

PART- III

33kV 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 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 lien, 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.

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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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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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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)
	Reinforced	23.54 (2400)
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

PART- III

TECHNICAL SPECIFICATION CHAPTER – T3

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 Brinell 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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	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.				
	To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter.				
	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.				
	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.				
	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.				
	INSULATOR				
	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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