

SECTION-III

SURVEY & SOIL INVESTIGATION

TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

SECTION- III

SURVEY & SOIL INVESTIGATION

1. General Information & Scope Of Work

- 1.1 The technical specifications cover detailed survey including route alignment, profiling, tower spotting, optimization of locations, check survey, contouring, and soil investigation for the transmission lines/ part of the transmission lines covered under this specification as included in the BPS.
- 1.1.1 The scope of work inter-alia shall include the following: -
- a) Detailed Survey using Total Work stations or alternatively using ALTM (Airborne Laser Terrain Modeling) techniques, inter-alia including:
 - i) Digitised profiling along the selected route along with plan details.
 - ii) Computer aided tower spotting & optimization
 - iii) Soil resistivity measurement along the route
 - b) Check survey including digitised contouring at undulated / hilly tower locations.
 - c) Soil Investigation
 - d) Preparation of Survey reports including estimation of Bill of Quantities, identification and explanation of route constraints (like Forest, Animal/ Bird sanctuary, reserve coal belt areas, oil pipe line/ underground inflammable pipe lines etc.), infrastructure details available en-route etc.
 - e) Collection of data/ details of ownership of land within the line corridor & tower base.
- 1.2 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 check survey (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 to be executed shall be decided by Site Engineer-in-charge during execution stage and the final quantities shall be as approved by Site Engineer-in-charge. The route alignment, detailed survey, including profiling & tower spotting, contouring, soil investigation, check survey 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.
- 1.3 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.

1.4 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.

1.5 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.

1.6 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.

2. Route Alignment

2.1 The route Alignment shall be carried out by the contractor using Survey of India topographical maps.

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 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 shall be designed for Multi Circuit (4 circuits) configuration of same voltage level considering reliability level of at least two (2). The top two circuits of these multi-circuit towers shall be used for stringing of the transmission line under present scope and the bottom two circuits shall be made available for stringing of any future transmission line of any transmission service providers/ State transmission utilities/Central transmission utilities passing through the same protected area. Further, the configuration and coordinates of such transmission towers shall be submitted to CEA, CTU & BPC (In case of TBCB Projects) by POWERGRID.

- 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 minimum.
- 2.2.6 The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.
- 2.2.7 Marshy and low-lying areas, river beds 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 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.
- 2.2.11 Areas subjected to flooding such as nalah shall be avoided.
- 2.2.12 Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches.
- 2.2.13 All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.
- 2.2.14 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.
- 2.2.15 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.
- 2.2.16 The line routing should avoid large habitations, densely populated areas, Forest, Animal/Bird sanctuary, reserve coal belt areas, oil pipe line/underground inflammable pipe lines etc. to the extent possible.
- 2.2.17 The areas requiring special foundations and those prone to flooding should be avoided.
- 2.3 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.
- 2.4 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.

- 2.5 Final route alignment drawing with latest topographical and other details/features including all rivers, railway lines, canals, roads etc. up to 8 km 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.
- 2.6 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 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 Soil resistivity, along the route alignment shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 meters. For calculating soil resistivity formula $2\pi a$ (Where $a=50$ m and r = megger reading in ohms) shall be adopted. Measurement shall be made at every 2 to 3 km along the length of the route. In case soil characteristics changes within 2 to 3 km, values shall have to be measured at intermediate locations also. Megger reading and soil characteristics should also be indicated in the soil resistivity results.

3.3 Route Marking

- 3.3.1 The route of the transmission line shall be recorded using GPS/ DGPS of positional accuracy less than 3m.
- 3.3.2 The co-ordinates of all the angle points as well as other important crossings, landmarks etc. shall be recorded using GPS for easy relocating.
- 3.3.3 At the starting point of the commencement of route survey a suitable peg/spike shall be driven firmly into the ground to indicate location of the survey instrument. The co-ordinates of the location of the survey instrument shall also be recorded. Further, the co-ordinates at prominent position at intervals of not more than 750 meters along the transmission line to be surveyed up to the next angle point shall also be recorded. Wooden peg of 50x50x650mm size shall also be driven at prominent position at intervals of not more than 750 meters along the transmission line to be surveyed up to the next angle point. Wire nails of 50 mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100 mm only above ground level. Wherever the line alignment crosses the EHT line, Railway line, P&T line or roads, the contractor shall record co-ordinates on the points of crossing. Wherever line route alignment passes over permanent land marks such as rock, boulders, culverts etc. suitable white paint marks with directional and POWERGRID

markings shall be made and co-ordinates recorded.

3.4 Profiling

- 3.4.1 The complete profiling along the route shall be carried out using modern surveying equipment viz. total stations. 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.
- 3.4.2 The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided tower spotting software.
- 3.4.3 A printed/ plotted output of the digitized profiling shall be submitted by the contractor to Employer's site-in-charge for review before taking up computer-aided tower spotting.
- 3.4.4 For reconductoring packages, the Contractor shall then plot the profile of the HTLS Conductor under hot and cold conditions using the above ground profile & existing tower details, verify the various statutory electrical clearances & span limitations on the profile using sag tension calculations of the HTLS Conductor.
- 3.4.5 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:
- (i) Wind and weight spans (under maximum and minimum temperature of conductor and no wind condition i.e. hot and cold condition)
 - (ii) Clearances from ground, power lines, highways, communication lines, rivers etc with conductor curves under hot and cold condition)
 - (iii) Clearances from earth wire & OPGW with top conductor at midspan for maximum and minimum temperature combination of earth wire & OPGW and top conductor.

3.5 Optimisation of Tower Location/ Tower Spotting

- 3.5.1 Optimisation of tower locations including profiling shall be done by the contractor using computer-aided tower spotting software - PLSCADD and shall furnish sample calculations and manual tower spotting drawings for some typical sections.
- 3.5.2 The sag-tension characteristics of the conductor as well as tower spotting data shall be furnished by the Employer to the contractor during execution stage. Sag template curves, if any required for tower spotting, shall be prepared by the contractor and two sets of sag-template curves shall be given to POWERGRID for checking of profile.
- 3.5.3 General description of towers is indicated in **Section-I** of this specification for

information of the Bidders.

3.5.4 **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 designs. 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, but the ground clearance at roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than specified minimum ground clearances.. 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.

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 D/DD/QD 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) Minimum ground clearance between crossing conductor under condition of maximum sag and railway line shall maximum of following:

(I) Vertical Clearance for OHE (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
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
5	Above 500 kV & upto 800 kV	21.86 m

(II) Vertical Clearance for high rise OHE:

Sl. No.	Transmission line voltage level	Minimum clearances from Rail Level
		New Power Line Crossing or Crossing Planned for Alteration
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
5	Above 500 kV & upto 800 kV	23.86 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

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
4	Above 400 kV & upto 500 kV	7.94 m
5	Above 500 kV & upto 800 kV	7.94 m

f) River Crossings

In case of major river crossing, river crossing towers shall be of suspension type alongwith 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 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).

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.

In case of crossing with B/C/DB/DC/QB/QC towers proper guying shall be provided to facilitate stringing of the power line crossing sections separately on obtaining line shutdowns.

Clearance between lines crossing each other shall be kept in accordance with the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2010 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	110-132 kV	220 kV	400 kV	765 kV	500 kV HVDC	800 kV HVDC	1200 kV
1	110-132KV	3.05	4.58	5.49	7.94	6.86	9.04	10.44
2	220KV	4.58	4.58	5.49	7.94	6.86	9.04	10.44
3	400KV	5.49	5.49	5.49	7.94	6.86	9.04	10.44
4	765KV	7.94	7.94	7.94	7.94	7.94	9.04	10.44
5	500KV HVDC	6.86	6.86	6.86	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.

When the angle of crossing has to be below 60 degree, the matter will be referred to the authority in charge of the telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Employer.

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

Wherever transmission line crosses an oil/ gas pipeline, the angle of crossing shall be as near to 90 degree possible and in no case less than 75 degrees. Further, a minimum separation of 25 m should be maintained between pipe line and transmission line footings & pipe/ counterpoise earthing.

j) Details En-route

All topographical details, permanent features, such as trees, building etc. within following distance on either side of the alignment shall be detailed on the profile plan: -

1	1200 kV Single Circuit	44.5 m
2	765 kV Double Circuit	33.5 m
3	765kV Single Circuit Delta	32 m
4	765kV Single Circuit Horizontal	37m
5	± 800 kV HVDC	34.5 m
6	400kV Single Circuit	26.0 m
7	400kV Double Circuit	23.0 m
8	± 500 kV HVDC	26.0 m
9	220 kV	16m
10	132 kV	12.5 m

3.6 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).

3.6.1 The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut by the Employer at the time of actual execution of the work as detailed below. Contractor may please note that Employer shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.

3.6.2 To evaluate and tabulate the trees and bushes coming within following distance on either side of the central line alignment the trees will be numbered and marked with quality paint serially from angle point 1 (I) onwards and the corresponding number will be painted on the stem of trees at a height of 1 meter from ground level.

1	1200 kV Single Circuit	44.5 m
2	765 kV Double Circuit	33.5 m
3	765kV Single Circuit Delta	32 m
4	765kV Single Circuit Horizontal	37m
5	± 800 kV HVDC	34.5 m

6	400kV Single Circuit	26.0 m
7	400kV Double Circuit	23.0 m
8	±500 kV HVDC	26.0 m
9	220 kV	16m
10	132 kV	12.5 m

The trees list should contain the following:

- Girth (circumstances) measured at a height of 1 meter from ground level.
- Approximate height of the tree with an accuracy of +2 meters.
- Name of the type of the species/ tree.
- The bushy and under growth encountered within following distance should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement: -

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	74 m
5	±800 kV HVDC	69m
6	400kV Single Circuit	52 m
7	400kV Double Circuit	46 m
8	±500 kV HVDC	52 m
9	220 kV	32m
10	132 kV	25m

3.6.3 The contractor shall also intimate the Employer, his assessment about the likely amount of tree & crop compensation etc. required to be paid by the Employer during execution stage. This assessment shall be done considering prevailing practices/guidelines, local regulations and other enquiries from local authorities.

3.6.3.1 The contractor shall also collect data/ details of ownership of land within the line corridor and tower base from the concerned revenue/ local authorities and submit

the same to owner as per format enclosed with this technical specification at Annexure-E.

3.6.4 The Contractor shall also identify the forest/ non-forest areas involved duly authenticated by concerned authorities.

- a) A statement of forest areas with survey/ compartment Number (all type of forest RF/ PF / Acquired forest/ Revenue forest/ Private forest/ Forest as per dictionary meaning of forest etc.)
- b) A statement of non-forest areas with survey/ compartment nos.
- c) Tree cutting details (Girth wise & specie wise)
- d) Marking of forest areas with category on topo sheets 1:2,50,000 showing complete line route, boundaries of various forest divisions and their areas involved.
- e) Village forest maps of affected line and affected forest area and marking of the same.
- f) Forest division map showing line and affected forest area.

3.6.5 The Contractor shall finalize the forest clearance proposal on the prescribed format, as per requirements of the state/ MOE & F, duly completed in all respects for submission by the Employer to the Forest Department.

3.7 Preliminary 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.

3.8 Check Survey of Tower Locations

3.8.1 The check survey shall be conducted to locate tower locations on ground conforming to the approved profile and tower schedule.

3.8.2 The co-ordinates of all the tower locations shall also be recorded using GPS / DGPS of positional accuracy less than 3m for easy relocating. The position of all tower locations shall be marked in the final digitized route alignment drawing with relative distances from any permanent bench mark area.

3.8.3 The contractor shall also collect required data at each tower location in respect of soil strata, ground water level, history of water table in adjacent areas/surface water, distance from permanent bench mark (these details to be furnished in a tabulated form) and classify the suitable type of foundation at each tower location based on the data collected at each location and detailed soil investigations carried out at selected locations etc.

3.9 Contouring at hilly/ undulated locations