classifications to effect more economy, or
b)	For locations where special foundations (well type or piles) are necessitated.
1.03.00	The proposal for these types of foundations shall be submitted by the Contractor based on the detailed soil investigation and approval for the same shall be obtained from the Owner.
2.00.00	SOIL INVESTIGATION
2.01.00	The transmission tower foundations shall be classified based on the soil conditions. Optimisation of foundation design and their safety mainly depends on correctness of soil data and their analysis.
2.02.00	The Contractor shall be required to carry out detailed soil investigation at various tower locations such as angle points, crossings, etc. 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.
2.03.00	This specification covers all the work required for detailed soil investigation and preparation of a detailed 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), preparations for the type of foundations and the safe bearing capacity for different sizes of foundations, different founding strata for the various locations along the transmission lines.
2.04.00	Soil Classification
2.04.01	The type of soils normally encountered in construction of transmission lines can be broadly classified into the following four types of soils.
a)	Sand
b)	Mixed Soils
c)	Clay soils

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d)	Rocky Soils
2.04.02	The soil at any location shall be classified only after completion of the following field work and tests:
a)	One bore hole of 150 mm id shall be drilled at the center point of tower.
b)	Standard penetration test (S.P.T) shall be carried out at 1.5 m interval or change of strata upto a depth of 7.0 meters below ground level or to refusal whichever occurs earlier. (By refusal it shall mean that a standard penetration below count (N) of 100 is a recorded for 30 cm penetration.
c)	Bore details shall be furnished upto 7.0 meters below ground level or refusal whichever occurs earlier.
d)	Details of water table upto 7.0 meters below ground level shall be furnished.
2.04.03	Based on the above SPT and other details collected the type of soil shall be classified as per clause 2.04.01 and the same shall be got approved by Engineer-in-Charge.
2.04.04	If the soil is classified as 'same' the bearing capacity and angle of repose shall be furnished alongwith calculations and justification.
2.04.05	If the soils is classified as 'mixed soil' or 'clay soil' the following tests shall be carried out. The samples required for the following tests shall be collected at the time of preliminary investigation carried:
a)	Detailed bore log with the IS classification of soil and its properties such as specific gravity, bulk unit weight, moisture content etc.
b)	Collecting undisturbed samples of 100/75mm diameter, 450 mm long from the bore holes at 1.5 m intervals of change of strata, starting from 3 meter and upto 7 meter below ground level.
c)	To find out the following soil properties laboratory tests shall be carried out on the above undisturbed samples:
	1) Type of soil and gradation (As per IS classification)
	2) Atterberg limit (Liquid and plastic limit only)
	3) Triaxial tests to determine shear parameters such as cohesion (c) and angle of internal friction.
	4) Natural moisture content, specific gravity and bulk unit weight.
	5) Consolidation test.
	6) Unconfined compression test.
	7) Unconsolidated undrained test.
	8) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates and organic matter and any other chemical harmful to the concrete foundations.
	9) The bearing capacity of soil at different levels starting from 3.0 meter and upto 7.0 meter below ground levels. The above shall be calculated based on above determined soil data and considering a base width of foundation as 2.0 meters.
2.04.06	While carrying out the SPT test if the blow count of 100 is recorded for 30 cm of penetration, the soil shall be classified as rocky soil. In case of rock the bore drilling

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	shall be continued 3.0 meters further to ascertain its sufficient thickness. Core recovery and crushing strength of the rock shall also be reported.		
2.05.00	The laboratory tests shall be carried out progressively during the field work after sufficient number 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.		
2.06.00	Test report for soil investigation shall be furnished for approval. The report shall include, but not limited to the following:		
	a)	Borelogs : Bore logs of each bore hole clearly identifying the satisfaction and the type of soil stratum with depth upto the refusal. The location of water table shall be identified in the borelog. The value of SPT at the depths where the tests were conducted from samples collected at various depths shall be clearly shown against the particular stratum.	
	b)	Test results of field and laboratory tests shall be summarised stratawise as well in combined tabular form with all relevant graphs, charts, tables, diagrams and photographs, if any, shall be submitted alongwith the report.	
	c)	Recommendations : The report should contain specific recommendations for the type of foundation. The Contractor shall acquaint himself about the type of structures and their functions from the Engineer-in-charge. The observation/recommendations, shall include but not limited to the following :	
	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.	
	ii)	Limit 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.	
	iii)	Comments on the chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.	
	iv)	Recommendations for additional investigation, beyond the scope of the present work, if contractor feels that such investigation is necessary.	
3.00.00	SOIL PROPERTIES		
3.01.00	For design of foundations, the following properties of soil shall be considered:		
3.01.01	Weight of soil		
	a)	Dry	1440 Kg/m ³
	b)	In presence of surface water	1440 Kg/m ³
	c)	In presence of soil water	940 Kg/m ³

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3.01.02	Soft Rock		
a)	Ultimate Bearing Capacity	62,500 Kg/M ²	
b)	Weight of Earth	1440 Kg/M ³	
c)	Angle of Repose Degrees	20 degrees	
3.01.03	Hard Rock		
a)	Limit Bearing Capacity	12,50,00 Kg/M ²	
b)	Ultimate Bond Between Steel and Concrete (M15)	10 Kg/M ²	
3.01.04	Properties of Soil		
	Type of soil	Limit Bearing Capacity	Angle of Repose (Degrees)
a)	Normal Dry Soil	24,000	20°
b)	Wet earth in the presence of sub soil water	12,000	10°
c)	Wet earth due to presence of sub surface water	12,000	10°
d)	Wet Black Cotton Soil	12,000	0°
4.00.00	LOADS ON FOUNDATIONS		
4.01.00	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.		
4.02.00	The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked :		
a)	Max. tension or uplift along the leg slope.		
b)	Max. compression or down-thrust along the leg slope.		
c)	Max. horizontal shear or side thrust.		
4.03.00	The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.		
4.04.00	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.		
5.00.00	STABILITY ANALYSIS		
5.01.00	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.		
5.02.00	The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:		

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5.02.01	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 as per formula detailed in Annexure-A of this Section on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. 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.		
5.02.02	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.		
5.02.03	Resistance against side-thrust	The chimney portion of the foundation shall be designed as per limit load method described at clause 38.6 of IS-456-1978, or as per any other international standard, 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.		
6.00.00	PROPERTIES OF CONCRETE			
6.01.00	The cement concrete used for the foundations shall be of grade M-150 corresponding to 1:2:4 nominal mix ratio with 20mm coarse aggregate for chimney portion and 40mm coarse aggregate for pyramid or slab portion.			
6.02.00	All the properties of concrete regarding its strength under compression tension, shear, punching and bend etc. as well as workmanship will conform to IS:456-1978.			
6.03.00	The weight of concrete to be considered for design of foundations below			
	<u>Type of concrete</u>	<u>Weight of dry region KN/m³ (Kg/m³)</u>	<u>Weight in presence of sub-soil water KN/M³ (KG/m³)</u>	
	Concrete	21.96 (2240)	12.16 (1240)	
	Reinforced	23.54 (2400)	13.73 (1400)	
6.04.00	The Portland Cement used in concrete shall conform to IS:269-1967.			
6.05.00	The Puzzelena cement used in concrete shall conform to IS:1489-1976. The curing time of Puzzolena cement will be decided at the time of execution of the contract.			
6.06.00	Concrete aggregates shall conform to IS:383-1970.			

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6.07.00	The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalis, organic materials or other deleterious substances. Portable water is generally preferred.
6.08.00	Reinforcement shall conform to IS:432-1966 for MS bars and hard drawn steel wires and to IS:1139-1966 and IS:1786-1966 for deformed and cold twisted bars respectively. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coating, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications.
7.00.00	DESIGN OF FOUNDATIONS
7.01.00	Structural design of the foundations shall be done by limit State method.
7.02.00	Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel.
7.03.00	The physical properties of soil under various conditions as furnished in clause 3.00.00 are to be considered for the design of various types foundations.
7.04.00	The composite rates quoted in schedule of prices shall be payable for foundations designed based on above soil properties and classified as per clause 1.00.00 above. The composite rate shall be paid to the Contractor for above foundations irrespective of change in approved design volumes in comparison to estimated volume. No extra payment shall be payable/recoverable on account of increase/decrease in concrete volumes, excavation volume, etc. Further, once the foundations are classified based on the preponderant soil, the payment shall be made based on composite rate and extra claim is not admissible for excavation in different kinds of soil encountered inside the pit. However, it may be noted that the soil properties furnished above are tentative in nature. After soil investigations, if it is found that the foundations listed in schedule of prices cannot be used at that location, new foundation design shall be developed based on properties furnished in soil report. The payment for these foundations shall be made based on unit rate quoted for excavation, concrete and reinforcement.
7.05.00	Particulars of the foundations, along with the estimated volumes of concrete and excavation volumes for the various types of towers shall be given in the bid. The foundation shall be designed such as to satisfy the following conditions:
7.06.00	The thickness of concrete in the chimney portion of the tower footing would be such that it provides minimum cover of not less than 100mm from any part of the stub angle to the nearest outer surface of the concrete in respect of all dry locations limiting the minimum section of chimney to 300mm square. In respect of all wet location, the chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum.
7.07.00	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.
7.08.00	The spread of concrete pyramid or slabs for both P.C.C. type foundations shall be limited to 45 degree with respect to the vertical. The centroidal axis of the slab shall

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	coincide with the axis of the chimney and pass through the center of foundation base. The design of the foundations (base slab and its reinforcement) shall take into account the additional stresses in the foundation resulting from the eccentricity introduced due to non-compliance of this requirement.
7.09.00	At least 50mm thick pad of size equal to the base of pyramid with its sides vertical will be provided below the pyramid to account for the unevenness of soils and impurities likely to be mixed in concrete due to direct contact of wet concrete with earth and also for allowing stone aggregate reaching upto corner edges. This pad will also be provided in cases where pyramids are provided over concrete slabs.
7.10.00	In case of fully submerged type foundation, at least one base slab of not less than 200 mm thick shall be provided. In case of reinforced concrete slab, the slab thickness should not be less than 300 mm.
7.11.00	The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100mm or more than 150 mm in case of dry locations and not less than 150 mm or more than 200mm in case of wet locations.
7.12.00	The total depth of foundations below the ground level shall not be less than 1.5 meters and more than 3.0 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.
7.13.00	The portion of the stub in the pyramid (or slab) shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and pyramid concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design.
7.14.00	In case of foundation having steel reinforcement in pyramid or base slab, at least 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.
7.15.00	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.
7.16.00	Unit Rates and Measurements The Bidders are required to furnish unit rates in the Bid proposal sheets.
7.17.00	The excavation volumes for each tower footing shall be estimated assuming the faces of surrounding earth as vertical keeping a distance of 150mm clearance from the extreme edge of the base slab of footing.
7.18.00	The concrete volume and dimensions of the foundation shall be determined from the drawings approved. Measurement of concrete volume shall be in cubic meters and shall be worked out to the second place of decimal. The rate of foundation per tower shall include excavation, stub setting, concreting, reinforcement, if any, shoring, shuttering, de-watering, stock-pilling, dressing, curing, back filling the foundation after concreting with excavated/borrowed earth (irrespective of leads) and consolidation of earth,

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	carriage of surplus earth to the suitable point of proposal as required by the Owner or any other activities related to completion of foundation works.
7.19.00	The steel required for reinforcement of special foundation shall be provided by the Contractor. Measurement will be based on the calculated weights of steel actually used in tonnes corrected to third place of decimal, no allowance being made for wastage. No payments will be made for wire required for binding the reinforcement chairs, bolsters and spacers, as the cost of these is deemed to be included in the unit rate quoted for the item of reinforcement.
8.00.00	CONSTRUCTION OF TOWER FOUNDATION
8.01.00	Excavation
8.01.01	Excavation work must not be started until the tower schedule and profile has been approved by the Owner.
8.01.02	Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. The excavation wall shall be vertical and the pit dimensions shall be such as to allow a clearance of 150mm on all sides from the foundation pad. The Contractor should ensure clearance of 150 mm from the foundation pad for quality work. 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.
8.01.03	The soil to be excavated for tower foundations shall be classified as under: a) Normal Soil : Soil removable by means of an ordinary pick axe, spade and shovel. b) Wet Soil : Where the subsoil water table is encountered within the range of foundation depth or/and where pumping or bailing out of water is required due to presence of surface water will be treated as wet soil. c) Rocky Soil : hard conglomerate or other soft or fissured rock which can be quarried or split with crow bars, wedges or pickaxes. However, if required, light blasting may be resorted to for loosening the material, but this will not in any way entitle the material to be classified as hard rock. d) Hard Rock : Any rock excavation other than specified under fissured rock above for which blasting, drilling, chiseling are required. The unit rate quoted for hard rock excavation shall be inclusive of all costs for such drilling, chiseling and blasting etc.
8.01.04	Where soil is of composite nature, classification of foundation shall be made accordingly.
8.01.05	No extra charge shall be admissible for the removal of the fallen earth in the pit, when once excavated. Shoring and timbering/shuttering as approved by authorized representative of the Owner shall be provided by the Contractor when the soil condition is so bad that there is likelihood of accident due to the falling of earth.
8.01.06	Where rock is encountered, the holes for tower footings, shall preferably be drilled, but

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	where blasting is to be resorted to as an economy measure, it shall be done with the utmost care to minimise the use of concrete for filling the blasted area. All cases where unnecessarily large quantities are excavated/blasted, resulting in placement of large volumes of concrete, payment of concrete shall be limited to approved design, the balance cost of concrete being to the Contractor's account. In case where drilling is done, the stubs may be shortened suitably with the approval of the Owner or his authorised representatives.
8.01.07	The Contractor shall supply requisite blasting materials and be responsible for the purpose of the storage and use of this material.
8.02.00	Setting of Stubs
8.02.01	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.
8.02.02	Setting of stub at each location shall be approved by the Owner's representative.
8.02.03	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: For each A type tower : 3 Nos. For each of B and C type : 2 Nos. 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.
8.02.04	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.
8.03.00	Mixing, Placing and Compacting of Concrete
8.03.01	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.
8.03.02	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 which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

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8.03.03	Form boxes shall be used for casting all type of foundations. The concrete shall be laid down in 150mm layers and consolidated well, so that the cement cream works up to the top and 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.
8.03.04	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.
8.03.05	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.
8.04.00	Back-Filling and Removal of Stub Template.
8.04.01	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.
8.04.02	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.
8.04.03	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.
8.05.00	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.
8.06.00	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

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	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. Volume of the earth to be cut shall be measured before cutting and got approved from the Owner. This volume of earth shall be considered for the purpose of payment against the head of benching work. The earth removed for setting of stub template or for casting of foundation with difference of elevations of 1M between the tower legs shall not be entitled for payment.
8.07.00	Protection of Tower Footing
8.07.01	The work shall include all necessary stone revetments, concreting and earth filling above ground level and the clearance from stacking on the site of all surplus excavated soil, special measures for protection of foundation close to or in nallahs, river bed hilly/undulated terrain etc, by providing suitable revetments or galvanised wire netting and meshing packed with boulders. The top seal cover of the stone revetments shall be done with M-150 concrete (1:2:4:mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.
8.07.02	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 irrespective of lead as per the rate provided in the letter of award. The consolidation of earth shall however be done after backfilling free of cost.

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PART- III

TECHNICAL SPECIFICATION CHAPTER – T3

TOWER LINE ERECTION AND STRINGING

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TOWER LINE ERECTION AND STRINGING

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	CHAPTER – T3 : TOWER LINE ERECTION AND STRINGING
1.00.00	GENERAL REQUIREMENTS
1.01.00	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.
1.02.00	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.
1.03.00	The quantities of conductor, earthwire, insulators hardware, accessories of conductor & earthwire, etc. are estimated by the Owner include excess material towards wastages and damages during erection.
2.00.00	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.
3.00.00	ASSEMBLY
3.01.00	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)-1976. 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.
3.02.00	Tightening and Punching of Bolts and Nuts
3.02.01	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

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	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.
3.02.02	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.
3.02.03	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.
4.00.00	INSULATOR HOISTING 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. Dam-aged 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.
5.00.00	HANDLING OF CONDUCTOR AND EARTHWIRE
5.01.00	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.
5.02.00	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

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	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 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.
5.03.00	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.
5.04.00	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.
5.05.00	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.
5.06.00	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.
5.07.00	The proposed 33 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.
5.08.00	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.
6.00.00	STRINGING OF CONDUCTOR AND EARTHWIRE

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6.01.00	The stringing of the conductor shall be done by standard stringing method.
6.02.00	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.
6.03.00	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.
6.04.00	The Bidder shall give complete details of the stringing methods which he 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.
6.05.00	Jointing
6.05.01	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.
6.05.02	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.
6.05.03	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.
6.06.00	Sagging-in-Operation
6.06.01	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.
6.06.02	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.
6.06.03	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,

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6.06.04	At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, the 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.
6.06.05	Tensioning and sagging operations shall be carried out in calm weather when rapid changes in temperatures are not likely to occur.
6.06.06	Tensioning and Sagging of Conductors and Earthwire The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The 'Initial' stringing chart shall be used for the conductor and 'final' stringing chart for earth-wire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.
6.07.00	Clipping In
6.07.01	Clipping of the conductors in positions shall be done in accordance with the recommendations of the manufacturer. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps.
6.07.02	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.
6.07.03	Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.
6.08.00	Fixing of Conductor and Earthwire Accessories Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.
7.00.00	REPLACEMENT
7.01.00	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.
7.02.00	The Contractor shall not be required to return to the Owner, empty conductor and earthwire drums and shall dispose off the same at his cost except for steel drums which shall be returned to Owner.

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7.03.00	Any conductor and earthwire drum which has been opened by the Contractor shall not be taken back by Owner and the unused conductor or earthwire in such drum shall be treated as wastage permissible within the overall limits specified at 6.14.2 above.
8.00.00	FINAL CHECKING TESTING AND COMMISSIONING
8.01.00	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: - Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted. - Concrete chimneys and their copings are in good finally shaped conditions. - All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever. - All bolts are properly tightened and punched/tack welded. - The stringing of the conductors and earthwire has been done as per the approved sag and tension charts and desired clearances are clearly available. - All conductor and earthwire accessories are properly installed. - All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed. - Wherever required it should be ensured that revetment is provided. - The original tracings 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. - 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. - All towers are properly grounded. - The line is tested satisfactorily for commissioning purpose.

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PART- III

TECHNICAL SPECIFICATION CHAPTER – T4

TRANSMISSION LINE MATERIAL

PART- III

TECHNICAL SPECIFICATION CHAPTER – T4

TRANSMISSION LINE MATERIAL

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	CHAPTER – T4 : LINE MATERIAL				
1.00.00	GENERAL				
1.01.00	All the equipments 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 33 KV AC transmission with single conductor and will give continued good performance.				
1.02.00	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.				
1.03.00	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:2629-1972. 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.				
1.04.00	The zine 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 zine used for galvanising shall be of grade Zn. 99.95 as per IS:209-1966.				
2.00.00	EARTHWIRE				
2.01.00	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				
2.02.00	Parameters of the earthwire - Refer Chapter-E12, clause 7.00.00 of Switchyard Technical Specification.				
2.03.00	The earth wire 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.				
2.04.00	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.				
3.00.00	CONDUCTOR				
3.01.00	The conductor shall be Aluminium Core Steel Reinforced (ACSR) DOG type. The conductor shall confirm to IS: 398 (Part-IV) - 1976 except where otherwise specified in Chapter E12 of Part-II.				
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4.00.00	CONDUCTOR ACCESSORIES				
4.01.00	Mid Span Compressed Joint For Conductor -As per details given in IS:2121 Part-2.				
4.02.00	Repair Sleeve Repair Sleeve of compression type shall be used to repair conductor with not more than one 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 so that the conductor strands are not damaged during installation. The Contractor shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve for Owners review.				
4.03.00	Vibration Damper.				
4.03.01	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 shall be used at tension points analysis done damper minimum on each side per conductor at suspension points for ruling design span.				
4.03.02	The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent..				
4.03.03	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.				
4.03.04	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 case excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.				
4.03.05	The vibration damper shall not have magnetic power loss more than 0.5 watt at 250 amp at 50 alternating current.				
4.03.06	The vibration analysis of the system, with and without damper and dynamic characteristics of the damper shall be submitted to Owner for approval supported by relevant technical documents and sample calculations. The damper placement charts shall include the following: Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span. Placement distances clearly identifying the extremities between which the distances are to be measured. Placement recommendation depending upon type of suspension clamp (viz Free centre				
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	type, Armour grip type, etc.) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.				
5.00.00	EARTHWIRE ACCESSORIES				
5.01.00	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 Brinnel Hardness of steel should not exceed 200. the steel sleeve shall be hot dip galvanised. The joints shall not permit slipping off, damage or 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 details of the joint shall be submitted for Owners approval.				
5.02.00	Vibration Damper For Earthwire				
5.02.01	Refer Clause 4.04.00 detailed above.				
5.03.00	Flexible Copper Bond : As detailed in IS:2121 Part3. The flexible copper bond shall be fitted with 2 nos. tinned copper connecting lugs which will be pressed jointed to either ends of the bond. One lug shall be suitable for 12 mm dia bolt and other for 16 mm dia bolt. The complete assembly shall also include one 16 mm dia 40 mm lug HRH MS bolt hot dip galvanised with nut and lock washer.				
5.04.00	Suspension Clamp For Earthwire : As detailed in IS:2121 Part3				
5.05.00	Tension Clamp For Earthwire				
5.05.01	The details shall be as per IS:2121 part-3. Only Compression type tension clamp shall be used to hold 7/3.66 mm 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 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.				
6.00.00	HARDWARE FITTINGS				
6.01.00	The hardware fittings shall be as per the specification and Indian standards/IEC .				
6.02.00	Fasteners				
6.02.01	All fasteners shall conform to IS:6639 - 1972. All fasteners shall be hot dip galvanised. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.				
6.02.02	Fully threaded bolt shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts. All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but not further. It shall be ensured that the threaded portion of the bolt protrudes not less than 5 mm and not more than 10 mm				
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	when fully tightened.
6.02.03	Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Thickness of washers shall conform to IS:2016-1967.
6.02.04	To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter.
6.02.05	Bolts may have either rolled or cut threads, Nuts may be threaded after galvanising to ensure clean threads but bolts shall not be threaded or rethreaded after galvanising. Nut threads shall be tapped oversize to closely fit those of the galvanised bolt. With no unnecessary looseness but free enough to permit the nut to be turned freely with fingers over the entire threaded length.
6.03.00	Forged Components Forged components other than those covered in the clauses mentioned herein above shall be made out class IV steel as per IS:2004 or equivalent. The items shall be normalised to achieve the required tensile properties. The forged components shall not have sharp corners and edges.
6.04.00	Markings Each component of hardware shall be marked with the trade mark of the manufacturer. Marks shall be forged or stamped with a steel die before galvanising. The marks shall be distinct, durable and conspicuous.
6.05.00	INSULATOR
6.05.01	Polymer Insulators: The polymer used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and impervious to moisture. The colour of the polymer insulator shall preferably be brown. When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage. The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The design shall take into account the adequacy in end sealing so as to prevent entry of moisture and subsequent tracking. Contractor shall make available data on all the essential features of design including the method of assembly of FRP and metal parts, polymer housing, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.

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7.00.00	All iron parts shall be hot dip galvanized. The composite insulators shall be meet the requirements of IEC 61109 & IEC 62217. The insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards. Corona And RI Performance All surfaces must be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localised pressure. The metal parts shall not produce any noise generating corona under the operating conditions. 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. Routine, Acceptance and Type tests: The Contractor shall carry out all the routine and acceptance tests as per relevant standards. All the materials shall confirm to type tests as per relevant standards.
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SUB SECTION - 2

2.0 GENERAL

This section covers the standard technical specification for GI Structures.

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

2.1 STEEL MATERIAL

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

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

TOLERANCE:

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

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

2.2 FABRICATION

GENERAL:

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

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

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

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

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

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

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

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

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

STRAIGHTENING:

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

CUTTING:

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

PUNCHING AND DRILLING:

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

Punched holes must be square with plates and the walls of the holes shall be parallel. The following maximum allowance in accuracy of punched holes is permissible:

- i) Holes must be perfectly circular and no tolerance in this respect is permissible.
- ii) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm, i.e. the allowable taper in punched holes should not exceed 0.8 mm in diameter.

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

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

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

WELDING:

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

MARKING OF MEMBERS FOR IDENTIFICATION.

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

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

PROTOTYPE ASSEMBLY:

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

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

2.3 GALVANISING:

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

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

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

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

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

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

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

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

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

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

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

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

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

2.4 INSPECTION OF MATERIALS

GENERAL:

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

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

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

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

MATERIAL TESTING

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

DIMENSIONS AND WORKMANSHIP:

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

INSPECTION OF TEST FAILURE:

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

2.5 PACKING TRANSPORTATION AND DELIVERY

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

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

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

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

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

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

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

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

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

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

2.6 APPLICABLE STANDARDS

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

1. IS : 209 - Zinc Ingot.

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

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

NTPC SPECIFICATION FOR TRANSMISSION LINE TOWER MATERIAL.

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