

POWER GRID CORPORATION OF INDIA LTD.
(A Government of India Enterprise)

**TECHNICAL SPECIFICATIONS
FOR
SURVEY & SOIL INVESTIGATION
FOR
EMPANELMENT OF SURVEY AGENCIES

VOLUME-II**

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TECHNICAL SPECIFICATION
(VOLUME-II)

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SECTION-I

SCOPE

TECHNICAL SPECIFICATIONS

SECTION-I

SCOPE

Revision History

Revision No.	Date	Clause Ref	Description
Rev-0	AUG'2024		First Release

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SECTION-I

SCOPE

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TECHNICAL SPECIFICATIONS

SECTION- I

SCOPE

1.0 Scope

1.1 The following transmission lines with scope defined in clause 1.2 below are included in the scope of the Contractor under various packages:

Package –.....

1.

1.2 This Specification covers the following scope of works:

- (i) Detailed survey including route alignment, profiling, tower spotting, optimization of tower structure locations,
- (ii) Contouring at hilly/ undulated locations (if covered under BPS)
- (iii) ~~Land Scheduling (if covered under BPS) including Village Identification, Boundary Demarcation, Cadastral Data Acquisition & Preparation, Cadastral Map Integration, Land Parcel and Ownership Identification on the Final route~~
- (iv) Works related to preparation of Forest Clearance Proposal (if covered under BPS)
- (v) Geotechnical investigation including special river crossing foundation locations viz. pile foundation locations (whenever applicable & covered under BPS);

1.3 The envisaged number of locations for Soil Investigation are as follows-

Sr. No.	Name of Line:.....	Unit	Qty.
i	Normal Locs (Upto 15m)		
a	All kinds of soils except fissured rock and hard rock	Locs.	
b	Fissured Rock	Locs.	
c	Hard Rock	Locs.	
ii	For Creek/Marshy/Low Bearing/Coastal /etc. (Upto 30m)	Locs.	
iii	For River Crossing (Upto 40m)	Locs.	
iv	For River Crossing (Upto 50m)	Locs.	

1.4 Location Details and Terminal Points

- 1.4.1 The transmission line shall emanate from substation/switchyard in the District/ State of and terminate at substation in the District/ State of

The transmission lines are passing through Plain*/Hilly*/Snow Zone*/Coastal*/Creek*/Marine* area.

..... Fill in the blanks with details applicable for land scheduling works.

**To be mentioned as per site requirement.*

2.0 Transmission towers and Line data

- 2.1 **General Description of the Tower:** The typical classification of towers are enclosed in Appendix-I of Section-II of Technical specification.

- 2.2 **Foundation Classification:** The typical foundation classification of towers are enclosed in Appendix-II of Section-II of Technical specification.

TECHNICAL SPECIFICATIONS

SECTION-II

SURVEY

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SURVEY

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TECHNICAL SPECIFICATIONS
SECTION- II
SURVEY

1. General Information & Scope of Work

- 1.1. The technical specifications cover detailed survey including route alignment, profiling, tower spotting, optimization of locations, contouring (if indicated in BPS), soil investigation (if indicated in BPS), works related with preparation of forest proposal, ~~and Land Scheduling (If indicated in BPS)~~ for the transmission lines/part of the transmission lines covered under this specification as included in the BPS.
- 1.2. The scope of work inter-alia shall include the following: -
- a) Detailed Survey using Total Work Stations and/or DGPS or alternatively using ALTM (Airborne Laser Terrain Modeling) techniques, inter-alia including:
 - i) Digitized profiling along the selected route along with plan details.
 - ii) Computer aided tower spotting & optimization
 - b) Soil Investigation
 - c) Preparation of Survey reports including estimation of Bill of Quantities, identification and explanation of route constraints (like Forest, Protected Areas such as Wildlife Sanctuary, National Parks, Tiger Reserve/corridors, reserve coal belt areas, oil pipeline/ underground inflammable pipelines etc.), infrastructure details available en-route etc.
 - d) ~~Land Scheduling including Collection of data/ details of ownership of land within the line corridor & tower base.~~
- 1.3. The Provisional quantities for the scope of work are indicated in relevant Price Schedules of BPS. The final quantities for route alignment, detailed survey ~~and land scheduling~~ (quantities in “kms” unit) shall be as approved by Site Engineer-in-charge and shall be along the approved route alignment. For contouring at undulated/hilly tower locations and soil investigations (quantities in “Locs.” unit), the actual quantities (Locs.) to be executed shall be decided by Site Engineer-in-charge during execution stage and the quantities of Benching/Revetment /Combination of Unequal Leg Extension/Raised Chimney shall be approved by Site Engineer-in-charge. The route alignment, detailed survey, including profiling & tower spotting, contouring, soil investigation, ~~land scheduling~~, input for forest proposal, etc. shall be carried out by the Contractor as per the technical specifications stipulated herein. Contractor shall indemnify the Employer for any loss or damage to properties, trees, etc. during the survey work.
- 1.4. The Contractor should note that Employer will not furnish topographical maps prepared by survey of India but will make available assistance that may be required

in obtaining these by providing letters of recommendation to the concerned authorities. Further, in case the contractor opts for use of ALTM techniques for detailed survey, he shall be responsible for obtaining necessary clearances/permissions, as may be required from concerned authorities. The Employer will provide assistance that may be required in obtaining these clearances /permissions by providing letters of recommendation to the concerned authorities.

- 1.5. The work shall be carried out by the contractor using modern surveying techniques. The bidder shall indicate in his offer, the detailed description of the procedure to be deployed. The details of the equipment & facilities including software for image processing, computer aided tower spotting etc. available with the bidder or his associates shall also be furnished with the bid.
- 1.6. The Contractor shall also engage services of a reputed geo-technical consultant or experts from independent educational/ research institutions for examining stability aspects of the selected transmission line route/ locations in hilly terrain wherever required.
- 1.7. The Contractor shall also engage services of a consultant having experience in Preparation of documents related with Forest proposal i.e., finalization of forest area statement with corresponding KML files, DGPS Maps, Shape Files, georeferencing of maps etc.
- 1.8. After carrying out the detailed survey and soil investigations, the contractor shall submit complete BOQ of the transmission lines, Tower schedule, Profiles, Survey reports and other details as per technical specification requirements to the Employer.
- 1.9. The Employer shall be getting the transmission line constructed by the EPC Agency on the route finalized by the Survey Contractor and based upon the deliverables viz. Profiles, Tower spotting, Tower Schedule etc. provided by Survey Contractor. Hence the Survey Contractor is to ensure the correctness of the Survey and above deliverables.

2. Route Alignment

- 2.1. The route Alignment shall be carried out by the contractor using Survey of India topographical maps, forest Maps, village maps, satellite imageries, etc.
- 2.2. Requirement of Transmission Line Routing:
 - 2.2.1. The Re-alignment/ routing, if any required, of the transmission line shall be most economical from the point of view of construction and maintenance. The contractor shall identify & examine 3 (three) alternative route alignments and suggest to the Employer the optimal route alignment.
 - 2.2.2. Routing/ Re-routing of transmission line through protected/reserved forest area should be avoided. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route

- should be aligned in such a way that involvement of forest area and cutting of trees is minimum.
- 2.2.3 In case, it is not possible to avoid protected areas, the towers of the transmission line upto 400 kV level which are installed in protected areas (National Parks, Wildlife Sanctuaries, Conservation Reserves, Community Reserves) shall be spotted with Multi Circuit (4 circuits) configuration of same voltage level
- 2.2.4 The route should have minimum crossings of Major river, Railway lines, National/ State highways, overhead EHV power line and communication lines.
- 2.2.5 The number of angle points shall be kept to a minimum.
- 2.2.6 The distance between the terminal points specified shall be kept the shortest possible, consistent with the terrain that is encountered.
- 2.2.7 Marshy and low-lying areas, riverbeds and earth slip zones shall be avoided to minimize risk to the foundations.
- 2.2.8 It would be preferable to utilize level ground for the alignment.
- 2.2.9 Crossing of power lines shall be minimum. Alignment of a transmission line with respect to existing line will be kept considering ROW and tower falling distance.
- 2.2.10 Crossing of Petroleum or Natural Gas Pipeline shall be minimum. Alignment of a transmission line with respect to the existing pipe line shall be kept as indicated in Clause 3.4 (i).
- 2.2.11 Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them.
- 2.2.12 Areas subjected to flooding such as nalah shall be avoided.
- 2.2.13 Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches and align the route preferably outside the radius of 10 kms.
- 2.2.14 Preferably the alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.
- 2.2.15 Certain areas such as quarry sites, tea, tobacco and saffron fields and rich plantations, gardens & nurseries which will present the Employer problems in acquisition of right of way and way leave clearance during construction and maintenance should be avoided.
- 2.2.16 Angle points during survey should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line except in cases where the only route available is through Congested area.
- 2.2.17 The line routing should avoid large habitations, densely populated areas, Forest,

Protected Areas such as Wildlife Sanctuary, National Parks, Tiger Reserve/corridors, reserve coal belt areas, mining areas, oil pipe line/underground inflammable pipe lines etc. to the extent possible.

- 2.2.18 The areas requiring special foundations and those prone to flooding should be avoided
- 2.2.19 Raised chimney foundation is to be provided in areas prone to flooding (if unavoidable)/water stagnation like paddy field /agricultural field and undulated areas to avoid direct contact of water with steel part of tower. The top of the chimney of foundation should be at least above HFL (High Flood Level) or the historical water stagnation/ logging level (based on locally available data) or above High Tide Level or 500 mm above Natural Ground level (whichever is higher).
- 2.3. The contractor shall also gather information regarding under construction/upcoming infrastructure like, powerline, railway line, mining area, irrigation/dam, highway, airport, renewable energy projects, petroleum/gas pipeline, etc. and shall be taken care during route alignment.
- 2.4. For examination of the alternatives & identification of the most appropriate route, besides making use of information/ data/ details available/ extracted through Survey of India Topographical maps, the contractor shall also carryout reconnaissance/ preliminary survey as may be required for verification & collection of additional information/ data/ details.
- 2.5. The contractor shall submit his preliminary observations & suggestions along with various information/ data /details collected, topographical map data marked with the alternative routes etc. The final evaluation of the alternative routes shall be conducted by the contractor in consultation with Employer's representatives and optimal route alignment shall be proposed by the contractor. Site visit and field verification shall be conducted by the contractor jointly with the Employer's representative for the proposed route alignment.
- 2.6. Final route alignment drawing with latest topographical and other details/ features, as mentioned above, on both sides of selected route alignment shall be submitted by the contractor for Employer's approval along with report containing other information/details as mentioned above.
- 2.7. Changes in the route alignment, if any, during detail survey, shall be incorporated in the final route alignment drawings.

3. Detailed Survey

- 3.1. The detailed survey shall be carried out using Total stations, DGPS, etc. along the approved route alignment. As an alternative, the contractor may also use ALTM (Airborne Laser Terrain Modeling) techniques of equal or better accuracy for the detailed survey.

3.2. Profiling

- 3.2.1 The complete profiling along the route shall be carried out using modern surveying equipment viz. total stations, DGPS, etc. Reference levels at every 20 meters along the route are to be recorded. RLs at other undulations along the route as well as in the route plan and other En-route details viz. crossings, building & structures, trees & other infrastructure etc. shall also be recorded. Areas along the route, which in the view of the contractor, are not suitable for tower spotting, shall also be marked in profile. Any undulation keeping conductor location as reference may also be indicated as dotted line in profile.
- 3.2.2 The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided tower spotting software.
- 3.2.3 The profile and computer aided tower spotting prepared by contractor shall also cover the following with respect to clauses mentioned in technical specification, tower spotting data and statutory requirement:
- a) Wind and weight spans (under maximum and minimum temperature of conductor and no wind condition i.e. hot and cold condition)
 - b) Clearances from ground, power lines, highways, communication lines, rivers etc with conductor curves under hot and cold condition)
 - c) Clearances from earth wire & OPGW with top conductor at midspan for maximum and minimum temperature combination of earth wire & OPGW and top conductor.
 - d) Conductor creep are to be compensated by over tensioning the conductor at a temperature of 30°C for ACSR or AACSR BERSIMIS, SNOWBIRD & LAPWING /26°C for AAAC/ AL59 conductors and ACSR or AACSR MOOSE, ZEBRA, PANTHER lower than the ambient temperature.
- 3.3. Optimization of Tower Location/ Tower Spotting
- 3.3.1 Optimization of tower locations including profiling shall be done by the contractor using computer-aided tower spotting software - PLSCADD.
- 3.3.2 The sag-tension characteristics of the conductor as well as tower spotting data shall be furnished by the Employer to the contractor during the execution stage.
- 3.3.3 For transmission line sections passing within a distance of 50 km from the boundary of two wind zones, higher of the two wind zones shall be considered.
- 3.3.4 For transmission line sections passing within areas up to 60 km from coast shall be considered under cyclone prone areas.
- 3.3.5 Before starting of tower spotting, the Contractor shall submit the criteria and other inputs files required for computer-aided tower spotting software – PLSCADD for verification by employer, based on the tower spotting data.
- 3.3.6 Tower spotting in PLS CADD shall preferably be carried out using Method-1

Structure (Stick model) indicating all the conductor attachment points as per Single line Diagram of Tower given in Tower Spotting Data (TSD). Contractor shall create structure file for all extensions as available in TSD / informed by employer. Allowable Spans (Wind Span / Weight Span) under Strength definition shall duly be filled based on single / both side span limitation given in TSD in Structure file while spotting with Method-1 structure. If in case Method-4 Structure spotting required, Structure Load table as per Tower design and Method-4 Structure model shall be provided by Employer.

- 3.3.7 Profile shall be made in such a way that following information should be incorporated in top portion profile above Towers in printed version and profile view & Sheet view of PLS CADD model.
- Angle Point No. / Structure No.
 - Type of Tower with Extensions
 - Mention of Raised Chimney, if used
 - Wind Span in meters
 - Weight Span for Hot and Cold Condition including Total and one side values in meters.
- 3.3.8 A general list of feature codes required to define the characteristic feature of surveyed points is as attached in **Appendix-III**. Feature codes shall be consistent for each point type or discreet feature. Other feature codes for other miscellaneous features may also be assigned, as per requirement. The same feature code shall be used for each type of feature, and consistency shall be maintained in grouping the new feature code near similar codes of other features.
- 3.3.9 Preferably, Satellite imagery downloaded through PLS CADD shall be shown under plan view along with marking of various features in the line corridor.
- 3.3.10 All the structures and sections shall be in compliance with TSD, properly strung in PLS CADD using Automatic Sagging option and should display Structure/Section Check Bitmaps given in the Software.
- 3.3.11 Subsequent to tower spotting, the contractor shall also provide the complete backup file of PLS-CADD file along with printed version.
- 3.3.12 General description of towers is indicated in Section-1 of this specification for information of the Bidders.

3.4. Tower Spotting

While profiling & spotting the towers, the following shall be borne in mind:

a) **Span**

The number of consecutive spans between the section points shall not exceed 15 spans or 5 km in plain terrain and 10 spans or 3km in hilly terrain as well as in coastal area. A section point shall comprise of tension point with B/DB/QB type or C/DC/QC type or D/DD/QD type towers as applicable.

b) **Extension/Truncation**

An individual span shall be as near to the normal design span 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/ leg extension. In case of locations where the ground clearance is available, truncated towers may be spotted. The provisions kept in the design of towers w.r.t. body/ leg extensions, truncations shall be intimated to the contractor by the Employer during execution stage.

c) **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 TSD. 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 deployed at such positions.

d) **Road Crossing**

At all important road crossings, the tower shall be fitted with normal suspension and tension insulator strings depending on the type of tower,. At all national highways, any tension tower based on span and angle of crossing may be used and crossing span shall not be more than 250 meters, unless higher span is permitted by national highways authority in case of highways having more lanes. Minimum clearance in air across road surface of Highways or roads for lowest conductor of an overhead lines shall be as follows:-

S.N.	Line	Clearance between conductor and road Surface across Highway (m)
1	1200 kV	30 m
2	765 kV	18.8 m
3	400 kV	14 m
4	220 kV	12.52 m
5	132 kV	11.6 m
6	+800 kV HVDC	22.75 m
7	+500 kV HVDC	17.25 m

e) **Railway Crossings**

All the railway crossings coming En-route the transmission line shall be identified by the Contractor. At the time of detailed survey, the railway crossings shall be finalised based on the following and also confirming to the regulation laid down by the Railway Authorities.

- i) The crossings shall be supported on D60/DD60/QD60 type tower on either side.

- ii) The crossing shall normally be at right angle to the railway track.
- iii) The minimum horizontal distance measured at right angles from the center of nearest track to any part of a structure (all structures shall be rigid and well founded), carrying electrical conductors crossing a railway shall be equal to the height of the structure in meters above normal ground level plus 6 meters.
- iv) No crossing shall be located over a booster transformer, traction switching station, traction sub-station, Overlap Section or a track cabin location in an electrified area.
- v) The crossing span will be limited to 300 meters or 80% of the normal span for which the structure is designed whichever is less.
- vi) Minimumm ground clearance between crossing conductor under condition of maximum sag and railway line shall maximum of following:
 - (I) **Vertical Clearance for Normal OHE where no double stack containers are to be run on railway tracks (other than high rise OHE):**

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level (New Power Line Crossing or Crossing Planned for Alteration)	
		HVAC	HVDC
1	Above 66 kV & upto 132 kV	15.56 m	-
2	Above 132 kV & upto 220 kV	16.46 m	-
3	Above 220 kV & upto 400 kV	18.26 m	-
4	Above 400 kV & upto 500 kV	19.16 m	21.23 m
5	Above 500 kV & upto 800 kV	21.86 m	25.74 m

(II) Vertical Clearance for high rise OHE for running of double stack containers on Railway tracks.:

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level (New Power Line Crossing or Crossing Planned for Alteration)	
		HVAC	HVDC
1	Above 66 kV & upto 132 kV	17.56 m	-
2	Above 132 kV & upto 220 kV	18.46 m	-
3	Above 220 kV & upto 400 kV	20.26 m	-
4	Above 400 kV & upto 500 kV	21.16 m	21.23 m
5	Above 500 kV & upto 800 kV	23.86 m	25.74 m

Note: Applicable only for electrification of routes where double stack container having maximum height of **6809mm** is plying.

(III) Minimum Clearances between Highest Traction Conductor & Lowest Crossing Conductor

Sl No:	Transmission line voltage level	HVAC	HVDC
1	Above 66 kV & upto 132 kV	3.05 m	-
2	Above 132 kV & upto 220 kV	4.58 m	-
3	Above 220 kV & upto 400 kV	5.49 m	6.04 m
4	Above 400 kV & upto 500 kV	7.94 m	6.79 m
5	Above 500 kV & upto 800 kV	7.94 m	9.04 m

f) River Crossings

In case of major river crossing, river crossing towers shall be of suspension type along with anchor towers of D/DD/QD type tower on either side of the main river crossing. Alternately on the basis of economics and / or site/ execution constraints crossing of rivers using normal extended angle towers (+18/+25/+30M/+35M/+45M, etc. Extensions) also shall be considered. For navigable rivers, clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to highest flood level (HFL). Minimum clearance in air for navigational or non-navigational rivers for lowest conductor of an overhead lines shall be as follows:-

S.N.	Line	Clearance above HFL for River crossing (m)	
		Navigational river	Non-navigational river
1	1200 kV	29.9 m	24 m
2	765 kV	25.55 m	18.0 m
3	400 kV	21.9 m	8.84 m
4	220 kV	20.10 m	7.02 m
5	132 kV	19.22 m	6.5 m
6	+800 kV HVDC	25.9 m	18.0 m
7	+500 kV HVDC	22.9 m	12.5 m

g) Power line Crossings

Where the line is to cross over another line, towers with suitable extensions may be used, depending upon the merit of the prevailing site condition.

For power line crossing of 400 kV or above voltage level, large angle & dead-end towers (i.e. D/DD/QD) shall be used on either side of power line crossing (i.e. D/DD/QD - D/DD/QD arrangement).

For power line crossing of 132 kV and 220 kV voltage level, angle towers (B/C/D/DB/DC/DD/ QB/QC/QD) shall be used on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

For power line crossing of 66 kV and below voltage level, suspension/ tension towers shall be provided on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

Use of D/DD/QD towers for crossing of 66kV, 132kV or 220kV voltage lines shall however be permitted for cases where more than +25 m extension are required due to site conditions.

Clearance between lines crossing each other shall be kept in accordance with the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023 as amended up-to-date. In order to reduce the height of the crossing towers, it may be advantageous to remove the ground-wire of the line to be crossed (if this is possible and permitted by the Employer of the line to be crossed).

Minimum clearance in meters between lines when crossing each other:

Sl. No.	Nominal System Voltage	110 - 132 kV	220 kV	400 kV	500 kV HVDC	765 kV	800 kV HVDC	1200 kV
1	110-132KV	3.05	4.58	5.49	6.79	7.94	9.04	10.44
2	220KV	4.58	4.58	5.49	6.79	7.94	9.04	10.44
3	400KV	5.49	5.49	5.49	6.79	7.94	9.04	10.44
5	500KV HVDC	6.79	6.79	6.79	6.79	7.94	9.04	10.44
4	765KV	7.94	7.94	7.94	7.94	7.94	9.04	10.44
6	800KV HVDC	9.04	9.04	9.04	9.04	9.04	9.04	10.44
7	1200 KV	10.44	10.44	10.44	10.44	10.44	10.44	10.44

h) Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degree possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations.

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.

i) Oil Pipe-Line Crossings

No tower footing or structure of an overhead line shall be closer than twenty five metre from the edge of the right of way of a Petroleum or Natural Gas pipeline. The Agency shall coordinate with utility for details about Right of way of Petroleum or Natural Gas pipeline. Wherever overhead line intending to cross the right of way of a Petroleum or Natural Gas pipeline, the angle of crossing of the overhead line with respect to the pipelines shall preferably be at right angles and, in any case, the crossing angle shall not be less than seventy five degrees.

j) **Details En-route**

All topographical details, permanent features, such as trees, building etc. within following RoW shall be detailed on the profile plan: -

S.N.	Line	Right of Way (Mtr)
1	1200 kV Single Circuit	89 m
2	765 kV Double Circuit	67 m
3	765kV Single Circuit Delta	64 m
4	765kV Single Circuit Horizontal	85 m
5	+800 kV HVDC	69 m
6	400kV Single Circuit	52 m
7	400kV Double Circuit	46 m
8	+500 kV HVDC	52 m
9	220 kV	35 m
10	132 kV	27 m

3.5. **Clearance from Ground, Building, Trees etc.**

Clearance **from** ground, buildings, trees and telephone lines shall be provided in conformity with the CEA’s Regulations 2023 (Measures relating to Safety and Electric Supply).

S.N.	Line	Ground Clearance (Mtr)
1	1200 kV Single Circuit	24.0 m
2	765 kV Double Circuit	18.0 m

3	765kV Single Circuit Delta	18.0 m
4	765kV Single Circuit Horizontal	18.0 m
5	+800 kV HVDC	18.0 m
6	400kV Single Circuit	8.84 m
7	400kV Double Circuit	8.84 m
8	+500 kV HVDC	12.5 m
9	220 kV	7.015 m
10	132 kV	6.1 m

3.6. Preliminary Tower Schedule

The profile sheets showing the locations of the towers together with preliminary schedules of quantities indicating tower types, wind & weight spans, angle of deviation, crossing & other details etc. shall be submitted by the contractor for review & approval by Employer’s site-in-charge.

3.7. Contouring at hilly/ undulated locations

3.7.1 Employer shall indicate the number of locations on which contouring is to be carried out for estimation of the quantities of benching /revetment/Raised Chimney/Unequal Leg Extensions.

3.7.2 The levels up or down of each pit centre with respect to centre of tower location shall be recorded at intervals of 2m using total stations/ DGPS and digitized contour plans shall be made. Based on the digitized elevation plans, the quantities of benching & protection work and possible unequal leg extensions / Raised Chimney shall be optimized using suitable computer-aided techniques/ software or manual method and submitted to the Employer.

3.8. Final Tower Schedule

3.8.1 The changes desired by the Employer in the preliminary tower schedule or as may be required based on detailed survey of tower locations & contouring by the contractor, shall be carried out by the contractor and the final tower schedule shall be submitted for approval of Employer. The tower schedule shall show position of all type of towers, span length, type of foundation for each tower, benching & revetment requirement, unequal leg extensions, deviation at all angles, crossings & other details etc.

3.9. Survey Methodology & Precision

3.9.1 All elevations shall be referenced to benchmarks established by the survey of

India. Survey operations shall begin and end at benchmarks approved by the Employer.

- 3.9.2 During the leveling of the profile, check surveys will be affected at intervals not exceeding 50 km with benchmarks of known elevations. The difference in elevations as surveyed by the contractor and as declared by Survey of India for these benchmarks shall not exceed the precision required for 3rd order surveys $e \leq 24k$, where k is the distance between benchmarks in km and e is the difference between elevations in mm.
- 3.9.3 In the absence of suitable benchmarks, the leveling shall be done by two independent leveling parties working in opposite directions along the same line. The difference in elevations between the two surveys shall not exceed the precision required for 3rd order surveys as stated above.
- 3.9.4 All-important objects and features along the transmission line centerline (railways, highways, roads, canals, rivers, transmission lines, distribution lines, telephone lines etc.) shall be surveyed and located with a positional accuracy of 1:2000 between points of known horizontal position.

4. Works related to preparation of Forest Clearance Proposal

4.1 Immediately on completion of Route Alignment and confirmation by Site Engineer-in-Charge, following activities are to be undertaken by the survey agency in consultation with consultant as per para 1.7 :

- a) Identification of Forest recorded in Revenue Record as Forest
 - i) Collection of Village/Khasra maps.
 - ii) Plotting of Line and RoW on these maps after geo-referencing.
 - iii) Identification of Plots/ Khasra involving forest with corresponding area falling in the RoW, as per land record. The land records for forest & non-forest area are to be recorded in the following format –

Sl. No.	Name of Village/ Tehsil/ District	Plot/ Khasra no.	Extent of Area involvement in RoW Corridor	Ownership

- b) Identification of Forest under Reserve/ Protected/Deemed Forest as per SOI Toposheet, Forest Maps and in consultation with local forest officials.
- c) Identification of Forest area declared as strip plantation along road and canal crossings.

- d) Based on above, KML file & DGPS maps showing forest area proposed for diversion viz-a-viz forest blocks, line route/ RoW polygon and corresponding Forest area statement to be prepared and finalized.
- e) The total Forest area involvement to be ascertained by considering all above forest areas.

4.2 Upon intimation by Employer, the Contractor shall finalize the forest clearance proposal on the prescribed format, as per requirements of the State/ MoEFCC, duly completed in all respects for submission by the Employer to the Forest Department after carrying out the following activities–

- a) Collection of Notification of RF/ PF/Deemed (if any) Forest Area from local forest office.
- b) Collection/ arrangement of Jamabandi of Khasra nos. for identification of area recorded in Revenue Record as Forest.
- c) Forest area details of alternative two route alignments shall also be submitted by the agency and with KML files showing forest area patches/ segments/ involvement in alternative routes also.
- d) Tree Enumeration to be undertaken in the identified forest patches as per following format:
 - i) In complete RoW
 - ii) Tree Felling List – In tower base and strips below each conductor, as per width specified by MoEFCC

Name of Tree	Scientific Name	Girth wise Nos.					
		upto 30 cms	31-60 cms	61-90 cms	91-120 cms	121-150 cms	More than 151 cms

4.3 Final documents as per checklist attached at **Appendix-IV** to be submitted to POWERGRID.

5. Land Scheduling.

~~5.1 Village Identification and Boundary Demarcation: Accurately identify all villages falling within the Transmission Line corridor and delineate their boundaries along the transmission line corridor.~~

~~5.2 Cadastral Data Acquisition and Preparation:~~

- ~~a) Obtain Cadastral maps in digital or physical format for each relevant village.~~

- ~~b) In case of physical format, Georeferenced all relevant cadastral maps to align with actual village boundaries and Transmission Line Corridor.~~
- ~~c) Marking of the transmission line route and corridor on the digitized/georeferenced cadastral maps.~~

~~5.3 Land Parcel and Ownership Identification:~~

- ~~a) Identify all Khasra numbers (individual field/plot identifiers) falling within the corridor.~~
- ~~b) Ascertain ownership details for each identified Khasra number, categorizing them as Private or Government-owned through Jamabandi / Khatauni copies~~
- ~~c) For private lands, Complete name of the first land owner in case of Multiple Land owners may be indicated. In case the land parcel is indicated commercial in the nature in the Jamabandi / Khasra-Khatauni copies the same may also be indicated in the land schedule statement.~~
- ~~d) For government lands, specify the Name of agency/ authority/ utility like Revenue, Railway, Forest, Defence, PSUs, Companies etc.~~

~~5.4 Land Schedule Statement: Prepare a comprehensive land schedule statement incorporating the following details for each identified Khasra number:~~

- ~~a) Line Section (Angle Point to Angle Point or Tower Number)~~
- ~~b) Ownership Detail.~~
- ~~c) State, District, Tehsil~~
- ~~d) Village/Mouza~~
- ~~e) Khasra No./Survey No./Plot No.~~
- ~~f) Extent of involvement of Khasra no. falling in the Transmission line Corridor (in sq.m.) for forest portion.~~
- ~~g) Land Type Classification like Agricultural, Commercial, forest, defence as per clause 5.3 (d) above.~~

~~5.5 Copies of Jamabandi of all Khasra nos. or equivalent document falling in the Transmission line corridor obtained through Revenue or Official Portal viz. Bhunaksha etc. to be provided.~~

6. Survey Report

- 6.1 Complete BOQ of the transmission lines as per format enclosed with this technical specification at **Annexure-A** shall be furnished in the survey report.

- 6.2 Information w.r.t infrastructure details available en-route, identification and explanation of route constraints, etc. shall also be furnished in the Survey report.
- 6.3 The contractor shall prepare and submit Foundation Classifications at each tower location along the transmission line route based on detailed soil investigations and other details/ information collected during detailed survey
- 6.4 The contractor shall also intimate the Employer, his assessment about the likely number and type of trees for each section. Further the contractor shall also provide the details of the prevalent crops, vegetables being cultivated by farmers, and any orchards, cash crops etc. along the enroute of line.
- 6.5 All observations which the Contractor thinks would be useful to the construction of the transmission lines mentioned under scope of work are to be reported.
- 6.6 Reports / Documents as indicated in Clause 4.0 for submission of Forest Clearance proposal.
- 6.7 For forest area, deliver a shapefile and a KML file containing Digitized Cadastral map boundaries of relevant Khasra nos. superimposed on the transmission line corridor. Each Cadastral Boundary polygon of relevant Khasra within the shapefile shall include attributes (Name and type of Forest, village/mouza, Khasra No./Survey No./Plot No.).
- 6.8 The georeferenced cadastral map with the transmission line corridor marked on it for the complete route in soft copy.
- 6.9 Land Schedule Statement: Provide a detailed land schedule statement in physical and Excel format encompassing all information specified in section 5.4 of the scope as per the table enclosed at **Annexure-E**.
- 6.10 Copies of Jamabandi of all Khasra nos. or equivalent document falling in the Transmission line corridor obtained through Revenue or Official Portal viz. Bhunaksha etc to be provided.
- 6.11 Soft copies of survey reports shall be furnished by the contractor to the Employer.

7. Statutory Regulations and Standards

- 7.1 Contractor is required to follow statutory regulations stipulated in Electricity Act 2003, Indian Electricity Rules and other local rules & regulations.
- 7.2 The codes and standards referred to in these specifications shall govern. In case of a conflict between such codes/ standards and these specifications, the provisions of the specifications shall prevail. Such codes, standards referred to shall mean latest revisions, amendments, changes adopted and published by relevant agencies.
- 7.3 Other Internationally acceptable standards which ensure equivalent or better performance than those specified shall also be acceptable.

SECTION-III

**TECHNICAL SPECIFICATIONS
FOR
EMPANELMENT OF SURVEY AGENCIES FOR
SOIL INVESTIGATION**

TECHNICAL SPECIFICATIONS

SECTION-III

SOIL INVESTIGATION

Revision History

Revision No.	Date	Description
Rev-0	AUG'2024	First Release

TECHNICAL SPECIFICATIONS

SECTION-III

SOIL INVESTIGATION

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TECHNICAL SPECIFICATIONS**SECTION- III****SOIL INVESTIGATION****1. Geotechnical Investigations****1.1. General**

1.1.1. Employer requires that a Geotechnical investigation be carried out at various tower locations to provide the designer with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation of transmission line towers can be classified and designed rationally.

1.1.2. These specifications provide general guidelines for geotechnical investigation of normal soils.. Any other information required for such locations shall be obtained by Contractor and furnished to Employer.

1.2. Scope

1.2.1. The scope of work includes soil investigations and furnishing bore log data at various tower locations / Substation locations. The provisional quantities have been indicated in Bill of Quantities. Soil investigations shall be carried out as decided by site in-charge besides critical locations like railway crossing, river crossing etc. Based on the bore log data/ soil parameter/ soil investigation results, the Contractor shall recommend the type of foundations suitable for each location and the same shall be got approved by the Employer.

1.2.2. These specifications cover the technical requirements for a Geotechnical investigation and submission of a Geotechnical Report. The work shall include mobilization of all necessary tools and equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire field investigation as well as laboratory tests, analysis and interpretation of data collected and preparation of the Geotechnical Report. Contractor shall also collect data regarding variation of subsoil water table along the proposed line route. The aforementioned work shall be supervised by a graduate in Civil Engineering having at least 5 years of site experience in geotechnical investigation work.

1.2.3. Contractor shall make his own arrangements to establish the co-ordinate system required to position boreholes, tests pits and other field test locations as per the locations identified by the Employer. Contractor shall determine the reduced levels (RL's) at these locations with respect to benchmarks used in the detailed survey. Two reference lines shall be established based on survey data/details. Contractor shall deploy at site all required survey instruments to the satisfactions of the Employer so that the work can be carried out accurately according to specifications and drawings. Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and nalas, etc., encountered along the transmission line route from the

best available sources and shall furnish complete hydrological details at the tower location including maximum velocity discharge, highest flood level (H.F.L), scour depth etc. of the concerned rivers, major streams and nalas (canals).

- 1.2.4. The field and laboratory data shall be recorded on the proforma recommended in relevant Indian Standards. Contractor shall submit to Employer two copies of field bore logs (one copy each to Employer site and Corporate Office) and all the field records (countersigned by the Employer) soon after the completion of each boreholes/ test.
- 1.2.5. Whenever Contractor is unable to extract undisturbed samples, he shall immediately inform the Employer. Payment for shall be subject to Employer being satisfied that adequate effort has been made to extract undisturbed samples. Special care shall be taken for locations where marshy soils are encountered and Contractor in such cases shall ensure that specified numbers of vane shear tests are performed and the results correlated with other soil parameters.
- 1.2.6. One copy of all field records and laboratory test results along with soil investigation report shall be sent to Employer. Employer may observe, at the laboratory testing procedures.
- 1.2.7. The Contractor shall interact with the Employer to get acquainted with the different types of structures envisaged and in assessing the load intensities on the foundation for the various types of transmission line towers and substation structures in order to enable him to make specific recommendation for the depth, founding strata, type of foundation and the allowable bearing pressure . Ultimate bearing Capacity as for Transmission line structures and Safe baring capacity for substation structures by applying F.O.S is to be furnished as per Table 1.0 (B)
- 1.2.8. After reviewing Contractor's geotechnical investigation draft report, Employer will call for discussions, , in order to comment on the report in the presence of Contractor's Geotechnical Engineer. Any expenditure associated with the redrafting and finalising the report, traveling etc. shall be deemed included in the rates quoted for the geotechnical investigations.
- 1.2.9. Contractor shall carry out all work expressed and implied in these specifications in accordance with requirements of the specification.
- 1.2.10. The contractor shall prepare and submit Foundation Classifications at each tower location along the transmission line route based on detailed soil investigations and other details/ information collected during detailed survey.
- 1.2.11. Pile type foundation shall be used for towers located in river or creek bed or on bank of river having scourable strata or in areas where river flow or change in river course is anticipated, based on detailed soil investigation and previous years' maximum flood discharge of the river, maximum velocity of water, highest flood level, scour depth and anticipated change in course of river based on river morphology data of at least past 20 years to ensure availability and reliability of the transmission line.

1.3. **General Requirements**

- 1.3.1. Wherever possible, Contractor shall research and review existing local knowledge,

records of test pits, boreholes, etc., types of foundations adopted and the behavior of existing structures, particularly those similar to the present project.

1.3.2. The water level in neighboring streams and water courses shall be noted. Contractor shall make enquiries and shall verify whether there are abandoned underground works e.g. worked out ballast pits, quarries, old brick fields, mines, mineral workings etc.

1.3.3. It is essential that equipment and instruments be properly calibrated at the commencement of the work. If the Employer so desires. Contractor shall arrange for having the instruments tested at an approved laboratory at its cost and shall submit the test reports to the Employer. If the Employer desires to witness such tests, Contractor shall arrange for the same.

1.4. **Codes and Standards for Geotechnical Investigations**

1.4.1. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail. Internationally accepted standards which ensure equal or higher performance than those specified shall also be accepted.

1.4.2. All work shall be carried out in accordance with the following Indian Standards and Codes:

Indian Standards	Title	International Standard
IS 1080	Codes of Practice for Design and Construction of Shallow Foundations on soils (other than Raft, Ring & Shell)	
IS 1498	Classification and Identification of Soils for General Engineering purposes.	ASTM D 2487 ASTM D 2488
IS 1892	Code of Practice for Subsurface Investigation for Foundation	
IS 1904	Code of Practice for Design and Construction of foundation in Soils: General Requirements.	
IS 2131	Method of Standard Penetration Test for Soils	ASTM D 1586
IS 2132	Code of Practice for Thin Walled Tube Sampling of Soils	ASTM D 1587
IS 2720 (Part 1-39) (relevant parts)	Method of Test for Soils (Relevant Parts)	
IS 2809	Glossary of Terms and symbols Relating to Soil Engineering	ASTM D 653-14

IS 2911 (Part I-VI)	Code of Practice for Design and construction of Pile Foundations (Relevant Parts)	
IS 3043	Code of Practice for Earthing	
IS 4078	Code of Practice for Indexing and Storage of Drill Cores.	
IS 4091	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles	
IS 4434	Code of Practice for In-situ Vane Shear Test for Soils	ASTM D 2573(M)-15 ASTM D 4648(M)-16
IS 4453	Code of Practice for Sub-Surface Exploration by Pits, Trenches, Drifts and Shafts	
IS 4464	Code of Practice for Presentation of Drilling information and core description in Foundation investigation	
IS 4968 (Part-II)	Method for Subsurface sounding for soils, dynamic method using cone and Bentonite slurry	
IS 5313	Guide for Core Drilling observations	
IS 6403	Code of Practice for Determination of Bearing Capacity of Shallow Foundation	
IS 6926	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects	
IS 6935	Method of Determination of Water level in a Bore Hole	
IS 2809	Glossary of Terms and symbols Relating to Soil Engineering	ASTM D 653- 14
IS 2911 (Part I-VI)	Code of Practice for Design and construction of Pile Foundations (Relevant Parts)	
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IS 6403	Code of Practice for Determination of Bearing Capacity of Shallow Foundation	
IS 6926	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects	
IS 6935	Method of Determination of Water level in a Bore Hole	
IS 7422 Part(I-V)	Symbols and Abbreviations for use in Geological Maps Sections and subsurface Exploratory Logs (Relevant parts).	
IS 8009 (Part-I)	Code of Practice for Calculation of Settlements of Foundations (Shallow Foundations subjected to symmetrical Vertical Loads).	
IS 8764	Method of Determination of Point Load Strength Index of Rocks.	
IS 9143	Method of Determination of Unconfined Compressive Strength of Rock Materials	ASTM D 7012-14e1
IS 9179	Method of Preparation of Rock Specimen for Laboratory Testing	
IS 9259	Specification for Liquid Limit Apparatus	ASTM D4318-17
IS 9640	Specification for Split Spoon Sampler	ASTM D1586-11
IS 10050	Method of Determination of Slake Durability Index of Rocks.	ASTM D4644-16
IS 11315 (Part 1-12)	Method for the Quantitative Description of discontinuities in Rock Mass	

1.5. **Field Investigation for Soils**

Tentative numbers of locations for soil investigation to be done is given in Section-I

1.5.1. **Boring**

Boreholes are required for soil investigations.

1.5.1.1. **General Requirements**

- a) Boreholes shall be made to obtain information about the subsoil profile, its nature and strength and to collect soil samples for strata identification and for conducting laboratory tests. The minimum diameter of the borehole shall be 150mm and boring shall be carried out in accordance with the provisions of IS1892 and the present specification.
- b) All boreholes shall be 15m deep for normal soil conditions except for marshy/Creek locations/low bearing Capacity locations where bore hole depth may be up to 30m . The depth of boreholes at river crossings shall be 0m unless specified for upto 50m for major rivers viz. Ganga, Brahmaputra, Narmada etc. in Section-I If a strata is encountered where the Standard Penetration Test Records N values greater than 100, with characteristics of rock, the borehole shall be advanced by coring at least 3m further in normal locations and at least 7m further for the case of river crossing locations with prior approval of the Employer. When the boreholes are to be terminated in soil strata an additional

Standard Penetration Test shall be carried out at the termination depth. No extra payment shall be made for carrying out Standard Penetration Tests.

- c) Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test of sampling level but not more than 15 cm above the borehole bottom. In case of cohesionless soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall preferably be advanced by slowly rotating the casing pipe and not by driving.
- d) In-situ tests shall be conducted and undisturbed samples shall be obtained in the boreholes at intervals specified hereafter. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water table in the bore hole shall be carefully recorded and reported following IS 6935. No water or drilling mud shall be used while boring above ground water table. For cohesion less soil below water table, the water level in the borehole shall at all times be maintained slightly above the water table.
- e) The borehole shall be cleaned using suitable tools to the depth of testing or sampling, ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned by using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.
- f) On completion of the drilling, Contractor shall backfill all boreholes as directed by the Employer.

1.5.1.2. **Auger Boring**

Auger boring may be employed in soft to stiff cohesive soils above the water table. Augers shall be of helical or post hole type and the cuttings brought up by the auger shall be carefully examined in the field and the description of all strata shall be duly recorded in the field bore log as per IS 1498. No water shall be introduced from the top while conducting auger boring.

1.5.1.3. **Shell and Auger Boring**

1.5.1.3.1. Shell and auger boring may be used in all types of soil which are free from boulders. For cohesion less soil below ground water table, the water level in the borehole shall always be maintained at or above ground water level. The use of chisel bits shall be permitted in hard strata having SPT-N value greater than 100 Chisel bits may also be used to extend the bore hole through local obstructions such as old construction. Boulders rocky formations, etc. The requirements in Clause 1.5.1.2 shall apply for this type of boring also.

1.5.1.3.2. Rotary method may be used in all types of soil below water table. In this method the boring is carried out by rotating the bit fixed at the lower end of the drill rod. Proper care shall be taken to maintain firm contact between the bit and the bottom of the borehole. Bentonite or drilling mud shall be used as drilling fluid to stabilise and protect the inside surface of the borehole. Use of percussion tools shall be permitted in hard

clays and in dense sandy deposits.

1.5.2. **Standard Penetration Test (SPT)**

1.5.2.1. This test shall be conducted in all types of soil deposits encountered within a borehole, to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. Structure sensitive engineering properties of cohesive soils and silts such as strength and compressibility shall not be inferred based on SPT values.

1.5.2.2. The test shall be conducted at every change of stratum or at interval of not more than 3.0 m.

1.5.2.3. The Equipment, accessories and procedures for conducting the test shall conform to IS 2131 and IS 9640. The test shall be conducted immediately after reaching to the test depth and cleaning of bore hole.

1.5.2.4. The test shall be carried out by driving a standard split spoon sampler in the bore hole by means of hammer of standard weight as specified in IS 2131, having a free fall of 750 mm. The sample shall be driven using the hammer for 450 mm recording the number of blows for every 150 mm. The number of blows for the last 300 mm drive shall be reported as N value.

1.5.2.5. This test shall be discontinued when the blow count is equal to 100 or the penetration is less than 25 mm for 50 blows. At the level where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labeled.

1.5.3. **Sampling**

1.5.3.1. **General**

- a) Sufficient number of soil samples shall be collected. Disturbed soil samples shall be collected for soil identification and for conducting tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate the physical bearing capacity and settlement properties of the soil.
- b) All accessories and sampling methods shall conform to IS 2132. all disturbed and undisturbed samples collected in the field shall be classified as per IS 1498.
- c) All samples shall be identified with date, borehole or test pit number, depth of sampling, etc. The top surface of the sample in-situ shall also be marked. Care shall be taken to keep the core and box samples vertical, with the mark directing upwards. The tube samples shall be properly trimmed at one end and suitably capped and sealed with molten paraffin wax. The Contractor shall be responsible for packing, storing in a cool place and transporting all the samples from site to the laboratory within seven days after sampling with probe, protection against loss and damage.

1.5.3.2. **Disturbed Samples**

Disturbed soil samples shall be collected in boreholes at regular intervals. The weight of sample as per table 2 of IS 1892 shall be collected at 0.5 m intervals starting from a depth of 0.5 m below ground level and at every identifiable change of strata to supplement the boring records. Samples shall be stored immediately in air tight jars which shall be filled to capacity as much as possible.

1.5.3.3. **Undisturbed Samples**

In each borehole undisturbed samples shall be collected at every change in stratum or at intervals not more than 3.0 m.

1.5.3.3.1. The spacing between the top levels of undisturbed sampling and standard penetration testing shall not be less than 1.0 m. Undisturbed samples shall be of 100 mm diameter and 450 mm in length. Samples shall be collected in a manner to preserve the structure and moisture content of the soil. Accessories and sampling procedures shall conform to IS 1892 and IS 2132

a) **Undisturbed sampling in cohesive soil:**

Undisturbed samples in soft to stiff cohesive soils shall be obtained using a thin walled sampler. In order to reduce the wall friction, suitable precautions, such as oiling the surfaces shall be taken. The sampling tube shall have a smooth finish on both surfaces and a minimum effective length of 450 mm. The area ratio of sampling tubes shall be less than 12.5%. However, in case of very stiff soils area ratio up to 20% shall be permitted.

b) **Undisturbed sampling in very loose, saturated, sandy and silty soils and very soft clays:**

Samples shall be obtained using a piston sampler consisting of a cylinder and piston system. In soft clays and silty clays, with water standing in the casing pipe, piston sampler shall be used to collect undisturbed samples in the presence of expert supervision.

Accurate measurements of the sampling depth, dimensions of sampler, stroke and length of sample recovery shall be recorded. After the sampler is pushed to the required depth, the cylinder and piston system shall be drawn up together, preventing disturbance and changes in moisture content of the sample;

c) **Undisturbed sampling in cohesion less soils**

Undisturbed samples in cohesion less soils shall be obtained in accordance with IS 8763. Sampler operated by compressed air shall be used to sample cohesion less soils below ground water table.

1.5.4. **Ground Water**

1.5.4.1. One of the following methods shall be adopted for determining the elevation of ground water table in boreholes as per IS 6935 and the instructions of the Employer:

a) In permeable soils, the water level in the borehole shall be allowed to stabilize

after depressing it adequately by bailing before recording its level. Stability of sides and bottom of the boreholes shall be ensured at all times.

- b) For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observations on the rise or fall of water level shall be made at each depth. The level at which neither fall nor rise is observed shall be considered the water table elevation and confirmed by three successive readings of water level taken at two hours interval.

1.5.4.2. If any variation of the ground water level is observed in any specific boreholes, the water level in these boreholes shall be recorded during the course of the field investigation. Levels in nearby wells, streams, etc., if any, shall also be noted in parallel.

1.5.4.3. **Subsoil water samples**

- a) Subsoil water samples shall be collected for performing chemical analysis. Representative ground water samples shall be collected when first encountered in boreholes and before the addition of water to aid boring or drilling.
- b) Chemical analysis of water samples shall include determination of pH value, turbidity, sulphate, carbonate, nitrate and chloride contents, presence of organic matter and suspended solids. Chemical preservatives may be added to the sample for cases as specified in the test methods or in applicable Indian Standards. This shall only be done if analysis cannot be conducted within an hour of collection and shall have the prior written permission and approval of the Employer.

1.5.5. **Vane Shear Test. (required for boreholes where UDS is not possible) (Only at Marshy/Creek Locations)**

Field vane shear test shall be performed inside the borehole to determine the shear strength and bearing capacity of cohesive soils, especially of soft and sensitive clays, which are highly susceptible to sampling disturbance. Equipment, accessories, test procedures, field observations shall correspond to IS 4434. Tests may also be conducted by direct penetration from ground surface. If the cuttings at the test depth in the borehole show any presence of gravel, sand shells, decomposed wood, etc., which are likely to influence the test results substantially, the test at that particular depth may be omitted with the permission of the Employer. However, the test shall be conducted at a depth where these obstructions cease to occur. On completion of the test, the results shall be reported in an approved proforma as specified in IS 4434, Appendix-A.

1.6. **Field Investigation for Rock**

1.6.1. **Rock Drilling**

1.6.1.1. If, during the investigations, large hard fragments or natural rock beds are encountered, work shall proceed with core drilling methods. The equipment and procedures for this operation shall conform to IS 1892. The starting depth of drilling in rock shall be certified by the Employer. At the end of the investigation, the hole drilled in rock shall be backfilled with grout consisting of 1-part cement and 3-parts sand by weight.

- 1.6.1.2. Drilling shall be carried out with NX size tungsten carbide (TC) or diamond tipped drill bits, depending on the type of rock and according to IS 6926. Suitable type of drill bit (TC/Diamond) and core catchers shall be used to ensure continuous and good core recovery. Core barrels and core catchers shall be used for breaking off the core and retaining it when the rods are withdrawn. Double tube core barrels shall be used to ensure better core recovery and to retrieve cores from layers of bedrock. Water shall be circulated continuously in the hollow rods and the sludge conveying the rock cuttings to the surface shall be collected. A very high core recovery ratio shall be aimed at in order to obtain a satisfactory undisturbed sample. Attempt shall be made to recover cores of 1.5 m in length. Normally TC bit shall be used. Change over to a diamond bit shall require the specific written approval of the Employer, and his decision as to whether a TC or a diamond bit is to be used shall be final and binding on Contractor.
- 1.6.1.3. No drilling run shall exceed 1.5 m in depth. if the core recovery is less than 80% in any run, the length of the subsequent run shall be reduced to 0.75 m. During drilling operations observations on return water, rate of penetration etc. shall be made recorded and recorded as per IS 5313.
- a) The colour of return water at regular intervals, the depth at which any change of colour of return water is observed, the depth of occurrence and amount of flow of hot water, if encountered, shall be recorded.
 - b) The depth through which a uniform rate of penetration was maintained, the depth at which marked change in rate of penetration or sudden fail on drill rod occurs, the depth at which any blockage of drill bit causing core loss, if any, shall be recorded.
 - c) Any heavy vibration or torque noticed during the drilling should be recorded together with the depth of occurrence.
 - d) Special conditions like the depth at which grouting was done during, drilling, presence of artesian conditions, loss of drilling fluid, observations of gas discharge with return water, etc., shall also be observed and recorded.
 - e) All the observations and other details shall be recorded as per daily drill and reported in a proforma as given in IS 5313, Appendix-A.
- 1.6.2. **Core Sampling**
- 1.6.2.1. Core samples shall be extracted by the application of a continuous pressure at one end of the core with the barrel held horizontally without vibration. Friable cores shall be extracted from the barrel directly into a suitably sized half round plastic channel section. Care shall be taken to extrude the samples in the direction of coring to avoid stress reversal.
- 1.6.2.2. Immediately after withdrawal from the core barrel, the cores shall be placed in a tray and transferred to boxes specially prepared for this purpose. The boxes shall be made from seasoned timber or any other durable material and shall be indexed on top of the lid according to IS 4078. The cores shall be numbered serially and arranged in the boxes in a sequential order. The description of the core samples shall be recorded as instructed in IS 4464. Where no core is recovered, it shall be recorded as specified in the standard.

Continuous record of core recovery and rock quality designation (RD/DD/QD) are to be mentioned in the bore log in accordance with IS 11315 (Part-II).

1.7. Laboratory Testing

1.7.1. Essential Requirements

- a) Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, water and rock samples as per relevant IS codes. One copy of all laboratory test data records shall be submitted to Employer progressively every week. Laboratory tests shall be carried out concurrently with the field investigations as initial laboratory test results could be useful in planning the later stages of field work. A schedule of laboratory tests shall be established by Contractor to the satisfaction of the Employer within one week of completion of the first bore hole;
- b) Laboratory tests shall be conducted using approved apparatus complying with the requirements and specification of Indian Standards or other approved standards for this type of work. It shall be checked that the apparatus is in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely at an approved laboratory.
- c) All samples, whether undisturbed or disturbed shall be extracted, prepared and examined by competent personnel properly trained and experienced in soil sampling. examination, testing and in using the apparatus in conformance with the specified standards;
- d) Undisturbed soil samples retained in liners or seamless tube samplers shall be removed, without causing any disturbance to the samples, using suitably designed extruders just prior to actual testing. If the extruder is horizontal, proper support shall be provided to prevent the sample from breaking. For screw tube extruders, the pushing head shall be free from the screw shaft so that no torque is applied to the soil sample in contact with the pushing head. For soft clay samples, the sample tube shall be cut by means of a high-speed hacksaw to proper test length and placed over the mould before pushing the sample into it with a suitable piston;
- e) While extracting a sample from a liner or tube, care shall be taken to assure that its direction of movement is the same as that during sampling to avoid stress reversal;

1.7.2. Tests

- 1.7.2.1. The laboratory tests shall be carried out progressively during the field work after sufficient number of samples has reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.

1.7.2.2. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid down in the relevant I.S. Codes. The following laboratory tests shall be carried out : -

- a) Tests of undisturbed and disturbed samples
 - i) Visual and engineering classification;
 - ii) Sieve analysis and hydrometric analysis;
 - iii) Liquid, plastic and shrinkage limits;
 - iv) Specific gravity;
 - v) Chemical analysis;
 - vi) Swell pressure and free swell index determination;
- b) Tests of undisturbed samples:
 - i) Bulk density and moisture content;
 - ii) Relative density (for sand),
 - iii) Unconfined compression test;
 - iv) Box shear test (for sand);
 - v) Triaxial shear tests (depending on the type of soil and field conditions on undisturbed or remoulded samples):
 - Unconsolidated undrained;
 - Consolidated drained test;
 - vi) Consolidation
- c) Tests on rock samples
 - i) Rock quality designation (RQD), RMR.
 - ii) UCC test.
 - iii) Point load index test
- d) Vane Shear Test (For Marshy/Creek Locations)
- e) Chemical analysis of sub soil water.

1.8. Geotechnical Investigation Report

1.8.1. General

Contractor shall submit a formal report containing geological information of the region, procedures adopted for geotechnical investigation, field observations, summarised test

data, conclusions and recommendations. The report shall also include detailed bore logs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, supporting calculations for the conclusions drawn, etc. Initially, Contractor shall submit three copies of the report in draft form for Employer's review;

- a) Contractor's Geotechnical engineer shall visit Employer's Office for a detailed review based on Employer's comments in order to discuss the nature of modifications, if any, to be done in the draft report. Contractor shall incorporate in the report the agreed modifications and resubmit the revised draft report for approval. Two copies of the detailed final approved report shall be submitted to Employer together with one set of reproducible of the graphs, tables etc.
- b) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different types of structures.

1.8.2. Data to be furnished

1.8.2.1. The report shall also include the following

- a) A plot plant/ location plan showing the locations and reduced levels of all field test e.g. boreholes, etc., property drawn to scale and dimensioned with reference to the established grid lines;;
- b) A true cross section of all individual boreholes and test pits with reduced levels and co-ordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted, samples collected at different depths and the rock stratum, if encountered;
- c) Geological information of the area including geomorphology, geological structure, lithology, stratigraphy and tectonics, core recovery and rock quality designation (RD/DD/QD), etc.,
- d) Observations and data regarding change of course of rivers, velocity, scour depths, slit factor, etc., and history of flood details for mid-stream and river bank locations;
- e) Past observations and historical data, if available, for the area or for other areas with similar soil profile, or with similar structures in the surrounding areas;
- f) Plot of Standard Penetration Test (uncorrected and corrected N values) with depth for each test site;
- g) Results of all laboratory test summarised according to Table 1.0 (A) for each sample as well as (ii) for each layer, along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores,
- h) For all triaxial shear tests, stress vs. strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the

magnitude of the same shall be indicated. The value of modulus of elasticity (E) shall be furnished for all tests along with relevant calculations;

i) For all consolidation tests, the following curves shall be furnished

i) e vs. $\log p$;

ii) e vs. p;

iii) Compression vs $\log t$ or vs \sqrt{t}

depending upon the shape of the plot, for proper determination of coefficient of consolidation. The point showing the initial condition (e_0 , p_0) of the soil shall be marked on the curves;

j) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

B) SUMMARY OF BEARING CAPACITIES CONSIDERING MAXIMUM RISE OF WATERTABLE

Locationno.	Foundation Classification	Depth of footing considered for bearing capacity calculation	Size of footing considered for bearing capacity calculation	Bearing capacity	
				Based on settlement criteria (for 50mm total settlement)	Based on shear failure criteria
		3.0m	3.0m x 3.0m		
		3.0m	5.0m x 5.0m		
		3.0m	7.0m x 7.0m		
		3.0m	9.0m x 9.0m		
		3.0m	10.0m x 10.0m		
		3.5m	3.0m x 3.0m		
		3.5m	5.0m x 5.0m		
		3.5m	7.0m x 7.0m		
		3.5m	9.0m x 9.0m		
		3.5m	10.0m x 10.0m		

Note: Ultimate bearing Capacity at for Transmission line structures and Safe bearing capacity for substation structures by applying F.O.SDetailed calculations of all the bearing capacities should be enclosed with soil investigation reports.

(Signature)	(Signature)	(Signature)
Prepared by	Checked & Reviewed by	Checked & Approved by
Soil investigator	Survey Contractor	POWERGRID Site / RHQ Engg.

C) For Chemical Test

As per Specifications - Clause 1.8.4

1.8.3. Recommendations

1.8.3.1. Recommendations shall be provided for each tower location duly considering soil type and tower spotting data. The recommendations shall provide all design parameters and considerations required for proper selection, dimensioning and future performance of tower foundations and the following:-

- a) The subsurface material must provide safe bearing capacity and uplift resistance by incorporating appropriate safety factors thereby avoiding rupture under ultimate loads;
- b) Movement of the foundation, including short-term and long-term components under transient and permanent loading, shall be strictly controlled with regard to settlement, uplift, lateral translation and rotation:
- c) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.
- d) For shallow foundation for Transmission Line Structures, the following shall be indicated with comprehensive supporting calculations: -
 - i) Ultimate bearing capacity for isolated square footing of sizes 4.0, 5.0, 6.0, 7.0 & 10 m at three different founding depths of 2, 2.5 and 3 below ground level considering both shear failure and settlement criteria giving reasons for type of shear failure adopted in the calculation.
 - ii) Ultimate bearing capacity for raft foundations of widths greater than 5m at 2.0, 2.5 & 3.0 below ground level considering both shear failure and settlement criteria.
 - iii) Rate and magnitude of settlement expected of the structure.
 - iv) Net safe bearing capacity for foundation sizes mentioned in para(i) above,
- e) The stable slopes for shallow and deep excavations, active and passive earth pressure at rest and angle of repose for sandy soils shall be furnished.
- f) Depending on the subsurface material, water table level and tower type, either reinforced concrete isolated pad and chimney, cast-in-situ bored pile special foundations shall be recommended at a given location.
- g) Allowable Ultimate bearing pressure shall be provided for the various sizes of isolated square footings founded at various depths below ground level considering both shear failure and movement criteria; rate and magnitude of movement expected of the structure (settlement, uplift, rotation) shall also be given.

- h) Allowable Ultimate bearing pressure shall be provided for the various sizes of isolated square footings founded at various depths below ground level considering both shear failure and movement criteria; rate and magnitude of movement expected of the structure (settlement, uplift, rotation) shall also be given.
- i) In cases where normal open cast foundations appear to be impractical, special pile foundations shall be given due consideration along with the following:
 - i) Type of pile foundation and reasons for recommending the same duly considering the soil characteristics.
 - ii) Suitable founding strata for the pile.
 - iii) Estimated length of pile for 500, 750 and 1000 KN and 4500 KN capacities; end bearing and frictional resistance shall be indicated separately.
 - iv) Magnitude of negative skin friction or uplift forces due to soil swelling.
- j) Where the subsoil water and soil properties are found to be chemically aggressive. Recommendation for protective coating to be applied on the foundations; susceptibility of soil to termite action and remedial measures for the same to be furnished.
- k) Suitability of locally available soils at site for filling, backfilling and adequate compaction shall be investigated.
- l) If expansive soil such as black cotton soil is encountered recommendation of removal or retainment of the same shall be given, in the latter case, detailed specifications of special requirements shall also be given.
- m) Susceptibility of subsoil strata to liquefaction in the event of earthquake and remedial measures, if required, shall be considered.
- n) Any other information of special significance such as dewatering schemes, etc. which may have a bearing on the design and construction shall be provided.
- o) Recommendations for additional soil investigations, beyond the scope of the present work, shall be given if Contractor considers such investigations necessary.
- p) In case of low bearing capacity locations where normal foundation may be adopted with soil strengthening, contractor shall suggest remedial

measure for soil improvement such as Stone blanket, Stone Columns, etc. along with placement arrangement.

1.8.4. **Hydrogeological Conditions**

1.8.4.1. The maximum elevation of ground water table, amplitudes of its fluctuations and data on water aggressivity with regard to foundation structure materials shall be reported. While preparing ground water characteristics the following parameters should be specified for each aquifer:

- a) bicarbonate alkalinity mg-eq/(deg)
- b) pH value
- c) content of aggressive carbon dioxide, mg/l;
- d) content of magnesia salts. mg/l, recalculated in terms of ions Mg^{+2} ;
- e) content of ammonia salts, mg/l, recalculated in terms of ions NH_4^+
- f) content of caustic alkalis, mg/l, recalculated in terms of ions Na^+ and K^+
- g) contents of chlorides,mg/l recalculated in terms of ions Cl^-
- h) contents of sulphates, mg/l, recalculated in terms of ions SO_4^{2-}
- i) aggregate content of chlorides, sulphates, nitrates, carbonates and other salts, mg/l

1.9. **Rates and Measurements**

1.9.1. **Rates**

The contractor's quoted rates shall be inclusive of making observations, establishing the ground level and co-ordinates at the location of each borehole, test pit etc. No extra payments shall be made for conducting Standard Penetration Test, collecting, packing, transporting of all samples and cores, recording and submittal of results on approved formats.

1.10. **Specific Requirements for Geotechnical Investigation at River Crossings**

1.10.1. The entire soil investigation work at river crossing locations (if required) shall be carried out in accordance with the relevant parts of the specifications for geotechnical investigation modified to the extent given below.

1.10.2. **Requirements**

1.10.2.1. Boreholes shall be executed to specified depth (refer clause 1.5.1.1 (b). If refusal strata is reached (i.e. SPT-N value is greater than 100 continuously for 5m depth) with characteristics of rock the borehole may be terminated at shallower depth i.e. at 5m in refusal strata, with prior approval of the Employer.

1.10.2.2. Laboratory testing shall be conducted on all soil samples to determine grain size

distribution, liquid limit and plastic limit of the different soil strata encountered.

1.10.2.3. Geotechnical Report must furnish the following:

- a) Geotechnical investigation scheme;
- b) Bore-logs indicating soil stratification, with IS classification, sampling details and
- c) SPT 'N' values;
- d) boreholes indicating soil stratification based on field and laboratory tests;
- e) Grain size distribution curves;
- f) IS classification of soils;
- g) Shear tests (UU), to be done on saturated soil samples;
- h) Bearing capacity of soil at different levels;
- i) Highest flood level (HFL);
- j) Maximum discharge, velocity etc. (from authenticated source such as CWC or appropriate State authorities);
- k) Recommendations regarding type of foundation to be adopted at the location
- l) A check list for reporting results of river crossing locational details, detailed soil investigation and river values for river crossing locations is enclosed at **Annexure-C.**

1.11. Special Terms and conditions for Geotechnical Investigation in the River bed

- 1.11.1. Contractor is required to mobilise a suitable arrangement (floating pontoon, plant, equipment etc.) to carry out geotechnical investigation work in creek/ river locations identified by the Employer.
- 1.11.2. In the event of storm or stoppage of work, etc., Contractor shall not be paid extra for mobilization/ remobilisation of floating pontoon, plant, equipment, etc.
- 1.11.3. Contractor shall fully satisfy himself about the conditions of creek/ river (depth of water, wave currents, wind conditions, etc.) prevailing in the area of proposed investigation and plan the necessary tools and plant to be deployed before quoting. Any claim resulting from lack of data collection in this respect shall not be entertained.
- 1.11.4. Contractor shall make his own arrangements for locating the coordinates and position of boreholes in creek/ river with respect to two grid-lines indicated by Employer.
- 1.11.5. Boring in creek or river shall be payable only below the bed level and no payment

shall be made for lowering the casing in water.

- 1.11.6. Contractor shall arrange for necessary transportation on water (e.g. motor boat) to facilitate the supervision of work by officials of Employer at its own cost.
- 1.11.7. Full details of the construction plant, proposed working method for boring and sampling in water shall be submitted along with the Tender.
- 1.11.8. The unit rate quoted for underwater boring shall include complete work required as per specification and no separate payment shall be made on any account.

2. Statutory Regulations and Standards

- 2.1. Contractor is required to follow statutory regulations stipulated in Electricity Act 2003, Indian Electricity Rules and other local rules & regulations.
- 2.2. The codes and standards referred to in these specifications shall govern. In case of a conflict between such codes/ standards and these specifications, the provisions of the specifications shall prevail. Such codes, standards referred to shall mean latest revisions, amendments, changes adopted and published by relevant agencies.
- 2.3. Other Internationally acceptable standards which ensure equivalent or better performance than those specified shall also be acceptable.

INPUT BOQ FORMAT FOR TRANSMISSION LINE

Annex-A (1/2)

Name of line :

Voltage -

Sl. No.	Description	Unit	Quantity
1	Line length	KM	
	a) Plain Terrain	KM	
	b) Hilly Terrain		
	i.) Hilly Terrain	KM	
	ii.) Mountainous Terrain	KM	
2	GPS coordinates		
	a) Start point		
	b) End point		
3	Bee Line	KM	
4	Detail of wind zone (lengthwise)		
	a) Wind Zone -....	KM	
5	States		
	a)	KM	
	b)	KM	
6	Length of RC section	KM	
7a	No of Circuits	No.	
7b	No. of bundle Conductor	No.	
8	Earthing		
	a) Pipe type		
	i) Normal Earthing	No.	
	ii) Chemical Earthing	No.	
	b) Counterpoise Type	No.	
	i) Normal Earthing 120m length	No.	
	ii) Normal Earthing 280m length	No.	
	iii) Chemical Earthing 120m length	No.	
	iv) Chemical Earthing 280m length	No.	
	c) Shieldwire Earthing	No.	
	i) PipeType Earthing	Set	
	ii) Counterpoise type Earthing	Set	
	d) Rod type (Qty same as pipe type earthing)	No.	
	e) Earthing for RC Location	No.	
9	Survey		
	a) Detailed survey	KM	
	b) Check Survey	KM	
10	Soil Investigation		
	a) All kind of soil except FR & HR	Loc.	
	b) Fissured rock	Loc.	
	c) Rocky Soil	Loc.	
	d) River Crossing Location	Loc.	
26	Bird Divertor	Nos	
11	No. of Locations in Undulated Terrain	No.	
12	Benching		
	a) All kind of soil except FR & HR	m3	
	b) Fissured rock	m3	
	c) Hard rock	m3	
13	Tower Protection		
	a) Random rubble	m3	
	b) Stone Bound	m3	
	c) Back Filling	m3	
	d) M-15 Cover seal	m3	

Sl. No.	Description	Unit	Quantity
14a)	Airport		
	a) Name of Civil Airport & Proximity to line	kms	
	b) Name of Defense Airport & Proximity to line	kms	
	c) Air to Ground Firing Ranges & Proximity to Line	kms	
14b)	Aviation Requirements		
	a) Painting of towers	No.	
	b) Unit wt of Towers to be painted	MT	
	c) Span marks	No.	
	d) Aviation Lights		
	i) 1 Medium+2 low intensity	No.	
	ii) 1 Medium+ 4 low intensity	No.	
15	No. of Transposition towers	No.	
16	River Crossings		
	a) Name of river		
	b) Crossing span (Bank-Bank)	M	
	c) Type of foundation for river crossing tower pile or open		
17	Crossing Details		
	a) Road Crossings (NH/SH)	No.	
	b) Power Line Crossings (132kV & above)	No.	
	c) Railway Crossing-electrified	No.	
	d) Railway Crossing-non- electrified	No.	
	e) Natural Gas/Petroleum Pipe Line	No.	
18	Forest Details:		
	a) Wild Life Sanctuary / National Park/ BioSphere Reserve		
	b) Reserved Forest	kms	
	c) Protected Forest	kms	
	d) Social/Revenue Forest	kms	
	e) Strip Plantation Forest	kms	
	f) Other Area (Specify)	kms	
19	Coastal Regulator Zone/Mangrove Area	M	
20	Special / Protected Areas:		
	a) Fifth Schedule Area	kms	
	b) Any type of Forest wherein Primitive Tribal Group & Pre Agricultural Committees also involved	kms	
	c) Ecologically Sensitive Area (ESA)	kms	
21	Power Line Crossings		
	a) 765 KV	No.	
	b) 400 KV	No.	
	c) 220 KV	No.	
	d) 132 KV	No.	
	e) 800 KV HVDC	No.	
	f) 500 KV HVDC	No.	
	g) No. of Underneath Crossings	No.	
22	Stringing of power line crossing under Live line condition	No.	
23	Line stretch in costal/creeks/backwaters etc	Kms	
24	Mining Areas	Kms	
25	Other Important details		
26	Bird Divertor	Nos	

Tower Type	Unit	Quantity	Foundation classification													Pile for Mid Stream locations	Pile other than Mid Stream	Stone column
			Dry	Wet	Wet cultivated	PS	FS	WBC	DFR	WFR	SFR	HR	Sandy					
A/DA/QA Type tower	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Normal Tower	Nos	0																
A+3M Extn	Nos	0																
A+6M Extn	Nos	0																
A+9M Extn	Nos	0																
B/B/QB Type tower	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
B1 Normal Tower	Nos	0																
B1+3M Extn	Nos	0																
B1+6M Extn	Nos	0																
B1+9M Extn	Nos.	0																
B1+18M Extn	Nos.	0																
B1+25M Extn																		
B2 Normal Tower	Nos	0																
B2+3M Extn	Nos	0																
B2+6M Extn	Nos	0																
B2+9M Extn	Nos.	0																
B2+18M Extn	Nos.	0																
B2+25M Extn																		
C/DC/QC Type tower	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
C1 Normal Tower	Nos	0																
C1+3M Extn	Nos	0																
C1+6M Extn	Nos	0																
C1+9M Extn	Nos	0																
C1+18M Extn	Nos	0																
C1+25M Extn																		
C2 Normal Tower	Nos	0																
C2+3M Extn	Nos	0																
C2+6M Extn	Nos	0																
C2+9M Extn	Nos	0																
C2+18M Extn	Nos	0																
C2+25M Extn																		
D/DD/QD Type tower	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
D1 Normal Tower	Nos	0																
D1+3M Extn	Nos	0																
D1+6M Extn	Nos	0																
D1+9M Extn	Nos	0																
D1+18M Extn	Nos	0																
D1+25M Extn	Nos	0																
D1+30M Extn	Nos	0																
D1+35M Extn	Nos	0																
D2 Normal Tower	Nos	0																
D2+3M Extn	Nos	0																
D2+6M Extn	Nos	0																
D2+9M Extn	Nos	0																
D2+18M Extn	Nos	0																
D2+25M Extn	Nos	0																
D2+30M Extn	Nos	0																
DD2+35M Extn	Nos	0																
Special +25	Nos	0																
DDH	Nos	0																
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

SUMMARY	D/C	M/C	TOTAL
Total suspension Towers	0		0
Total Tower Type 'D/DD/QD'	0		0
Total Tension Towers	0		0
total Normal Towers	0		0
Total Anchor Towers	0		0
Total RC Towers	0		0
Total Towers	0		0

Package.....									
Tower Type\Extn	+0	+3	+6	+9	+18	+25	+30	+35	Total
A									0
B1									0
B2									0
C1									0
C2									0
D1									0
D2									0
Special									0
DE									0
Total	0	0	0	0	0	0	0	0	0

Note:

- 1 Above BoQ to be prepared separately for Line length covered in Specific Package and Wind Zone.
- 2 In case of involvement of Coastal / Cyclonic prone area, Separate BoQ shall be prepared for such area
- 3 If in case Transmission line traverse through multiple altitude mostly in hilly area, BoQ shall be prepared for each range of Altitude based on the design consideration
- 4 Basis of Foundation classifications such as existing lines traverse through similar area/terrain, Soil Investigation etc. to be mentioned
- 5 Line line stringing quantities may be provided based on existing lines connected through Generating Stations,
- 6 Bird Diverter quantities may be considered for lines passing through Designated Forest Stretch.
- 7 Aviation Aids shall be provided as per IS-5613/Mandate of AAI / Defence etc.
- 8 Transposition Tower shall suitably be considered for Transmission Lines with Length more than 100km
- 9 Suitable quantities for Tower footing protection works may be considered for locations spotted in undulated terrain along with the basis of estimation
- 10 For transmission line sections passing within a distance of 50 km from the boundary of two wind zones, higher of the two wind zones shall be considered.
- 11 Areas of Transmission line passes through cyclonic prone area (within 60km from Coast)/Creek Region/Aggressive soil) shall be considered under Coastal Area.
- 12 Raised chimney foundation is to be provided in areas prone to flooding/water stagnation like paddy field /agricultural field and undulated areas to avoid direct contact of water with steel part of tower
- 13 Quantities of Sheild wire / Additional earthing shall be provided on every 7 to 8 kms distance for direct earthing of both shield wires
- 14 Quantity for Soil Investigation shall be finalised after considering the locations where Soil Investigation carried out during Pre-Bid Stage

FORMAT FOR REPORTING RESULTS OF SURVEY OF RIVER CROSSING STRETCH OF TRANSMISSION LINE

Inputs:

River crossing profile, ground profile, GL, HFL, Tower type, Reference bench mark details:

- Base width
- Slope
- Loads
- Stub sections/ Leg sections

Soil Report (up to 40m./50m. depth)

- N Value
- Cohesion © and friction angle (Ø) -Dry Density & Submerged density of soil - Soil composition including bore log data.
- Soil Strata distribution details depth wise
- R.L of ground (Soil investigation and foundation location)
- Mean grain size
- Silt factor calculations
- Scour depth calculations
- Special Recommendations, if any.
- River crossing profile showing the position of R.C towers and Anchor towers with span details.
- Any other details like bunds, roads, bridges etc. with their R.L.S.

River Values

- Max. discharge
- Max. velocity (Vmax.)
- HFL
- Clear water way
- River Meandering history.
- Navigable/ Non Navigable
- Location reference of above River values for crossing details.
- River bed level. (RL)

General Description of the Tower

Sl No	Type of Tower	Deviation Limit	Typical Use
1	A/DA/QA*	0 – 2 deg.	To be used as Tangent tower.
2	B1/DB1/QB1*	0 deg.	To be used as Section Tower.
		0 - 7 deg.	a) Angle towers with tension Insulator string.
			b) Also to be used for uplift force resulting from an uplift span up to 200m under broken wire conditions.
c) Also to be used for Anti Cascading Condition.			
3	B2/DB2/QB2*	0 deg.	To be used as Section Tower.
		7 - 15 deg.	a) Angle towers with tension Insulator string.
			b) Also to be used for uplift force resulting from an uplift span up to 200m under broken wire conditions.
c) Also to be used for Anti Cascading Condition.			
4	C1/DC1/QC1*	0 deg.	To be used as Section Tower.
		15 - 22deg.	a) Angle tower with tension insulator string.
			b) Also to be used for uplift forces resulting from an uplift span up to 200m under broken wire condition.
c) Also to be used for anti-cascading condition.			
5	C2/DC2/QC2*	0 deg.	To be used as Section Tower.
		22-30 deg.	a) Angle tower with tension insulator string.
			b) Also to be used for uplift forces resulting from an uplift span up to 200m under broken wire condition.
c) Also to be used for anti-cascading condition.			
6	D45/DD45/ QD45*	30 - 45 deg.	a) Angle tower with tension insulator string.
			b) Also to be used for uplift forces resulting from an uplift span up to 300m under broken wire condition.
7	D60/DD60/ QD60*	45 - 60 deg.	a) Angle tower with tension insulator string.
			b) Also to be used for uplift forces resulting from an uplift span up to 300m under broken wire condition.
			Dead end with 0 deg to 15 deg deviation both on line side and sub-station side (slack span)

		0 deg.	a) Complete Dead end
			b) For river crossing anchoring with longer wind span

Transposition tower for Lines

Transposition is to be done generally for all transmission lines whose length is greater than 100 km.

**Two numbers of transposition towers have been envisaged in the double circuit transmission line and **three number of transposition towers have been envisaged in the single circuit transmission line having horizontal configuration of towers.

General Description of Foundation Classification

1.0 Type of Foundations

The foundation shall generally be of open cast type. Plain Cement Concrete/ Reinforced Cement Concrete footing shall be used for all type of normal towers. All the four footings of the tower and their extensions shall be similar for a particular location, except where soil condition and or water table are different at different legs. The total depth of foundation, below ground level shall be upto 3.5 meters. For Hard Rock type and also where specific site conditions/ properties demand foundation of different depths (lower or higher), the same shall be adopted.

Further, for multi-circuit tower foundations, the foundation depth shall be 3.5 meters and for river crossing open cast foundations, the foundation depth shall be more than 3.5 meters.

2.0 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 (except pile foundations which is described in relevant section of this specification).

2.1 Normal Dry

To be used for locations where normal dry cohesive or non-cohesive soils are met. Foundations in areas where surface water encountered from rain runoff shall also be classified as normal dry.

2.2 Sandy Dry Soil

To be used for locations where cohesion less pure sand or sand with clay content less than 10% met in dry condition. If the clay content is more than 10% met in dry condition, the foundation shall be classified as Normal Dry.

2.3 Wet

To be used for locations where sub-soil water table is met between 1.5 meters from ground level and the depth of foundation below the ground level.

2.4 Wet Cultivated

To be used for locations where there is no sub-soil water within the foundation depth but which are in surface water for long period with water penetration not exceeding one meter below the ground level e.g. paddy fields/ cultivated field. However, if water penetration due to surface water is more than one meter below ground level, the adoption of suitable foundation shall be decided by site-in-charge in consultation with Corporate engineering Department

2.5 Partially Submerged

To be used at locations where sub-soil water table is met between 0.75 meter and 1.5 meter below the ground level.

2.6 **Fully Submerged**

To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.

2.7 **Black Cotton Soil**

To be used at locations where soil is clay type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is considered submerged in nature.

2.8 **Fissured Rock**

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.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. Where fissured rock is encountered with subsoil water table less than 1.5 meter below ground level, submerged fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

2.9 **Hard Rock**

The locations where chiseling, drilling and blasting is required for excavation for monolithic rock for a particular leg/ tower, Hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.

2.10 The sub-soil water table is not constant and its level changes during different seasons due to various factors. In case during soil investigation/ trial pit or during excavation, if wet soil/ fissures rock is encountered within the foundation depth, it is to be considered that water table has been encountered (considering that water table had reached that level sometime in past) and accordingly type of foundation shall be classified.

2.11 Where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the foundation pit.

2.12 The foundation classification at any particular location shall be based on the type of soil (clay/ sandy/ silt/ fissured rock etc.) and water table, presence of surface water, etc. at the location. However, in case of locations which are in vicinity of rivers, depending upon case to case, type of foundation is to be decided considering other aspects also e.g. in case RL (reduced level) of a location in comparison to the HFL is lower and there is possibility of submergence at the time of floods due to absence of river bunds/ protection etc., FS type foundation with suitable raised chimney is to be adopted. Further in case there is a possibility of change in river course, considering the nature and turbulence of probable water flow and subsequent scouring of soil, pile type or special foundation may be considered for these locations.

GENERAL FEATURE CODE LIST

Row	Feature Code	Feature Description
1	100	Angle Point
2	101	Ground Level
3	200	Hut
4	201	Government Building
5	202	Pump House
6	203	Building
7	204	Residential Area
8	205	Industry
9	206	Village
10	207	School
11	208	Industry Area
12	209	Temple
13	210	Masjid / Mosque
14	211	Church
15	212	Graveyard
16	213	GSM Towers
17	214	Wind Mill
66	263	Solar Park
18	215	Water Tank
19	300	Railway boundry
20	301	Railway Track
21	302	LT Line
22	303	11kV OH Line
23	304	33kV OH Line
24	305	66kV OH Line
25	306	132kV OH Line
26	307	220kV OH Line
27	308	400kV OH Line
28	309	500kV OH HVDC Line
29	310	765kV OH Line
30	311	800kV OH HVDC Line
31	312	1200kV OH Line
32	313	U/G Cable
33	314	Telephone Line / Pole
34	315	Transformer
35	316	Water Pipe Line
36	317	Gas Pipe Line
37	318	Oil Pipe Line
38	319	Other Pipe Lines
39	320	Water Course

40	321	Nala
41	322	Canal
42	323	River
43	324	Lake
44	325	Drain/Ditch
45	326	Pond
46	327	Bund
47	328	Open Well
48	329	Bore Well
49	330	Tar Road
50	331	Walkway
51	332	Unmetalled Road
52	333	Metalled Road
53	334	State Highway
54	335	National Highway
55	336	Concrete Road
56	400	Garden
57	401	Orchard
58	402	Field/Farm
59	403	Forest
60	404	Plantation
61	500	Light Pole
62	501	Rocky
63	502	Fence
64	503	Bridge
65	504	Culvert
67	505	Spotting Prohibited Zones

Documents related to Submission of forest proposal

1. **Division/ District/ Village and Component Wise** (Tower Foundation, Stringing RoW and Remaining RoW) Forest and Non-forest Area involved in the project.
2. **Map** showing line route and required forest land for diversion, boundary of adjoining forest in the **Survey of India colour topo sheet of 1:50,000 scale**.
3. **DGPS Maps in shape file** of forest land proposed for diversion.
4. **Segment wise kml files** showing the line route and forest area patches.
5. **Coloured map showing 3 alternative route study** and reasons for **rejection** of the other **2 routes/ Justification** for locating the project in forest area.
6. **Employment** likely to be generated.
7. **Cost benefit Analysis**, if applicable. (>5 ha in hilly areas & >20 ha in plain areas)
8. **Area calculation statement** showing details of forest area involved, non-forest area involved and item wise breakup/ village wise details of forest area proposed for diversion.
9. **Details of total no of trees enumerated in the forest area and number of trees proposed for felling**. This should be species wise and girth wise and summary of both list is to be submitted.
10. **Details of towers** located on forest and non-forest area with Coordinates.
11. Documents related to **notification of forest area**.
- ~~12. **Land Scheduling details with Khasra maps and Jamabandi details.**~~
13. 10 Km radius map showing National Park, Wildlife Sanctuary etc (Jharkhand).